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Floods on the Kenai Peninsula, Alaska, October and November 2002

Introduction

Record-setting precipitation and unusually warm temperatures produced widespread flooding in south-central Alaska in the fall of 2002. The unusual weather patterns persisted in the region for more than two months. On the Kenai Peninsula, heaviest rainfall and most severe flooding occurred October 22-24, and November 23, 2002. Flooding was most severe on the western part of the peninsula, especially between Ninilchik and Homer (fig. 1). Floods on eight streams exceeded previous record peak streamflows and many others reached near-record streamflows. The flooding destroyed critical portions of the limited road system, isolated communities, damaged private property, and damaged spawning and riparian habitat. This report summarizes (1) precipitation data collected at National Weather Service and U.S. Geological Survey (USGS) sites, (2) peak gage-height and peak streamflow at active and discontinued USGS streamflow gaging stations, and (3) shows the effect of these flood data on the statistical computation of the 100-year flood. Site locations are shown in figure 1.

Flood Damage

Repair costs for damaged State roads exceeded 10 million dollars. The Sterling Highway, which is the only road access to the western Kenai Peninsula, was severely damaged at several locations during the October flood. Bridge approaches washed out at Deep Creek and Anchor River. The Ninilchik River bridge approach washed out, closing the only road into Ninilchik Village. Nikolaevsk Village also was isolated because of bridge failure on the North Fork Anchor River. East End Road, servicing communities east of Homer, was damaged at several locations. Many private bridges crossing Anchor River, Fritz Creek, and numerous other creeks also were destroyed. Less damage occurred during the November flood, but road access to the lower Kenai Peninsula was cut off for a second time when bridge

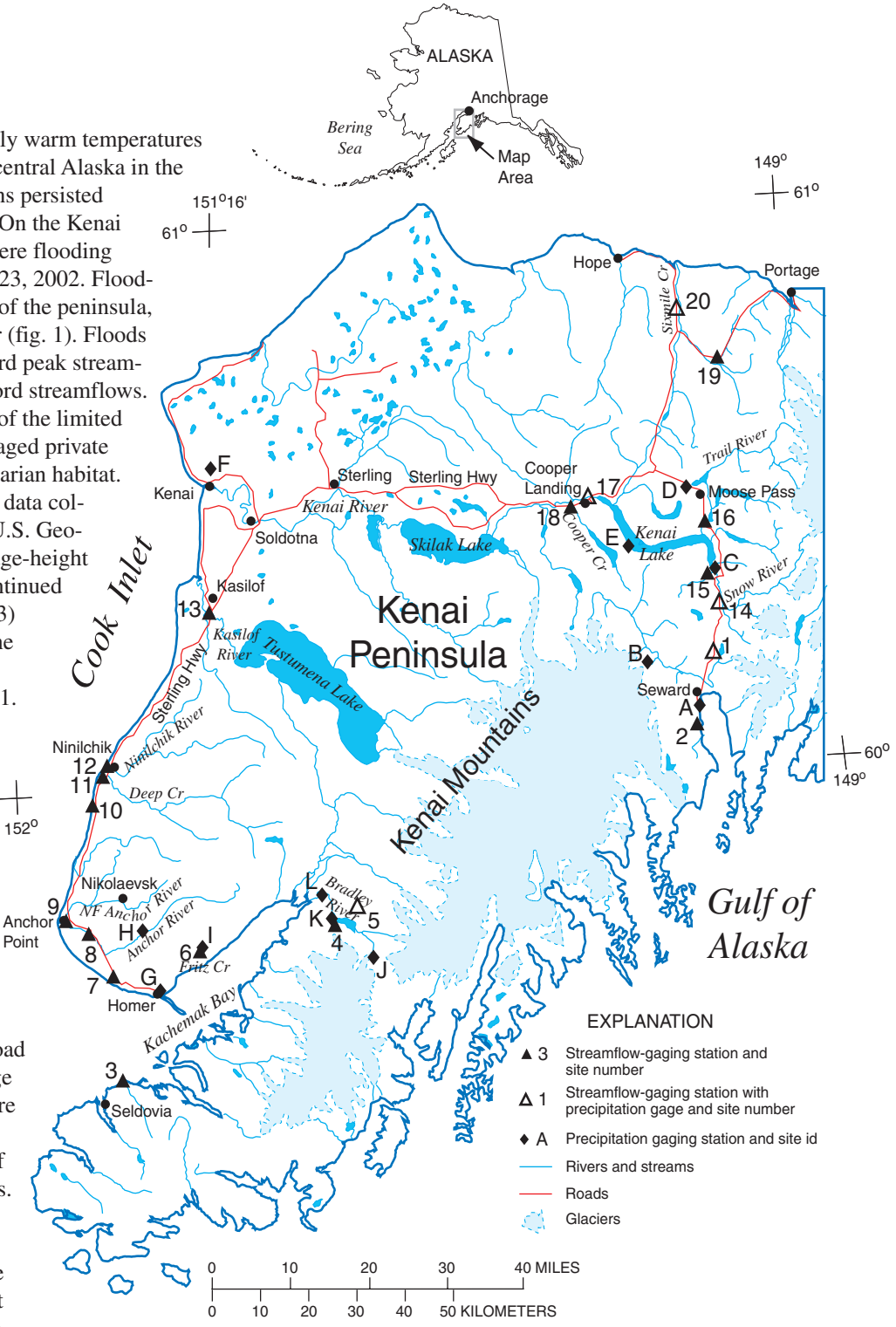

Figure 1. Kenai Peninsula with location of sites listed on tables 1 and 2.

Flood-water debris on East End Road, Homer, Alaska, October 24, 2002. Photograph taken by Chad W. Smith, U.S. Geological Survey.

approaches washed out on the Anchor River crossings on the Sterling Highway and Old Sterling Highway (at Anchor Point). Ninilchik Village was cut off for a second time when the bridge approach on the Ninilchik River washed out. Several streams, including Ninilchik River, Deep Creek, and Anchor River, were severely damaged from channel scour and sediment deposition, bank erosion, and land slides.

Meteorology of the Storms

Meteorological conditions that produced the heavy rainfall over the Kenai Peninsula in 2002 began in late September and remained constant through the end of November (Ben Balk, National Weather Service, written commun., 2002). A high-pressure ridge formed along the coast of British Columbia, Canada, and low-pressure troughs formed in the Bering Sea and Hudson Bay area, resulting in a south to north storm track into south-central Alaska creating unseasonably warm temperatures and heavy rainfall in the Kenai Peninsula region. Many of the storms carried subtropical moisture from latitudes as far south as Hawaii. These patterns are not unusual in this region for one- or two-week periods, but this trend lasted for more than two months.

Precipitation

Precipitation for October and November 2002 in areas where flooding occurred ranged from 130 percent of average in the Seward area to 400 percent in the Bradley River Basin. There was measureable precipitation on most days during these two months. October precipitation fell as rain because of unusually warm temperatures, even at the higher elevations of the Kenai Mountains. November precipitation was mostly rain, with some snowfall at elevations greater than 1,500 feet. Heaviest rainfall was on October 22-24, and November 22-23, 2002. Table 1 lists precipitation totals during the periods of heaviest rainfall, when the majority of the flooding occurred. Measured 24-hour totals exceed historical monthly average precipitation at several at of the sites.

Peak Gage Height and Streamflow

Peak gage height and streamflow were obtained for 34 USGS active and inactive streamflow gaging stations on the Kenai Peninsula during the October and November floods. Large flood peaks were measured at 20 of the sites (fig. 1), and floods at

Table 1. Precipitation for selected sites (see figure 1) on the Kenai Peninsula, Alaska, 2002

Site	Name	Elevation, in feet	Precipitation, In Inches								
			Oct. 22	Oct. 23	Oct. 24	Total Oct. 22-24	Historical October Monthly Average	Nov. 22	Nov. 23	Total Nov. 22-23	Historical November Monthly Average
A	Seward[1]	110	2.02	3.68	2.23	7.93	9.81	1.31	4.03	5.34	7.15
B	Seward 8 NW[1]	410	1.36	2.65	2.04	6.05	9.64	1.83	3.45	5.28	5.84
C	Seward 19 N[1]	454	0.06	4.54	3.26	7.86	4.96	0.28	4.54	4.82	3.16
1	Grouse Creek[2]	200	--	--	--	--	--[3]	2.09	4.49	6.58	--[3]
14	Snow River[2]	470	1.89	2.55	1.60	6.04	--[3]	1.28	2.09	3.37	--[3]
D	Moose Pass 3NW[1]	463	0.64	1.42	1.16	3.22	3.79	1.18	1.64	2.82	3.21
20	Sixmile Creek[2]	250	0.87	1.74	1.43	4.04	--[3]	1.38	2.48	3.86	--[3]
E	Cooper Lake Project[1]	505	0.76	2.30	2.10	5.16	4.92	0.53	0.42	0.95	3.29
18	Kenai River at Cooper Landing[2]	420	0.85	0.91	0.77	2.50	--[3]	1.02	0.48	1.49	--[3]
F	Kenai Airport[1]	91	0.37	0.90	0.82	2.09	2.66	0.06	0.02	0.08	1.69
G	Homer Airport[1]	64	1.26	2.88	0.14	4.28	2.77	0.72	2.09	2.81	2.87
H	Homer 8 NW[1]	1,080	0.97	2.51	1.46	4.94	3.63	0.53	2.84	3.37	2.84
I	Homer 9E[1]	512	0.55	2.45	1.45	4.45	2.50	3.50	1.78	5.28	2.22
J	Upper Nuka[2]	1,300	6.93	7.24	1.37	15.5	7.65	3.67	7.30	11.0	9.96
5	Middle Fork Bradley[2]	2,300	4.25	5.40	1.10	10.8	4.37	4.30	5.49	9.79	5.77
K	Bradley Lake Dam[2]	1,050	2.86	4.41	0.95	8.22	4.56	1.66	2.88	4.54	--[4]
L	Bradley Tidewater[2]	25	2.66	4.48	1.27	8.41	5.29	1.44	3.86	5.30	--[4]

[1]National Data Climate Center (2002).
[2]Daily values of precipitation are available from the computer files of the Alaska Science Center, Water Resources Office.
[3]Precipitation gage is new, no historic data.
[4]Insufficient data, tipping bucket rain gage is usually frozen in November.

8 sites surpassed previous record levels. Table 2 lists the period of record, peak gage height, peak streamflow, and peak basin yield for the October and November floods. Also listed are the 100-year flood streamflows computed for data through 1999 (Curran and others, 2003) and the updated 100-year flood streamflows, computed with the highest of the October-November 2002 flood peaks. The flood peaks in October and November were considered part of the same event due to this persistent weather pattern. Eight sites exceeded the original 100-year flood, of which three (Anchor River at Anchor Point, Cook Inlet Tributary near Ninilchik, and Ninilchik River at Ninilchik) exceeded the revised 100-year flood. The flooding was most notable in smaller drainage basins. Larger rivers, such as the Kenai and Kasilof Rivers, have large lakes that attenuated the peak flows of the smaller tributaries. Most of the flooding was in the lower western Kenai Peninsula, south from Ninilchik. However, new peak-of-record streamflows also were observed on Trail River, Cooper Creek,

Road damage, Ninilchik River at Ninilchik, Alaska, October 25, 2002. Photograph taken by David F. Meyer, U.S. Geological Survey.

Table 2. Peak gage heights, streamflows during October and November, 2002, and 100-year flood magnitude for selected stations (see figure 1) on the Kenai Peninsula, Alaska

(mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; (ft^3/s)/mi^2, cubic feet per second per square mile; --, no data; *, new peak of record)

Site No.	Station No.	Station Name	Drainage area (mi^2)	Period of Record for peak data	October 2002 Maximum Peak Data				November 2002 Maximum Peak Data				100-yr flood[1] (ft^3/s)/mi^2	
					Day (month/day)	Gage height (ft)	Stream flow (ft^3/s)	Peak basin yield (ft^3/s)/mi^2	Day (month/day)	Gage height (ft)	Stream flow (ft^3/s)	Peak basin yield (ft^3/s)/mi^2	For data though 1999	For data though 2002
1	15237730	Grouse Creek at Lake Outlet near Seward	6.24	1997-P	10/24	8.05	451*	72.3	11/23	7.87	401	64.5	1,080[2]	--
2	15238600	Spruce Creek near Seward	9.26	1967-P	10/23	6.63	1,560	168	11/23	6.04	835	90.2	4,090	3,910
3	15238820	Barabara Creek near Seldovia	20.7	1972-92	10/23	4.00	1,450	70.0	--	--	--	--	2,640	2,640[3]
4	15238978	Battle Creek diversion above Bradley Lake near Homer	0.95	1992-P	10/23	7.50	151*	159	11/23	6.60	80	11.6	159[4]	188
5	15239050	Middle Fork Bradley River near Homer	9.25	1980-P	10/23	9.49	1,310	142	11/23	8.99	259	28.0	1,660	1,770
6	15239500	Fritz Creek near Homer	10.4	1963-P	10/24	12.1	700e	67.3	11/23	11.37	530	51.0	664	819
7	15239800	Diamond Creek near Homer	5.35	1963-81	10/24	15.50	357*	66.7	11/23	14.33	282	52.7	342	418
8	15239900	Anchor River near Anchor Point	137	1965-74, 1978-87, 1991-92, 2000-P	10/24	9.30	8,000	58.4	11/23	9.1	9,000*	65.7	6,090	8,300
9	15240000	Anchor River at Anchor Point	224	1953-66, 1984-92	10/24	9.38	13,400	59.8	11/23	9.60	14,500*	66.1	8,670	14,000
10	15240500	Cook Inlet Tributary near Ninilchik	5.19	1966-81	10/24	17.16	359*	72.2	11/23	15.72	255	49.1	169	284
11	15241500	Deep Creek near Ninilchik	220	--	10/24	23.2	22,000	100	11/23	21.2	--	--	7,300[2]	--
12	15241600	Ninilchik River at Ninilchik	135	1963-85, 1999-P	10/24	9.39	6,600*	48.8	11/23	6.96	3,200	23.7	1,780	4,880
13	15242000	Kasilof River near Kasilof	738	1949-74, 1977	10/24	5.70	7,700	10.4	--	--	--	--	14,400	14,400[3]
14	15243900	Snow River near Seward	128	1970, 1974, 1977, 1997-P	10/24	13.22	12,600	98.4	11/23	10.95	6,870	53.7	--	--
15	15243950	Porcupine Creek near Primrose	16.8	1963-89	10/24	20.64	1,540	92.3	--	--	--	--	4,550	4,550[3]
16	15248000	Trail River near Lawing	181	1947-77, 1987	10/24	11.09	8,200*	45.3	--	--	--	--	8,890	9,360
17	15258000	Kenai River at Cooper Landing	634	1947-P	10/26	14.64	15,300	24.1	--	--	--	--	26,400[6]	26,100[6]
18	15261000	Cooper Creek at mouth near Cooper Landing	48.6	1958-64, 1998-P	10/23	12.45	1,230*	25.3		11.28	337	6.9		
19	15269500	Granite Creek near Portage	28.2	1967-81	--[5]	10.85	1,800	63.8	--	--	--	--	3,090	3,090[3]
20	15271000	Sixmile Creek near Hope	234	1979-90, 1997-P	10/24	13.56	10,800*	46.2	11/23	11.68	4,170	17.8	10,600	13,000

[1] 100-year flood calculated using observed station data and regional weighted skew from Curran and others (2003), unless otherwise noted.
[2] Less than 10 years of systematic observed peak flow data, used regional flood-frequency equation from Curran and others (2003).
[3] October and November, 2002 peaks are less than highest systematic peak and not used in computations following Bulletin 17-B guidelines (Interagency Committee on Water Data, 1982).
[4] Used data through 2001.
[5] Exact date of peak unknown, but did occur on October 23 or 24, 2004.
[6] 100-year flood calculted using only observed station data. See Curran and others (2003) for details.
e Estimated.
P Present

Bridge damage, Sterling Highway at Deep Creek near Ninilchik, Alaska, October 25, 2002. Photograph taken by David F. Meyer, U.S. Geological Survey.

and Sixmile Creek. These three river basins all originate in the Northern Kenai Mountains.

The "100-year Flood"

The 100-year flood is the standard used by most Federal and state agencies for zoning, flood plain management, bridge design, and emergency planning. The National Flood Insurance Program uses the 100-year flood as the standard for flood plain management and for determining the need for flood insurance. The term "100-year flood" is misleading because it leads people to believe it happens only once every 100 years. How can it be that several streams on the Kenai Peninsula had two "100-year floods" one month apart? The term "100-year flood" is a statistical designation meaning there is a 1-in-100 chance that a flood this size will happen during any given year, and is determined from magnitude of past floods. The 100-year flood magnitude is revised periodically as new streamflow data and updated regional regression equations become available. The USGS updates flood magnitude and frequency, and regional regression equations about every 10 years. Ten years of flood data for a stream is considered a minimum for statistical purposes, but a longer record provides a better estimate. For example, streamflow data collected at Fritz Creek near Homer since 1963 indicate the estimated 100-year flood streamflow is higher now than it was when calculated using data through 1999. This change highlights the importance of continued river monitoring. When there are less than 5 years of flood data for a stream, regional flood regression equations can be used to determine the 100-year flood. This procedure was used to determine the 100-year flood for Deep Creek near Ninilchik. When there are at least 5 years of data, the observed data should be weighted with regional regression equations, as was done with Grouse Creek. The USGS has recently released a report detailing the method for determining flood magnitude and frequency at ungaged and under-gaged sites in Alaska (Curran and others, 2003).

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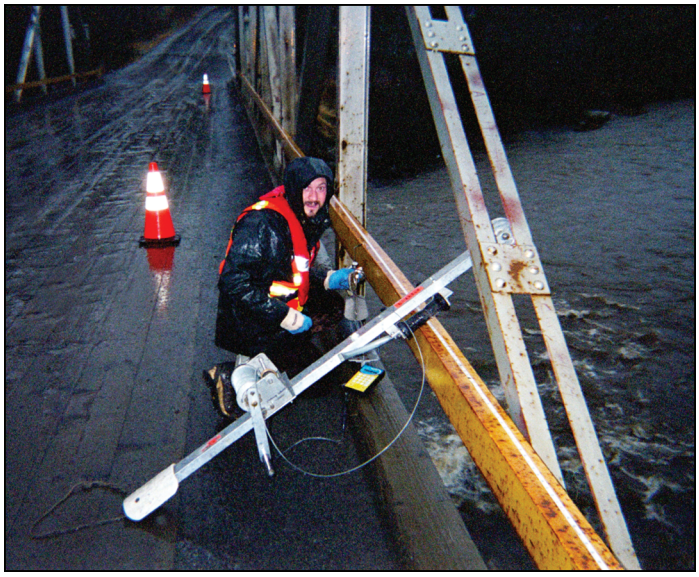

USGS hydrographer measuring streamflow after the October 24, 2002 flood peak at Anchor River at Anchor Point, Alaska. Photograph taken by Jeff M. Wiles, U.S. Geological Survey.

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