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1965

by
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1965 Progress Report
Glacier Observations
Glacier National Park, Montana
Introduction

This report records the results obtained during the 1965 season in the continuing program of observations on the Grinnell and Sperry Glaciers in Glacier National Park, Montana. This is carried on cooperatively by the Geological Survey, the National Park Service, and the Weather Bureau. It includes the determination of annual changes in the surface elevation of the glaciers by the measurements of profiles; changes during the summer months by the placement of and observations at ablation stakes; mapping the glacier termini in selected years to record advance or recession; determination of annual movement by the location of marked rocks; the operation of two storage-precipitation gages in the immediate vicinity of the Grinnell Glacier to record annual precipitation; the operation of two gaging stations, one just below the Grinnell Glacier during the summer months and one just below the outlet of Grinnell Lake on a year-round basis; temperature data near the Grinnell Glacier and temperature and precipitation data at Sperry Chalet near the Sperry Glacier during the summer months. The investigations carried on are described in the section for each glacier.

The period covered by this report, from about September 1, 1964, to September 1, 1965, showed below normal temperatures and above normal precipitation. The following comments are abstracted from the

monthly Climatological Data for Montana:

November 1964 - Unseasonably cold and some snow.

December 1964 - Severely cold -- coldest December on record at many stations.

January 1965 - Western mountain snowpacks were seasonably very heavy at the end of January.

March 1965 - Coldest March on record at many stations. Snow surveys showed that mountain snow fields contained record or near record water volume.

April 1965 - Snow surveys at month's end showed water content at or near record level.

July 1965 - Maximum temperatures cooler than normal and minimum above normal.

August 1965 - Stormy, cool, and wet. Latter conditions have prevailed since March.

The available temperature and precipitation data for Sperry Chalet and Grinnell Glacier, along with the data for the 3 summer months at West Glacier, are shown in table 1. The data in the table indicates that summer temperatures were below average and precipitation above average in the area of the glaciers. At the Sperry Chalet both July and August mean temperatures were below the mean, and the precipitation was above the mean for the 6-year record available. (Record started at this location in 1960). The mean August temperature at the Grinnell No. 1 station was below the average for the above 6-year period.

At West Glacier during the April-August period the mean temperature was 1.6° below and the precipitation 4.70 inches above the 30-year average (1931-1960). At Summit during the same period the mean temperature was 1.1° below and the precipitation 1.00 inches above the 26-year average (1935-1960).

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Table 1 - Temperature and precipitation data,
July, August, and September, 1960 to 1965 inclusive.

Year	Mean Temperature °F	Maximum Temperature °F	Mean Maximum Temperature °F	Minimum Temperature °F	Mean Minimum Temperature °F	Precipitation Inches
	July : Aug. : Sept.:	July : Aug. : Sept.:	July : Aug. : Sept.:	July : Aug. : Sept.:	July : Aug. : Sept.:	July : Aug. : Sept.:

WEST GLACIER

Mean a/	64.0	62.0	53.3	—	—	—	80.6	78.5	67.2	—	—	—	47.3	45.5	39.4	1.27	1.33	1.89
1960	66.1	57.9	52.9	93	87	80	84.4	70.2	67.8	40	34	26	47.8	45.5	38.0	0.00	2.75	0.59
61	64.8	66.4	47.5	89	96	76	81.1	84.6	59.7	35	39	20	48.5	48.1	35.3	2.20	0.76	3.33
62	61.3	60.6	52.2	83	91	79	77.4	75.5	67.7	33	37	27	45.2	45.7	36.7	0.58	1.03	1.65
63	61.7	63.2	57.0	90	90	89	77.5	79.3	71.3	39	37	32	45.9	47.1	42.7	1.70	0.79	1.80
64	62.7	56.7	48.9	88	81	72	78.7	70.2	60.3	40	32	27	46.7	43.1	37.4	3.50	1.51	2.71
1965	61.7	61.8	44.3	89	89	74	79.5	76.3	53.9	32	32	29	43.9	47.3	34.6	2.25	4.12	3.03

SPERRY CHALET

1960	62.7	50.7	—	84	76	—	73.0	57.6	—	39	30	—	52.3	43.7	—	0.15	3.82	—
61	58.0	61.9	—	75	90	—	67.8	71.8	—	37	36	—	48.2	51.9	—	3.27	3.30	—
62	52.9	51.0	—	74	82	—	61.2	58.9	—	32	31	—	44.5	43.1	—	0.76	2.41	—
63	53.5	56.6	—	76	81	—	62.0	66.5	—	35	36	—	44.9	46.7	—	2.30	1.60	—
64 b/	56.1	45.5	—	79	76	—	66.4	56.7	—	37	33	—	45.7	42.3	—	2.69	3.52	—
1965	53.4	53.1	—	74	77	—	62.9	59.9	—	35	29	—	43.8	46.2	—	1.98	6.44	—

GRINNELL GLACIER

1960	—	51.1	—	—	81	—	—	59.3	—	—	31	—	—	42.8	—	—	—	—
61	—	61.7	—	—	89	—	—	73.6	—	—	33	—	—	49.8	—	—	—	—
62	—	54.5	—	—	84	—	—	63.5	—	—	35	—	—	45.2	—	—	—	—
63	—	57.5	—	—	82	—	—	68.4	—	—	38	—	—	45.5	—	—	—	—
64	—	49.1	—	—	74	—	—	57.3	—	—	31	—	—	40.8	—	—	—	—
1965	—	54.3	—	—	82	—	—	64.4	—	—	28	—	—	44.1	—	—	—	—

a/ From 30-year record, 1931-1960.

b/ No record July 1-3.

Grinnell Glacier

General

The compilation of maps of the Grinnell Glacier based on aerial photographs taken in 1950 and 1960 was completed and the maps published. The two maps are on a scale of 1:6000 (one inch = 500 feet) with a 20-foot contour interval and are shown on a single sheet, 22" x 34", for convenience in comparison. The 1950 map supersedes the map published in 1953 as it was based on more adequate control than was available at the time of the previous compilation.

Surface Changes

Profiles

Profiles No. 1 and No. 2 were remeasured on September 5, and 6, and No. 3 on September 7. In the description of the profiles the term "station" refers to the distance from the initial point.

The profiles for 1957, 1962, and 1963 are shown graphically on figure 1. The 1964 and 1965 profiles have not been added in view of the small change since 1963. The mean elevation for subdivisions of profiles 1, 2, and 3 are shown in tables 2, 3, and 4 for all the years in which measurements were made.

Reference to these tables indicates a continued lowering trend in the surface elevation of the glacier even though some years showed a higher surface elevation than the previous year. Profiles No. 1 and No. 2 indicate a net decrease in surface elevation of approximately

25 feet in the 15-year period since 1950. Profile No. 3, which was first measured in 1957, showed a net decrease of 10 to 11 feet during the 8-year period.

Profile No. 1

Profile No. 1 was remeasured on September 5, and 6. The 1965 profile was found to be about 2 feet lower than the 1964 profile between stations 200 and 350. Otherwise the profiles for the two years were essentially the same. A few minor variations were noted, but these could be partly due to the difference in location and spacing of the observed points. The low point or trough in the profile, near the head wall, at about station 2000 was essentially at the same elevation in both years.

Profile No. 2

Profile No. 2 was remeasured on September 5, and 6. This was similar to Profile No. 1 in that between stations 200 and 350 the 1965 surface was about 2 feet lower than it was in 1964. Otherwise the 1965 profile was practically coincident with the 1964 profile.

The measurements at Profiles No. 1 and No. 2 indicate melting is most pronounced near the edge of the glacier.

Profile No. 3

Profile No. 3 was measured on September 7. This profile was not measured in 1964, so the following comparisons refer to the 1963 profile. Between stations 200 and 400 the 1965 surface was much the same as in 1963; from station 400 to 600 it was below by as much as 5 feet in places; from station 600 to 1200 it was practically the same as in 1963; from station 1200 to 1800 it was above by as much as 6 feet in places; and between stations 1800 and 2000 the 1965 surface was generally 1 to 2 feet above the 1963 surface. The 1963 measurements ended at station 2000.

Table 2. - Profile No. 1, Grinnell Glacier, Montana

Mean elevations, feet

Date	Distance from reference point, feet			
	100-500	500-1000	1000-1500	1500-2000
Sept. 14, 1950	6463.5	6510.3	—	—
Aug. 22, 1952	6463.6	6510.0	6529.5	—
Sept. 4, 1953	6460.2	6505.5	6523.6	—
Sept. 27, 1954	6461.1	6505.8	—	—
Sept. 8, 1955	6462.0	6505.1	6523.9	—
Aug. 30, 1956	6462.6	6504.4	6522.9	6515.4
Aug. 13, 1957	6461.6	6504.0	6522.0	6513.6
Sept. 10, 1957	6458.1	6500.7	6518.3	6508.3
Aug. 12, 1958	6454.8	6497.0	6513.2	6503.2
Sept. 14, 1958	6449.2	6491.1	6507.8	6497.6
Aug. 14, 1959	6454.9	6498.3	6514.4	6501.9
Sept. 12, 1959	6452.2	6495.7	6512.2	6500.3
Sept. 2, 1960	6453.0	6495.9	6511.1	6502.3
Sept. 19, 1961	6447.0	6489.2	—	—
Sept. 1, 1962	6446.6	6488.4	6505.0	6496.1
Sept. 12, 1963	6440.6	6484.2	6499.9	6492.4
Aug. 28, 29, 1964	6437.3	6482.8	6499.3	6490.8
Sept. 5, 6, 1965	6438.8	6482.7	6498.8	6490.2

Table 3. - Profile No. 2, Grinnell Glacier, Montana

Mean elevations, feet

Date	Distance from reference point, feet				
	100-500	500-1000	1000-1500	1500-2000	2000-2500
Sept. 14, 1950	6460.1	6523.3	6564.8	—	—
Aug. 22, 1952	6460.3	6522.6	6563.8	6604.8	—
Sept. 4, 1953	6458.4	6519.5	—	—	—
Sept. 27, 1954	6459.5	6522.0	6564.4	—	—
Sept. 6, 1955	6460.6	6521.8	6563.9	—	—
Aug. 30, 1956	6461.7	6521.6	6563.8	6604.6	6659.9
Aug. 13, 1957	6460.2	6521.3	6563.2	6602.9	6657.2
Sept. 10, 1957	6456.6	6517.9	6560.6	6600.9	6654.9
Aug. 12, 1958	6452.5	6515.2	6557.1	6596.4	6649.6
Sept. 15, 1958	6446.4	6509.8	6551.6	6591.2	6642.7
Aug. 14, 1959	6453.0	6516.2	6558.6	6598.4	6651.6
Sept. 12, 1959	6449.9	6513.6	6555.7	6597.1	6649.5
Sept. 3, 4, 6, 1960	6449.9	6514.1	6555.5	6594.7	6646.7
Sept. 1, 2, 1962	6442.8	6506.4	6547.4	6586.9	6640.7
Sept. 12, 1963	6437.5	6499.2	6541.8	6582.4	6634.4
Sept. 15, 1964	6436.5	6499.1	6541.1	6581.4	—
Sept. 5, 6, 1965	6436.4	6499.6	6540.9	6580.2	6635.0

Table 4. - Profile No. 3, Grinnell Glacier, Montana

Mean elevations, feet

Date	Distance from reference point, feet	
	300-1000	1000-1700
Sept. 11, 1957	6577.9	6681.4
Aug. 13, 1958	6575.0	6677.5
Aug. 15, 1959	6575.7	6679.3
Sept. 12, 1959	6573.9	6677.9
Sept. 6, 1960	6574.1	6676.7
Sept. 3, 1962	6573.4	6673.2
Sept. 13, 1963	6769.1	6667.3
Sept. 7, 1965	6567.9	6670.1

Ablation

The ablation measurements are determined by drilling a hole, about 1 inch in diameter, with an ice auger and then placing wooden stakes, $3/4$ " square and 6 feet long, in the hole. Each 6-foot stake was marked with black keel showing the location number, position in the hole, and the date placed. The stakes were numbered from bottom up, the lowest or bottom stake being 1. The black keel marking has not always been satisfactory, becoming indistinct, particularly for stakes that have been in place for 2 years or more. To overcome this difficulty a new method was tried in 1965, which promises to give definite information. A "tapewriter" was used with $1/2$ " aluminum or copper strips. The identifying information and date was imprinted on a strip of the metal about 3" long which was then tacked on the stake near its upper end. The following is an example of the imprinting:

5/4/1/8/11/65.

This indicates location 4, bottom or lowest stake in hole, placed August 11, 1965. The tapewriter was quick and convenient to use and readily carried along with the rest of the equipment.

Five ablation stakes were placed on August 11, and 12, and remeasured on September 6, and 7. Six stakes set in previous years were found and observed; one from 1961, two from 1963, and three from 1964.

The results of the ablation measurements are shown in table 5, and the locations are shown in figure 2.

The five stakes placed in 1965 were remeasured 25 or 27 days later. The ablation varied from 3.1 to 6.2 feet. As shown by the table there was no snow from the previous winter at three of the 1965 locations and only $\frac{1}{2}$ -foot at one location. The other location had a snow depth of 6.6 feet.

Finding the 1961 stakes was a particularly useful addition to the record. This showed a net change of 12.5 feet or about 3 feet per year. Movement during the 4-year period was 125 feet or an average of 31 feet per year. The bottom-of-hole elevation at the time of placement, July 20, 1961, was 6663.3; and on August 11, 1965, was 6651.6, a decrease of 11.7 feet. The slope of the glacier surface along the direction of movement was about 12 or 13 feet in the 125-foot distance. This would indicate that the ice at the bottom of the hole was moving on a slope about the same as the surface of the glacier.

The 1963 stake, S-2, placed on July 27, 1963, was observed on August 29, 1964, and September 6, 1965. The bottom-hole elevation on these dates were 6477.9, 6478.3, and 6477.0, respectively. These values, considering some possible errors in the stadia determination of elevations, would indicate the movement of the ice mass in the area was practically horizontal. Movement during the 2-year period was 60 feet or 30 feet per year.

Table 5 - Ablation, Cornwell Glacier, N. 1964

		Ablation, feet									
		3-2-64	3-2-65	3-2-64	3-1-64	3-4-65	2-2-65	2-7-65	4-2-65	5-9-65	5-9-65
Date placed		8/29/64	7/27/63	7/27/64	7/21/64	8/12/65	8/12/65	8/12/65	7/23/65	9/27/64	8/11/65
Depth of hole, feet		19.6	19.0	9.9	9.0	15.0	12.9	15.0	10.0	2.9	8.1
Depth of snow, feet		0.0	4.0	9.2	7.5	0.0	0.0	0.0	2.5	9.9	6.6
Date		8/12/65	9/12/63	9/25/64	9/15/64	9/6/65	9/6/65	9/6/65	9/11/65	9/7/65	9/7/65
Days		309	167	55	54	25	29	27	772	356	27
Ablation, feet		2.1	10.4	0.4	1/ 9.0	0.2	3.1	6.0	1.2	2.7	4.9
Date		9/6/65	8/29/64	9/6/65							
Days		25	321	353							
Ablation, feet		2.9	3.9	1.9							
Date			9/6/65								
Days			374								
Ablation, feet			1.5								

a/ Surface 1.9 higher on September 6, 1965 than on September 15, 1964.

b/ Stakes completely melted. Ablation may have been more than 9.5.

Movement

Eight previously marked rocks were relocated, also 4 ablation stakes. Three additional rocks were marked and located to serve as replacement for those becoming lost or too near the edge of the glacier to give reliable results. The 1965 location of the rocks and the 4 ablation stakes are shown on figure 2.

The results of the 1965 observations are as follows:

Rock or stakes	Movement a/ (feet)	Remarks
59-1	-	Fallen into crevasse. Could not be located.
50-2	45	Movement and location inconsistent with previous observations.
59-2	35	
63-1	38	
64-1	34	
58-1	70	Inconsistent with previous observations.
63-2	20	
59-3	32	
59-4	100	Since 1963, about 50 feet per year.
S-1-64	40	
S-2-63	60	Since 1963, or 30 feet per year.
S-3-64	28	
S-8-61	125	Since 1961, 31 feet per year for the 4-year period.

a/ Movement since 1964 unless otherwise indicated.

Recession

The shoreline of the lake at the end of the glacier showed a distinct change since 1964. For a distance of 900 feet the 1965 shoreline was 20 to 50 feet back from the 1964 position. Although this indicates a recession, the change is probably due as much to the breaking away of the ice along the shoreline as actual melting. Considering that the movement of the glacier is 20 to 35 feet per year toward the lake, the actual loss of ice along the 900-foot section referred to averaged about 50 feet. No observations were made along the edge of the glacier except at the 3 profiles where no significant difference was indicated from recent years.

Precipitation and Runoff

The two storage-precipitation gages, established and maintained by the Weather Bureau and the National Park Service, one in 1949 and one in 1955, were continued in operation. The gaging station at the outlet of Grinnell Lake, established in 1949, and the one just below the glacier, established in 1959, were also continued in operation. The results of the observations at the two precipitation gages, along with the runoff at the outlet of Grinnell Lake for corresponding periods, are shown in table 6. The time of observations at the precipitation gages varies from year-to-year so the observed results are not strictly comparable on an annual basis. However, summer precipitation is usually rather low so the difference between the observed values and the values if observed on the same date each year

would not be an appreciable percentage of the total. The amounts listed are therefore close to true annual values. Considering the 15-year period, July 21, 1950, to August 12, 1965, the average at gage no. 1 was 103.4 inches. The average annual runoff at the gaging station below Grinnell Lake for the same period was 97.6 inches, or only 5.8 inches less than the observed precipitation at gage no. 1. This difference is probably low and, as the runoff figures are more definite than the precipitation figures, it would indicate that the catch at gage no. 1 is somewhat less than the average for the entire basin above the gaging station.

The measured precipitation at gage no. 2, as in previous years, was much greater than at gage no. 1. For the 10 years of record available at both gages the observed value for no. 2 averages 52 percent greater than at no. 1. Year-to-year comparisons have varied from a minimum of 34 percent to a maximum of 65 percent. As stated in previous reports the difference in wind patterns, which in turn are influenced by the rugged mountain terrain, are, no doubt, primarily responsible for the pronounced difference in catch at the two gages.

The relation between runoff at the gaging station below Grinnell Lake and the measured precipitation at the two gages varies appreciably from year to year. This relationship is strongly influenced by summer temperatures. High summer temperature following a winter of low snowfall could result in a high runoff value. Conversely, a summer of low temperatures could result in a low value of runoff even though the snowfall for the preceding winter had been high.

The gaging station immediately below the glacier (see figure 2) was placed in operation for the season on June 30. The recorder had continued in operation until December 11, following the last inspection on October 11, 1964. The stage discharge relation during portions of this period was affected by ice.

The results obtained thus far at this station are shown in table 7 and compared with the record for the corresponding months at the gaging station below the outlet of Grinnell Lake. The comparisons for the months of August and September are the most significant. The records for July, except for 1960, 1963, and 1965, are partly estimated as the station was not placed in operation until after July 1. Records for October and subsequent months are affected by ice and based, to some extent, on estimations. For convenience in comparison, the monthly percentage relationship for the available months is shown in table 8. For the 7 seasons of record the runoff at the station below the glacier for August and September averaged 83 and 66 percent, respectively, of the corresponding values at the station below the outlet of Grinnell Lake. The August ratios varied from 75 to 96 percent and the September ratios from 46 to 88 percent. The lowest September value, 42 percent, occurred in 1965. The area at the gaging station below the glacier is 32 percent of that at the gaging station below the outlet of Grinnell Lake.

Table 6. - Precipitation and runoff data in vicinity of Grinnell Glacier

Period	: Number of days	: Precipitation (inches) : : A : : Gage : : No. 1 a/	: B : : Gage : : No. 2 b/	: Percent : : B/A :	: Runoff : : (inches) : : c/
Aug. 27, 1949-July 20, 1950	327	125.1	-		87.0
July 21, 1950-July 24, 1951	369	117.5	-		109.8
July 25, 1951-July 15, 1952	357	108.3	-		90.4
July 16, 1952-July 31, 1953	381	106.9	-		101.9
Aug. 1, 1953-Aug. 5, 1954	370	138.2	-		107.3
Aug. 6, 1954-Aug. 10, 1955	370	109.2	-		105.2
Aug. 11, 1955-Aug. 7, 1956	363	100.7	152.8 d/	152	98.5
Aug. 8, 1956-July 16, 1957	342	88.7	137.2	155	81.4
Aug. 17, 1957-July 17, 1958	365	78.9	115.8	147	84.0
July 18, 1958-Aug. 4, 1959	383	111.6	184.6	165	108.8
Aug. 5, 1959-July 21, 1960	352	107.7	166.6	155	91.6
July 22, 1960-Aug. 8, 1961	383	98.3	131.8	134	106.1
Aug. 9, 1961-July 26, 1962	352	87.1	121.4	139	73.3
July 27, 1962-July 18, 1963	356	101.1	157.6	157	90.7
July 19, 1963-July 30, 1964	378	95.5	144.1	151	108.1
July 31, 1964-Aug. 12, 1965	378	102.0	164.0	161	107.6

a/ Measured at storage precipitation gage near end of horse trail 0.4 mile from glacier.

b/ Measured at storage precipitation gage about $\frac{1}{2}$ mile southeast of gage described in footnote a/.

c/ Measured at gaging station at outlet of Grinnell Lake.

d/ August 15, 1955 to August 7, 1956.

Table 7. - Runoff Comparisons, Grinnell Creek
at Grinnell Glacier and Grinnell Creek
near Many Glacier (just below outlet
of Grinnell Lake)

Month	Grinnell Creek at Grinnell Glacier (Dr. area-704 acres)		Grinnell Creek near Many Glacier (Dr. area-2221 acres)		Percent A/B
	Runoff		Runoff		
	Acre-feet A	Inches	Acre-feet B	Inches	
July 1959	2460	41.93	4310	23.27	57
August	1700	28.98	2260	12.21	75
September	1230	20.97	2280	12.29	54
October 1959	662	11.29	1500	8.09	44
July 1960	2770	47.30	4180	22.57	66
August	1700	28.98	2080	11.23	82
September	975	16.62	1190	6.44	82
October	351	5.98	599	3.24	59
November 1960	115	1.96	336	1.81	34
July 1961	2570	43.88	3500	18.90	73
August	2260	38.51	2360	12.75	96
September	666	11.35	944	5.10	71
October	1190	20.20	2530	13.65	47
November 1961	51	0.87	403	2.18	13
July 1962	2090	35.57	2820	15.25	74
August	1840	31.37	2170	11.74	85
September	729	12.42	935	5.05	78
October	529	9.01	1050	5.65	50
November	329	5.60	664	3.59	50
December 1962	113	1.93	403	2.18	28
July 1963	2310	39.39	3650	19.72	68
August	1860	31.78	2170	11.71	86
September	1350	23.09	1530	8.25	88
October	567	9.66	696	3.76	82
November 1963	213	3.63	345	1.86	62
July 1964	2790	47.56	4420	23.88	63
August	1550	26.42	2000	10.80	78
September	600	10.22	1300	7.02	46
October	581	9.90	1250	6.75	46
November 1964	220	3.75	327	1.77	67
July 1965	2450	41.69	4130	22.29	59
August	2040	34.72	2560	13.85	80
September 1965	412	7.03	987	5.33	42

Table 3 - Discharge below Grinnell Glacier in percent
of discharge below Grinnell Lake.

Year	Month					
	July	Aug.	Sept.	Oct.	Nov.	Dec.
1959	57	75	54	44	-	-
1960	66	82	82	59	34	-
1961	73	96	71	47	13	-
1962	74	85	78	50	50	28
1963	63	86	88	82	62	-
1964	63	78	46	46	67	-
1965	59	80	42	-	-	-
Mean	67	83	66	55	45	-

Sperry Glacier

General

Investigations on the Sperry Glacier during the 1965 season were limited to the placement of 6 ablation stakes on August 6, and 7, and making measurements at them on October 14. Pictures were taken from a photo point first used in 1945 for comparative purposes. Profiles were not measured in 1965. Two trees, ages of which had previously been determined by G. M. Baden, former seasonal Naturalist, were located. These trees were 190 and 226 years old at the time of the determination in 1960. The locations are approximately 4500 feet downvalley from the present front of the glacier.

Ablation

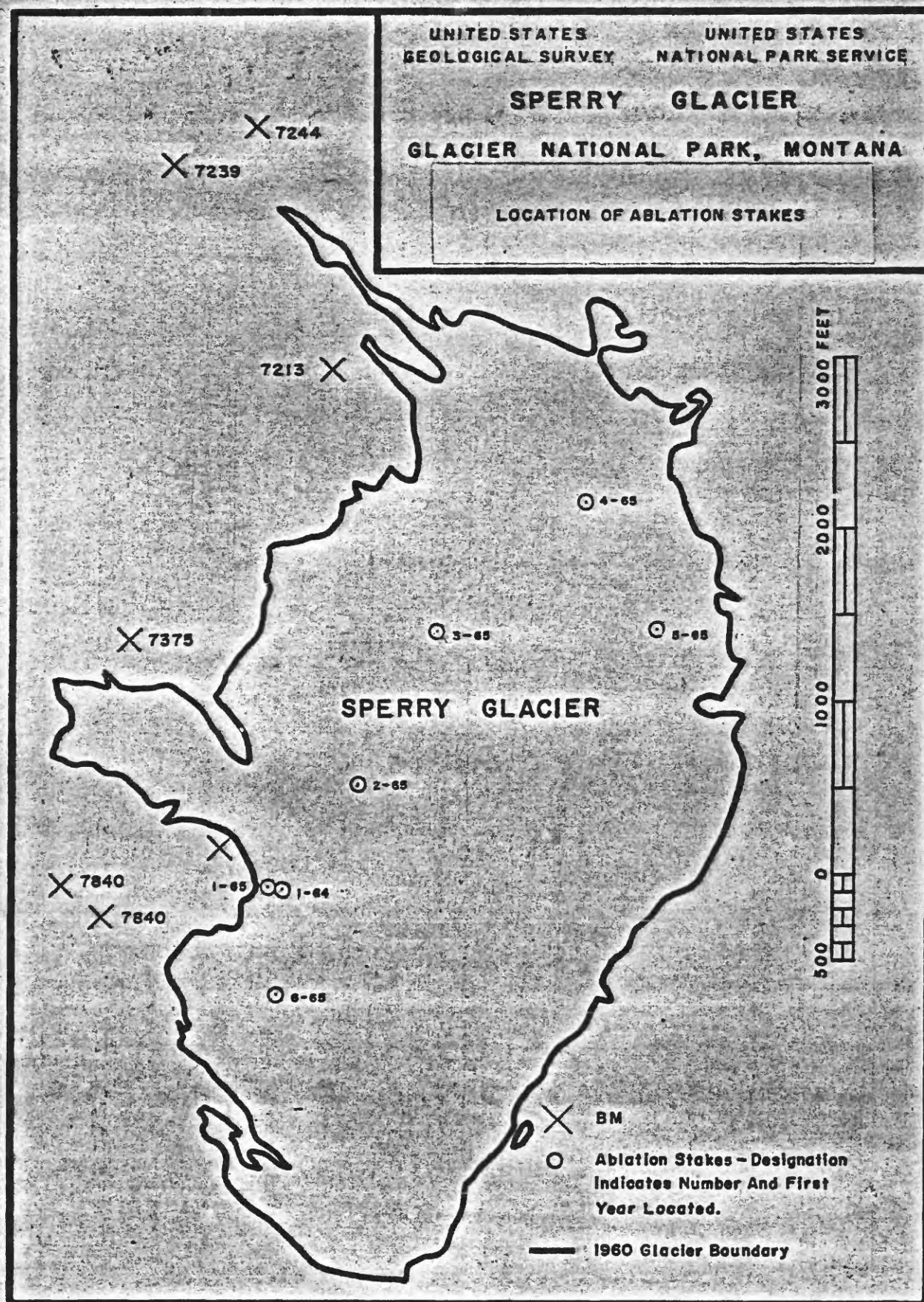
As above stated 6 stakes were placed on August 6, and 7, and observed on October 14. On the latter date there was about 19 inches of new snow on the glacier. Measurements were made down to the glacier surface prior to this snowfall. The results of the measurements are shown in table 9. Ablation during the 68- or 69-day period varied from 4.2 to 5.6 feet, averaging 5.0 feet. In addition to the stakes placed in 1965, 2 stakes from previous years, one placed in 1963, and one in 1964, were found in October. The 1963 stake showed a net change of 4.8 feet. The ablation from time of placement, July 31, 1963, to September 7, 1963, was 7.1 feet. The surface in October 1965 was therefore 2.3 feet higher than in September 1963. At the 1964 location the change was 5.1 feet in a period of almost 15 months.

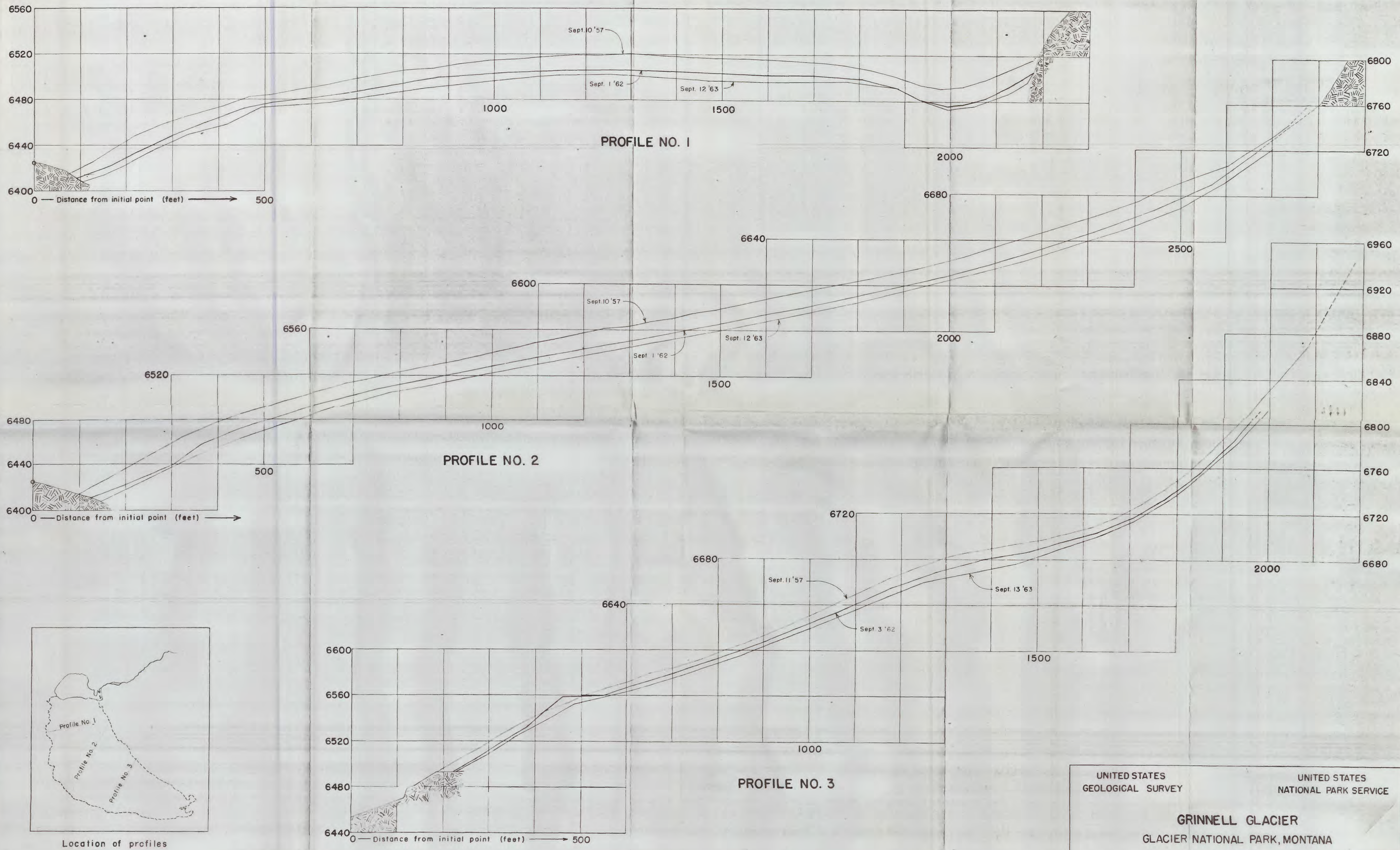
Table 9 - Ablation, Sperry Glacier, Montana

	Ablation Stakes							
	S-1-63	S-1-65	S-2-65	S-3-65	S-4-65	S-5-64	S-5-65	S-6-65
Date placed	7/31/63	8/6/65	8/7/65	8/11/65	8/7/65	7/23/64	8/7/65	8/7/65
Depth of hole, feet	16.3	13.3	5.5	13.2	12.9	9.4	13.3	10.8
Depth of snow, feet	2.5	1.0	4.3	13.2	12.9	8.0	13.3	0.0
Date	9/7/63	10/14/65	10/14/65	10/14/65	10/14/65	10/14/65	10/14/65	10/14/65
Days	38	69	68	68	68	419	68	68
Ablation, feet	7.1	5.3	a/ 5.5	5.6	4.6	5.1	4.5	4.2
Date	10/14/65							
Days	739							
Ablation, feet	4.8							

a/ Stake completely melted out. Ablation may have been somewhat more than amount indicated.

FIGURE 3





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