D-200

The Climate of Yellowstone and Grand Teton National Parks

National Park Service Occasional Paper Number Six

The Climate of Yellowstone and Grand Teton National Parks

Richard A. Dirks
National Science Foundation
and
Brooks E. Martner
Department of Atmospheric Science
University of Wyoming

U.S. Department of the Interior / National Park Service
National Park Service Occasional Paper Number Six
1982

Cover photo by B. Martner

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the ejnoyment of life through outdoor recreation. The Department assesses our mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under United States administration.

LIBRARY OF CONGRESS CATALOGING IN PUBLICATION DATA

Dirks, Richard A.
The climate of Yellowstone and Grand Teton National Parks.

(National Park Service occasional paper; no. 6)
Bibliography: p.
1. Yellowstone National Park--Climate. 2. Grand Teton National Park--Climate. I. Martner, Brooks E. II. Title. III. Series.
QC984.W8D57 551.69787'52 81-607578
AACR2

For sale by the Superintendent of Documents
U.S. Government Printing Office,
Washington, D.C. 20402

CONTENTS

ACKNOWLEDGMENTS

The authors are grateful for the assistance of the following people during the course of the research project.

At the University of Wyoming: Larry V. Irving installed and periodically serviced the UW meterological instruments in the Parks. Frank Davis and Patti Walsh did the computer programming. Lucy Brunner typed most of the annual reports and Loralee Howell typed the manuscript for this publication.

At the Parks: Douglas Houston, Don Despain, and Mary Meagher of the Yellowstone National Park Research Biologist Office, Ted Bucknall of the Yellowstone National Park-Headquarters, Tim Blank at Yellowstone National Park-Canyon, Gary Poulson of the U.S. Forest Service at Teton Village, Peter Hayden of Grand Teton National Park, and other park rangers and personnel provided valuable assistance and/or advice. Phil Farnes of the Soil Conservation Service, Bozeman, Montana, provided unpublished precipitation data and helpful discussions on precipitation in the Parks.

Reviewers: We thank D. Despain, P. E. Farnes, J. W. Fassler, D. B. Houston, W. E. Marlett, and V. L. Mitchell for reviewing this manuscript.

SUMMARY

Climatological records were compiled and integrated to provide a summary of the climate of the Yellowstone and Grand Teton National Parks region. Semicontinuous records of daily maximum and minimum temperature and precipitation exist for several stations in the Parks, beginning as early as 1887. Wind, humidity, sunshine, and other data are very sparse. Tabulations of monthly means and extremes of temperature and precipitation are presented for several stations. Annual precipitation histories, wind velocity distributions, and other climatic data are also provided. The complexity of terrain and the wide range of elevations preclude the possibility that a single generalized description can accurately represent the climate at all localities in the region. However, the data presented typify most of the climatic regimes within the Parks.

INTRODUCTION

Yellowstone and Grand Teton National Parks are among the largest and most spectacular parks in the United States. Far removed from major urban and industrial development and secluded among major ranges of the Rocky Mountains, the Parks have a relatively pristine natural environment in which the processes of nature can be observed. The harsh, mid-latitude, high-mountain climate is a powerful environmental force.

This report presents a brief technical summary of the climate of Yellowstone National Park (YNP) and Grand Teton National Park (GTNP). It is intended to provide a basic, quantitative summary of climatic elements in the Parks region, to extrapolate these observations to remote areas, and to provide an overall description of climate in the Parks. Zoological, botanical, ecological, and hydrologic research, forest fire and recreational management, and other studies should find the data provided in this report beneficial. The information will also be useful to the casual visitor to the Parks who has an interest in climate. A less technical description of the climate of YNP is given by Wirshborn (1978).

Climatic data were extracted from records of the National Weather Service, Federal Aviation Administration, U.S. Forest Service, Soil Conservation Service, and independent sources. The University of Wyoming operated a special wind and temperature measuring network in the Parks for a three year period. Meteorological instrument sites in the Parks region are shown on the map in Figure 1 and are identified in Table 1.

This report is intended to serve as a convenient, basic source of climatic data for the Parks. Those who require additional information or greater detail are referred directly to the five University of Wyoming (UW) project reports by the Department of Atmospheric Science (Dirks 1974, 1975, 1976; Martner 1976, 1977). The data are presented in English measurement units and conversion factors for metric units are given in the Appendix. The Appendix also lists sources of current and additional climatic data.

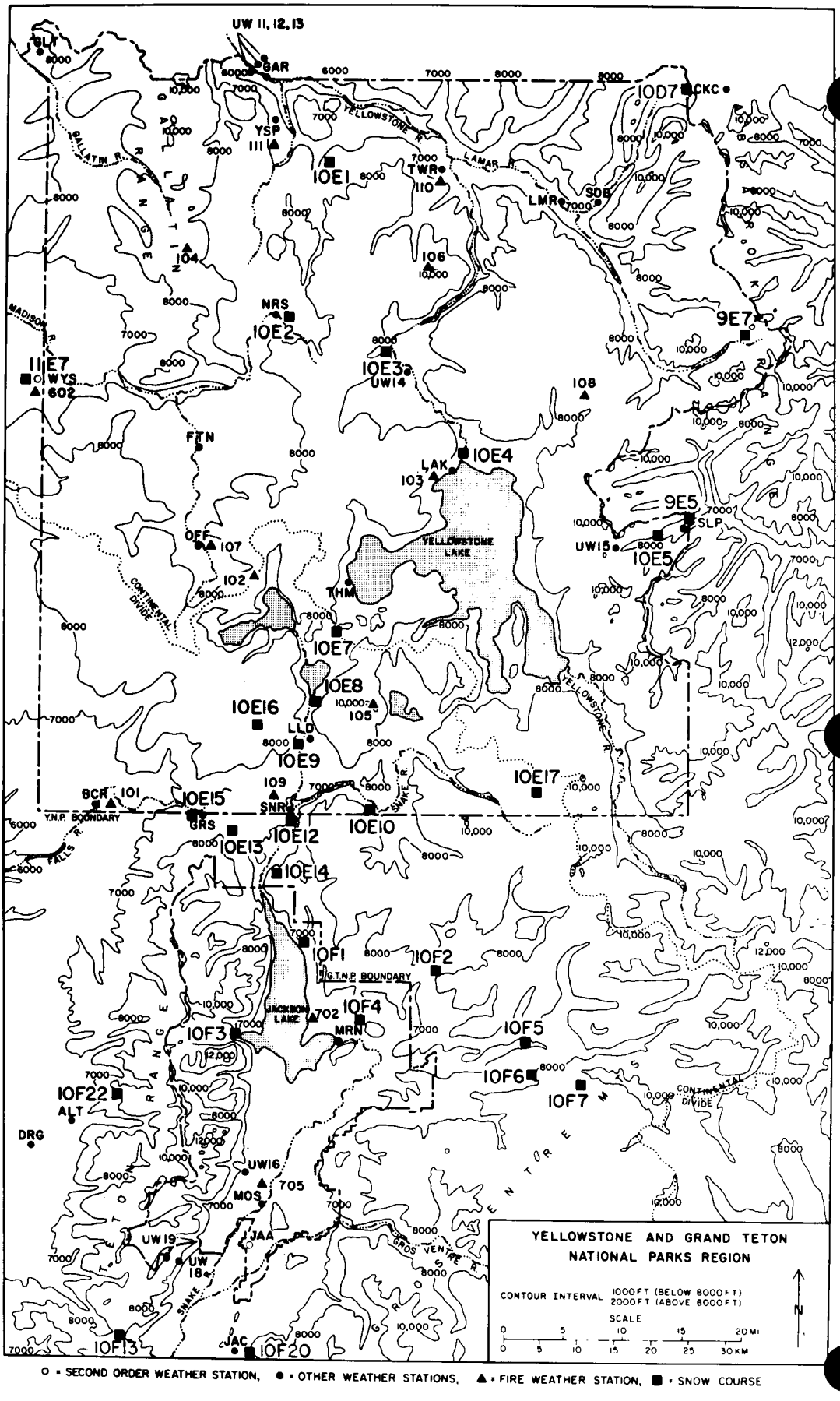
UW 11, 12, 13
GLY
BAR
YSP
111
10E1
TWR
110
LMR
SOB
10D7
CKC
104
106
NRS
10E2
10E3a
UW14
9E7
11E7
WYS
602
108
FTN
10E4
LAK
103
9E5
SLP
UW15
10E5
OFF
107
102
YELLOWSTONE LAKE
THM
10E7
10E8
105
10E16
LLD
10E9
109
10E17
BCR
101
10E15
SNR
GRS
10E12
10E10
10E13
10E14
10F1
10F2
Y.N.P. BOUNDARY
G.T.N.P. BOUNDARY
JACKSON LAKE
702
10F4
MRN
10F3
10F5
10F6
10F7
10F22
ALT
DRG
UW16
705
MOS
UW19
JAA
UW 18
10F13
JAC
10F20
YELLOWSTONE AND GRAND TETON
NATIONAL PARKS REGION
CONTOUR INTERVAL 1000FT (BELOW 8000FT)
2000FT (ABOVE 8000FT)
SCALE
0 5 10 15 20MI
0 5 10 15 20 25 30KM
N
O = SECOND ORDER WEATHER STATION, ● = OTHER WEATHER STATIONS, ▲ = FIRE WEATHER STATION, ■ = SNOW COURSE

Table 1. Index to Meteorological measurement sites in the Parks region.

Station Map code	Station name	State	Elevation (feet)
Second order weather stations			
(semi-hourly recordings of temperature, wind, precipitation)			
JAA	Jackson (airport)	WY	6444
WYS	W. Yellowstone (airport)	MT	6644
	(town)		6669
Other weather stations			
(daily max./min. temperatures, daily precipitation)			
ALT	Alta	WY	6430
BCR	*Bechler River	WY	6300
CKC	Cooke City (NE Entrance)	MT	7553
DRG	Driggs	ID	6097
FTN	*Fountain (Fountain Hotel)	WY	7220
GAR	Gardiner (Game Ranch)	MT	5300
GLT	*Gallatin RS	MT	6900
GRS	Grassy Lake	WY	7240
JAC	Jackson	WY	6244
LAK	Lake Yellowstone	WY	7741
LLD	Lewis Lake Divide	WY	7900
LMR	*Lamar RS (Buffalo Ranch)	WY	6470
MOS	Moose	WY	6470
MRN	Moran	WY	6798
NRS	*Norris	WY	7450
OFF	*Old Faithful	WY	7367
SDB	Soda Butte	WY	6600
SLP	*Sylvan Pass (E. Entrance)	WY	6958
SNR	Snake River	WY	6882
THM	*Thumb	WY	7772
TWR	Tower Falls	WY	6266
YSP	Yellowstone Park HQ (YNP-HQ, also Mammoth Hot Springs, Ft. Yellowstone)	WY	6241
Fire weather stations			
(once or twice daily recordings of several meteorological parameters in summer)			
101	Bechler River RS	WY	6453
102	Divide Look Out	WY	8779
103	Lake RS	WY	7740
104	Mt. Holmes LO	WY	10336
105	Mt. Sheridan LO	WY	10308
106	Mt. Washburn LO	WY	10250
107	Old Faithful	WY	7367
108	Pelican Cone LO	WY	9580
109	Snake River RS	WY	6882
110	Tower Falls RS	WY	6266
111	Yellowstone Park HQ (Mammoth HS)	WY	6241
602	West Yellowstone	MT	6669
702	Colter Bay RS	WY	6850
705	Moose HQ	WY	6457
UW project stations			
(continuous recordings of wind and temperature)			
UW11	*Stevens Creek	MT	5450
UW12	*Hayes Ranch	MT	6160
UW13	*Parker Point	MT	7830

Fig. 1. Base map of Yellowstone and Grand Teton National Parks region. Station codes are explained in Table 1.

UW14	*Hayden Valley (no temperature)	WY	7780
UW15	*Sylvan Pass	WY	8560
UW16	*Beaver Creek	WY	6610
UW18	*Mid-Rendezvous (no wind direction)	WY	8500
UW19	*Upper Rendezvous (wind)	WY	10300
	(temperature)		9600

Snow courses
(monthly snow depth and water content in winter-spring)

9E5	East Entrance	WY	7000
9E7	Parkers Peak	WY	9400
10D7	Northeast Entrance	MT	7400
10E1	Lupine Creek	WY	7300
10E2	Norris Basin	WY	7500
10E3	Canyon	WY	7750
10E4	Lake Camp	WY	7850
10E5	Sylvan Pass	WY	7100
10E7	Thumb Divide	WY	7900
10E8	Aster Creek	WY	7700
10E9	Lewis Lake Divide	WY	7900
10E10	Colter Creek	WY	7600
10E12	Snake River Station	WY	6780
10E13	Glade Creek	WY	7200
10E14	Huckleberry Divide	WY	7300
10E15	Grassy Lake	WY	7265
10E16	Pitchstone Plateau	WY	8640
10E17	Two Ocean Plateau	WY	9200
10F1	Arizona	WY	6850
10F2	Base Camp	WY	6900
10F3	Moran Bay	WY	6800
10F4	Moran	WY	6800
10F5	Turpin Meadows	WY	6930
10F6	Four Mile Meadows	WY	7770
10F7	Blackrock	WY	8600
10F13	*Teton Pass	WY	8500
10F20	Snow King Mountain	WY	7600
10F22	Freds Mountain	WY	8000
11E7	West Yellowstone	MT	6700

* = measurements have been terminated

HISTORY OF CLIMATIC OBSERVATIONS

Fragmentary records or meteorological measurements in YNP were kept by some of the early Park superintendents and were published in their annual reports. Continuous meteorological records began at Mammoth Hot Springs (then Fort Yellowstone) in 1887 under the U.S. Army administration of the Park. Scattered observations and measurements at several locations in the Park were recorded in army log books and kept by the Hospital Corps under administration of the Post Surgeon until 1916. The U.S. Weather Bureau established a first order station at Mammoth in 1903 and operated it until 1941. Since 1941 all routine weather observations in YNP have been taken by National Park Service personnel.

Meteorological observations in the Teton area date back to 1889 with the first cooperative observer at Jackson. Continous records at Jackson began in 1916 with U.S. Forest Service personnel. The oldest continuous record in Jackson Hole is from Moran, where Bureau of Reclamation personnel initiated observations in 1911.

Special meteorological studies were conducted during 2 to 4 week mid-winter periods in YNP by groups of scientists from 1960 to 1971 (e.g., Schaefer 1964). These studies took advantage of the pristine atmospheric environment of the Park and emphasized research on the formation of ice crystals in the geyser basins during extremely cold conditions.

Inferences about the climate of past centuries in the Parks can be made from paleoclimatic evidence, such as in the tree ring studies of Stockton (1973). This

report, however, is concerned with only climatic data since the beginning of recorded meteorological measurements in the Parks.

PHYSIOGRAPHY

The physical geography of an area has an important influence on its surface climate. Yellowstone National Park is primarily a forested volcanic plateau, with an average elevation of about 8,000 feet, situated at the northwest corner of Wyoming (Fig. 1). The plateau is surrounded by higher mountains except on the southwest, where the Snake River High Plains lie about 1,000 feet lower than the volcanic plateau.

The plateau itself is studded with mountains which reach 11,000 feet and is carved by river canyons and wide valleys to as low at 5,300 feet above sea level. The Continental Divide traverses YNP from its southeast corner to its western boundary. The watersheds of the Snake, Yellowstone, Madison, and Gallatin rivers are located in the southwestern, northern and east-central, western, and northwestern regions of the Park, respectively. The highest elevation in YNP is 11,358 feet, at Eagle Peak near the southeast corner, and the lowest point (5,300 ft) is located in the northwest near Gardiner, Montana.

The physiography of GTNP is characterized by the steep slopes of the Teton Mountains on its western boundary. Several peaks exceed 12,000 feet; Grand Teton is the highest at 13,766 feet. The range extends south-southwestward from the Yellowstone Plateau and varies in width from 10 to 15 miles. The eastern slopes of the Teton Range fall abruptly down to Jackson Hole, an intermountain basin about 48 miles long and 6 to 12 miles wide. The Snake River meanders southward through the basin floor which varies in altitude from 7,000 to 6,000 feet. To the east of GTNP lie the Absaroka Mountains and to the southeast lies the Gros Ventre Range.

Yellowstone Lake (elevation 7,733 feet, area 139 square miles, maximum depth 300 feet) in YNP and Jackson Lake (elevation 6,772 feet, area 42 square miles, maximum depth 425 feet) in GTNP are the major bodies of water in the Parks.

NARRATIVE CLIMATE SUMMARY

Yellowstone and Grand Teton National Parks cover an area of 3,956 square miles. Because of the size and complexity of the region's topography and the frequent location of climatological stations in the lower elevations, a complete description of the Parks' diverse climates is not possible. In particular, the mountainous regions of the Parks are not adequately represented by existing data. Dirks (1974) describes the climate of several geographic subregions of the Parks. A general descriptive summary for the entire area is given below. Representative temperature, precipitation, wind, and other data for specific locations are presented in the sections which follow.

The Parks are located deep within the interior of the North American continent, far from the climate-moderating influences of the oceans. Ordinarily, a severe (hot summers and cold winters) and dry climate is expected at such localities. However, the high elevation of the Parks' region is conducive to moderate precipitation and mild summers. Located between 43 and 45 degrees north latitude, the Parks are well within the normal southward excursions of the polar front and are thereby exposed to the frequent, semiperiodic passage of winter storm systems. Summer precipitation is more often dominated by local showers and thunderstorms than by organized frontal systems.

Summer days are usually mild and nights are crisply cool throughout the region. Daytime maximums 70-80°F are commonly replaced by nighttime minimums below 40° F in summer. July is the warmest month, but even then temperatures in excess of 90°F are rare. The record highest temperatures in the Parks region are 103°F at Gardiner in 1960 and 101° F at Jackson in 1934. Summer daytime temperatures are slightly cooler near the shores of the cold waters of Yellowstone and Jackson Lakes. The length of the season between the last freeze in spring and the first freeze in autumn is very brief at all but the lowest elevations. Occasional nighttime frosts can be expected to occur even in midsummer at the higher elevations.

Winters are cold with daily maximum temperatures often remaining below the freezing mark. January is the coldest month with temperatures typically ranging from near 0° F at night to the middle twenties in early afternoon at the nonmountain locations. Extreme cold conditions occur when arctic air invades the intermountain basins and valleys, stagnates there, and is further cooled because of terrestrial radiation into clear skies from snow-covered ground. Frigid stable air sometimes remains trapped for days in the cold basin while warmer temperatures prevail at higher elevations. The record lowest temperatures in the Parks are -66° F near West Yellowstone in 1933 and -63° F at Moran the same year.

Spring and autumn are transitional seasons

between the long cold winter and the short mild summer. The snow cover of winter lingers on the ground into May at many locations. Autumn is pleasant, but cool, with precipitation occurring as either rain or snow.

The average annual precipitation at stations in the Parks area ranges from as little as 11 inches at Gardiner (the lowest elevation in the area) to 38 inches at Bechler River in the southwest corner of YNP. Greater amounts undoubtedly occur high in the mountains, but data are not available for these remote locations. Snow course records suggest that the annual precipitation may exceed 70 inches on the Pitchstone Plateau in the Lewis Lake area of YNP. This is the only area of YNP which is not immediately downwind of a major mountain range.

There is a significant north-south gradient of precipitation along Jackson Hole in GTNP. The southern part of Jackson Hole is somewhat protected from precipitation by the tall massif of the Teton Range upwind which creates a precipitation "shadow." The northern end of Jackson Hole receives more precipitation because of the relative absence of an upwind barrier. There is also an east-west gradient of snowfall across Jackson Hole with greater amounts accumulating closer to the Teton Mountains.

Most areas of the Parks receive more precipitation in winter than in summer. The high elevations are responsible for deep accumulations of snow in winter which remain on the ground into spring. The highest peaks in the Tetons harbor small glaciers and areas of snow cover all year round. The relatively low stations in northern YNP receive their greatest amounts of precipitation during the spring and summer months.

Surface winds in the Parks display a wide range of prevailing directions, mean speeds, and frequency of calm periods, depending strongly on the surrounding topography and elevation of the site. Diurnal and seasonal changes in the distribution of wind velocities occur at protected locations (e.g., within valleys). At the higher exposed locations (such as fire lookout stations) the prevailing winds are consistently from the southwest. Periods of calm are rare at high exposed places but fairly common in basins and closed valleys, especially in early morning. Subfreezing temperatures and strong winds often combine in winter to create dangerously cold wind-chill conditions in the Parks.

Temperature, precipitation, wind, and other climate factors at specific locations are discussed in the sections that follow.

CLIMATOLOGICAL SUMMARY TABLES

Monthly mean and extreme values of temperature and precipitation for ten stations in the Parks region are given in Tables 2-11. Similar summaries for Cody, Wyoming; Cooke City, Montana; Crandall Creek, Wyoming; Driggs, Idaho; Dubois, Wyoming; Gardiner, Montana; NE Entrance, Montana; and Old Faithful, Wyoming, can be found in Dirks (1974).

Table 2.
Climatological Summary

Latitude 43°46'
Longitude 111°02'
Elev. (Ground) 6,431

Station Alta

Means and Extremes for Period 1941-1970

	Temperature (°F)								Precipitation totals (inches)								Mean number of days					
	Means			Extremes								Snow, Sleet[b]						Temperatures (°F)				
																		Max.		Min.		
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days[a]	Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip. .10 or more	90° and above	32° and below	32° and below	0° and below	Month
JAN	29.7	9.9	19.8	55.0	1959	-35.0	1963	1429	1.69	0.81	1943						6.2	0.0	18.7	30.1	5.6	JAN
FEB	34.7	12.1	23.4	57.0	1958	-36.0	1942	1170	1.33	0.84	1968						4.7	0.0	10.6	27.0	4.0	FEB
MAR	38.7	15.2	27.0	63.0	1960	-23.0	1943	1181	1.30	0.68	1958						5.4	0.0	7.5	29.5	2.7	MAR
APR	48.1	25.5	36.8	75.0	1946	- 2.0	1953	837	1.67	1.54	1957						5.0	0.0	0.9	23.9	0.1	APR
MAY	60.8	34.2	47.5	85.0	1966	8.0	1967	543	2.22	1.12	1957						7.0	0.0	0.0	13.4	0.0	MAY
JUN	68.1	40.4	54.2	90.0	1954	23.0	1945	326	2.71	1.58	1964						8.2	0.1	0.0	3.6	0.0	JUN
JUL	79.5	47.0	63.3	95.0	1960	20.0	1968	93	0.90	1.08	1943						2.8	0.7	0.0	0.4	0.0	JUL
AUG	78.0	45.2	61.6	92.0	1954	24.0	1956	136	1.37	1.25	1962						3.6	0.7	0.0	0.6	0.0	AUG
SEP	68.1	37.8	53.0	90.0	1950	15.0	1965	366	1.56	1.11	1946						4.2	0.7	0.0	8.2	0.0	SEP
OCT	56.8	30.1	43.4	79.0	1956	3.0	1970	670	1.47	1.05	1967						4.6	0.0	0.5	18.9	0.0	OCT
NOV	39.6	18.8	29.2	71.0	1946	-22.0	1955	1062	1.56	1.16	1968						6.0	0.0	7.8	27.4	1.7	NOV
DEC	31.6	12.4	22.0	52.0	1946	-25.0	1942	1336	1.80	1.11	1941						6.4	0.0	16.5	29.8	3.8	DEC
					July		Feb				June											
Year	52.8	27.4	40.1	95.0	1960	-36.0	1942	9149	19.58	1.58	1964						64.0	1.5	62.4	212.7	18.1	Year

Average length of record, years (28)

Table 3.
Climatological Summary

Latitude 43°29'
Longitude 110°46'
Elev. (Ground) 6,244

Station Jackson

Means and Extremes for Period 1941-1970

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days[a]	Precipitation totals (inches): Mean	Greatest daily	Year	Snow, Sleet[b]: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip .10 or more	Temperatures (°F) Max.: 90° and above	32° and below	Min.: 32° and below	0° and below	Month
JAN	25.6	3.8	14.7	55.0	1953	-49.0	1962	1566	1.55	1.15	1943						5.3	0.0	21.0	30.1	13.1	JAN
FEB	31.4	7.4	19.4	56.0	1951	-44.0	1942	1280	1.08	1.16	1963						3.7	0.0	14.2	27.3	9.3	FEB
MAR	38.3	13.0	25.7	61.0	1966	-32.0	1966	1221	1.04	0.65	1946						3.9	0.0	6.7	29.8	5.3	MAR
APR	51.3	24.2	37.8	81.0	1943	- 4.0	1945	816	1.09	0.90	1948						3.7	0.0	0.2	26.1	0.0	APR
MAY	62.5	30.1	46.3	83.0	1948	13.0	1943	577	1.51	1.01	1966						5.1	0.0	0.0	19.7	0.0	MAY
JUN	70.2	36.2	53.2	94.0	1941	19.0	1966	354	1.84	1.04	1967						5.9	0.1	0.0	7.8	0.0	JUN
JUL	81.0	40.1	60.6	95.0	1946	24.0	1954	146	0.70	1.00	1962						2.3	1.1	0.0	2.8	0.0	JUL
AUG	79.3	38.0	58.6	94.0	1958	18.0	1960	202	1.14	1.13	1941						3.5	0.7	0.0	6.6	0.0	AUG
SEP	70.3	31.2	50.8	93.0	1956	14.0	1954	426	1.25	1.16	1966						3.3	0.3	0.0	18.8	0.0	SEP
OCT	58.7	23.6	41.1	84.0	1958	5.0	1957	738	1.04	0.84	1949						3.5	0.0	0.2	25.6	0.0	OCT
NOV	39.2	15.8	27.5	64.0	1954	-27.0	1955	1128	1.28	1.12	1950						4.1	0.0	7.8	27.5	4.0	NOV
DEC	27.9	7.1	17.5	57.0	1945	-40.0	1961	1479	1.65	1.40	1964						5.8	0.0	19.4	30.6	9.4	DEC
Year	53.0	22.5	36.8	95.0	July 1946	-49.0	Jan 1962	9933	15.17	1.40	Dec. 1964						50.1	2.2	69.5	252.5	41.0	Year

Average length of record, years (30)

Table 4.
Climatological Summary

Latitude 44°34'
Longitude 110°24'
Elev. (Ground) 7,741

Station Lake Yellowstone

Means and Extremes for Period 1948-1970

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days[a]	Precipitation totals (inches): Mean	Greatest daily	Year	Snow, Sleet[b]: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip .10 or more	Temperatures (°F) Max.: 90° and above	32° and below	Min.: 32° and below	0° and below	Month
JAN	22.4	-1.1	10.7	44.0	1962	-50.0	1963	1686	2.08	1.35	1969						7.0	0.0	25.7	30.2	15.3	JAN
FEB	28.2	0.5	14.3	49.0	1958	-46.0	1951	1428	1.38	1.20	1962						4.7	0.0	16.2	25.3	11.7	FEB
MAR	32.9	1.1	17.0	56.0	1960	-42.0	1965	1466	1.29	0.64	1951						5.1	0.0	12.1	26.2	11.7	MAR
APR	42.8	14.4	28.6	65.0	1952	-21.0	1970	1074	1.15	0.89	1965						4.0	0.0	1.9	24.5	2.4	APR
MAY	52.1	25.2	38.7	73.0	1956	1.0	1954	806	1.52	0.86	1966						4.8	0.0	0.0	24.7	0.0	MAY
JUN	61.3	33.2	47.3	84.0	1970	14.0	1951	540	1.98	1.00	1964						6.2	0.0	0.0	13.4	0.0	JUN
JUL	71.6	38.9	55.2	89.0	1955	23.0	1952	301	1.13	1.32	1952						3.5	0.0	0.0	3.9	0.0	JUL
AUG	70.4	38.0	54.2	85.0	1970	22.0	1956	329	1.63	1.40	1961						4.7	0.0	0.0	6.3	0.0	AUG
SEP	61.5	29.8	45.7	83.0	1950	7.0	1965	576	1.51	1.57	1966						4.3	0.0	0.0	17.4	0.0	SEP
OCT	51.0	22.3	36.7	72.0	1955	-2.0	1951	887	1.20	1.24	1964						3.6	0.0	0.8	28.0	0.1	OCT
NOV	34.7	12.7	23.7	63.0	1949	-30.0	1955	1245	1.47	0.80	1958						5.8	0.0	11.1	28.9	4.3	NOV
DEC	26.2	4.5	15.4	45.0	1962	-38.0	1964	1528	1.97	1.42	1955						7.0	0.0	23.0	32.4	11.5	DEC
Year	46.3	18.3	32.3	89.0	July 1955	-50.0	Jan 1963	11866	18.29	1.57	Sept 1966						60.7	0.0	91.7	261.3	57.0	Year

Average length of record, years (22)

a = Base 65 F (estimated)
b = Current data unavailable
T = Trace, an amount too small to measure
* = More than 0 but less than one-half day
+ = Also on earlier dates, months or years

Table 5.
Climatological Summary

Station Lamar RS

Latitude 44°54′
Longitude 110°14′
Elev. (Ground) 6,470

Means and Extremes for Period 1948-1972

	Temperature (°F)								Precipitation totals (inches)								Mean number of days					
	Means			Extremes								Snow, Sleet[b]						Temperatures (°F)				
																		Max.		Min.		
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days[a]	Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip .10 or more	90° and above	32° and below	32° and below	0° and below	Month
JAN	23.3	-0.9	11.2	47.0	1953	-55.0	1962	1646	0.93	0.90	1962						3.0	0.0	20.7	26.6	13.4	JAN
FEB	30.8	5.0	17.9	54.0	1958	-43.0	1951	1327	0.59	0.66	1962						2.3	0.0	12.8	23.5	9.3	FEB
MAR	36.9	7.9	22.4	60.0	1966	-37.0	1965	1311	0.68	0.50	1962						2.5	0.0	7.9	24.9	7.2	MAR
APR	48.1	19.5	33.8	73.0	1952	-14.0	1953	915	0.78	0.65	1953						2.9	0.0	0.5	22.5	0.5	APR
MAY	60.2	27.7	44.0	82.0	1954	9.0	1954	645	1.45	0.70	1964						5.1	0.0	0.0	21.0	0.0	MAY
JUN	68.3	34.2	51.2	87.0	1954	17.0	1968	426	2.09	0.99	1969						6.7	0.0	0.0	10.6	0.0	JUN
JUL	78.1	36.9	57.5	94.0	1956	21.0	1952	237	1.26	1.60	1952						4.1	0.5	0.0	6.4	0.0	JUL
AUG	76.8	34.8	55.8	91.0	1954	19.0	1960	282	1.18	0.99	1960						3.8	0.2	0.0	10.7	0.0	AUG
SEP	67.6	28.4	48.0	91.0	1950	5.0	1962	516	1.28	1.45	1966						3.5	0.0	0.0	20.1	0.0	SEP
OCT	56.6	21.6	39.1	77.0	1957	-4.0	1961	818	0.76	0.78	1964						2.5	0.0	0.5	23.3	0.1	OCT
NOV	39.0	13.1	26.1	65.0	1962	-35.0	1959	1194	0.64	0.65	1966						2.0	0.0	6.4	25.4	4.5	NOV
DEC	27.3	2.9	15.1	47.0	1965	-51.0	1964	1547	0.82	0.43	1957						3.2	0.0	18.9	27.9	11.9	DEC
Year	51.1	19.3	35.2	94.0	July 1956	-55.0	Jan 1962	10864	12.46	1.60	July 1952						41.7	0.8	67.6	242.8	46.8	Year

Average length of record, years (21)

Table 6.
Climatological Summary

Station Moran

Latitude 43°51′
Longitude 110°35′
Elev. (Ground) 6,798

Means and Extremes for Period 1955-1970 Temperature
1941-1970 Precipitation

	Temperature (°F)								Precipitation totals (inches)								Mean number of days					
	Means			Extremes								Snow, Sleet						Temperatures (°F)				
																		Max.		Min.		
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days[a]	Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip .10 or more	90° and above	32° and below	32° and below	0° and below	Month
JAN	24.3	1.0	12.7	44.0	1967	-44.0	1963	1617	2.81	1.53	1963	42.5	93.0	1970	15.0	1962	9.0	0.0	26.0	31.0	16.0	JAN
FEB	30.4	4.1	17.3	51.0	1963	-46.0	1956	1344	2.10	0.98	1963	31.6	50.0	1945	15.0	1951	7.0	0.0	16.0	28.0	12.0	FEB
MAR	36.4	7.5	22.0	56.0	1966+	-33.0	1955	1326	1.82	0.75	1959	27.1	51.5	1950	16.0	1959	7.0	0.0	10.0	31.0	10.0	MAR
APR	45.4	20.7	33.1	66.0	1962	-11.0	1970	951	1.72	1.07	1965	12.4	29.0	1970	9.0	1958	6.0	0.0	1.0	29.0	1.0	APR
MAY	57.9	30.4	44.2	78.0	1956	8.0	1970	639	2.03	1.25	1963	2.9	15.0	1942	5.0	1967+	7.0	0.0	*	20.0	0.0	MAY
JUN	66.8	37.7	52.3	85.0	1970	19.0	1966	374	1.85	0.95	1953	0.5	6.5	1954	4.0	1954	6.0	*	0.0	8.0	0.0	JUN
JUL	77.4	41.5	59.5	90.0	1955	28.0	1956	167	0.88	1.07	1951	0.0	T	1954	T	1954+	3.0	*	0.0	1.0	0.0	JUL
AUG	75.6	40.1	57.9	90.0	1961	24.0	1965	215	1.30	0.92	1961	0.1	2.0	1943	2.0	1943	4.0	0.0	0.0	3.0	0.0	AUG
SEP	65.1	33.0	49.1	84.0	1967+	14.0	1965	469	1.59	1.05	1961	2.3	20.0	1961	13.5	1950	4.0	0.0	0.0	15.0	0.0	SEP
OCT	53.4	24.9	39.2	73.0	1957	2.0	1970	793	1.40	1.03	1967	5.5	20.0	1961	7.0	1946+	4.0	0.0	1.0	27.0	0.0	OCT
NOV	36.7	15.0	25.9	58.0	1969+	-28.0	1955	1167	2.32	1.08	1958	23.9	49.3	1942	12.0	1942	8.0	0.0	10.0	30.0	4.0	NOV
DEC	27.1	5.2	16.2	45.0	1965+	-36.0	1961	1507	2.69	1.75	1964	40.1	79.5	1951	18.0	1951	9.0	0.0	23.0	31.0	11.0	DEC
Year	49.7	21.8	35.8	90.0	Aug 1961+	-46.0	Feb 1956	10569	22.51	1.75	Dec 1964	188.9	93.0	Jan 1970	18.0	Dec 1951	74.0	*	87.0	254.0	54.0	Year

Average length of record, years (16, temperature; 30, precipitation)

a = Base 65 F (estimated)
b = Current data unavailable
T = Trace, an amount too small to measure
* = More than 0 but less than one-half day
+ = Also on earlier dates, months or years

Table 7.
Climatological Summary — Station Moose

Latitude 43°40′
Longitude 110°43′
Elev. (Ground) 6,470
Means and Extremes for Period 1959-1970

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days[a]	Precipitation totals (inches): Mean	Greatest daily	Year	Snow, Sleet: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip .10 or more	Temperatures (°F) Max.: 90° and above	32° and below	Min.: 32° and below	0° and below	Month
JAN	25.4	2.8	14.1	45.0	1960	-44.0	1963	1573	2.77	0.91	1965	53.0	103.0	1965	21.0	1962	8.0	0.0	23.0	31.0	14.0	JAN
FEB	31.3	6.1	18.7	55.0	1953	-30.0	1960	1303	1.93	0.91	1962	31.4	69.0	1960	14.0	1960	6.0	0.0	16.0	28.0	11.0	FEB
MAR	37.5	10.1	23.8	58.0	1966	-25.0	1965+	1271	1.45	1.40	1965	25.1	47.5	1964	12.0	1965	5.0	0.0	8.0	31.0	8.0	MAR
APR	48.6	22.9	35.8	70.0	1969	-10.0	1970	870	1.46	1.22	1965	10.5	23.0	1963	7.0	1967	5.0	0.0	*	28.0	*	APR
MAY	61.8	31.0	46.4	81.0	1966	10.0	1967	569	1.78	1.15	1963	2.1	7.0	1964+	5.0	1961	6.0	0.0	*	18.0	0.0	MAY
JUN	70.8	37.9	54.4	88.0	1968	20.0	1966	314	2.13	1.10	1969	*	T	1966	T	1966	7.0	0.0	0.0	5.0	0.0	JUN
JUL	81.7	41.2	61.5	92.0	1960	27.0	1969+	114	0.68	0.77	1962	*	T	1963	T	1963	2.0	1.0	0.0	1.0	0.0	JUL
AUG	79.7	39.6	59.7	93.0	1961+	23.0	1965+	168	1.16	1.04	1960	0.0	0.0		0.0		3.0	1.0	0.0	4.0	0.0	AUG
SEP	68.4	33.2	50.8	88.0	1967	15.0	1965	420	1.69	1.43	1966	1.0	6.0	1959	4.0	1959	5.0	0.0	0.0	14.0	0.0	SEP
OCT	56.7	24.2	40.5	76.0	1963+	1.0	1970	745	1.22	0.80	1960	4.0	20.0	1961	6.0	1961	4.0	0.0	*	27.0	0.0	OCT
NOV	39.5	16.0	27.8	62.0	1965	-18.0	1967	1110	1.96	0.94	1963	25.8	46.0	1961	15.0	1964	7.0	0.0	6.0	29.0	3.0	NOV
DEC	27.0	3.0	15.0	45.0	1965+	-35.0	1961	1543	2.35	1.51	1964	43.1	75.0	1964	14.0	1959	7.0	0.0	21.0	31.0	3.0	DEC
Year	52.4	22.3	37.4	93.0	Aug 1961+	-44.0	Jan 1963	10009	20.58	1.51	Dec 1964	196.0	103.0	Jan 1965	21.0	Jan 1962	65.0	2.0	74.0	247.0	49.0	Year

Average length of record, years (12)

Table 8.
Climatological Summary — Station Snake River

Latitude 44°08′
Longitude 110°40′
Elev. (Ground) 6,882
Means and Extremes for Period 1948-1957

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days[a]	Precipitation totals (inches): Mean	Greatest daily	Year	Snow, Sleet[b]: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip .10 or more	Temperatures (°F) Max.: 90° and above	32° and below	Min.: 32° and below	0° and below	Month
JAN	24.9	1.9	13.4	45.0	1950	-39.0	1951		4.23	2.20	1953						12.7	0.0	22.0	30.8	13.6	JAN
FEB	30.4	2.2	16.3	50.0	1954	-45.0	1950		3.75	1.35	1950						10.0	0.0	14.7	28.2	13.0	FEB
MAR	35.1	6.6	20.8	58.0	1956	-36.0	1955		3.38	1.04	1954						9.1	0.0	10.9	31.0	10.9	MAR
APR	47.6	18.5	33.0	65.0	1952	-10.0	1956		2.02	0.89	1954						7.0	0.0	0.5	29.0	1.1	APR
MAY	57.8	27.6	42.7	80.0	1954	6.0	1950		1.84	1.00	1957						5.4	0.0	0.0	22.2	0.0	MAY
JUN	66.3	32.9	49.6	86.0	1954	21.0	1951		2.08	0.99	1950						5.3	0.0	0.0	14.6	0.0	JUN
JUL	78.4	37.8	58.1	97.0	1951	25.0	1956		1.40	2.00	1950						3.4	0.6	0.0	5.4	0.0	JUL
AUG	76.5	36.2	56.3	88.0	1949	21.0	1956		1.30	0.87	1948						4.2	0.0	0.0	11.0	0.0	AUG
SEP	68.2	28.4	48.3	89.0	1950	14.0	1956		1.46	1.70	1950						3.6	0.0	0.0	25.2	0.0	SEP
OCT	54.1	21.8	37.9	75.0	1957	0.0	1951		2.10	1.04	1951						6.4	0.0	0.4	32.1	0.1	OCT
NOV	37.1	11.3	24.2	61.0	1949	-38.0	1955		3.05	0.96	1955						8.4	0.0	9.4	31.0	7.1	NOV
DEC	26.6	5.0	15.8	44.0	1950	-37.0	1948		4.53	1.75	1948						11.3	0.0	21.4	30.9	10.8	DEC
Year	50.3	19.2	34.7	97.0	Jul 1951	-45.0	Feb 1950		31.15	2.20	Jan 1953						86.8	0.6	79.3	291.4	56.6	Year

Average length of record, years (9)

a = Base 65 F (estimated)
b = Current data unavailable
T = Trace, an amount too small to measure
* = More than 0 but less than one-half day
+ = Also on earlier dates, months or years

Table 9.

Latitude 44°55′
Longitude 110°25′
Elev. (Ground) 6,266

Climatological Summary

Station Tower Falls

Means and Extremes for Period 1941-1970

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days[a]	Precipitation totals (inches): Mean	Greatest daily	Year	Snow, Sleet[b]: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip .10 or more	Temperatures (°F) Max.: 90° and above	32° and below	Min.: 32° and below	0° and below	Month
JAN	25.9	-0.1	12.9	55.0	1954	-48.0	1951	1590	0.89	0.67	1962						3.0	0.0	12.8	19.0	9.5	JAN
FEB	33.5	4.9	19.2	56.0	1950	-41.0	1951	1285	0.82	0.74	1962						3.1	0.0	7.4	17.8	6.5	FEB
MAR	40.2	9.1	24.6	62.0	1956	-32.0	1955	1274	0.86	0.62	1962						3.2	0.0	3.6	19.1	5.0	MAR
APR	50.7	20.0	35.4	73.0	1952	-5.0	1953	891	1.10	0.80	1953						3.6	0.0	0.3	18.3	0.3	APR
MAY	61.1	28.3	44.7	82.0	1954	0.0	1954	632	2.20	1.07	1960						6.7	0.0	0.0	23.3	0.0	MAY
JUN	68.6	33.9	51.2	88.0	1954	16.0	1951	417	2.30	1.28	1947						6.5	0.0	0.0	12.0	0.0	JUN
JUL	79.3	37.5	58.4	94.0	1944	20.0	1952	206	1.50	1.15	1952						4.9	0.8	0.0	5.2	0.0	JUL
AUG	78.8	36.4	57.6	94.0	1961	19.0	1956	237	1.44	1.07	1952						4.8	0.5	0.0	8.0	0.0	AUG
SEP	69.0	29.3	49.2	93.0	1955	11.0	1945	486	1.42	0.95	1941						4.1	0.2	0.0	21.1	0.0	SEP
OCT	56.7	22.0	39.3	78.0	1957	-2.0	1961	812	0.78	0.71	1959						2.7	0.0	0.3	19.1	0.1	OCT
NOV	38.1	11.5	24.8	62.0	1949	-31.0	1959	1206	0.76	0.69	1958						3.0	0.0	5.5	19.5	4.4	NOV
DEC	29.4	4.5	16.9	46.0	1962	-34.0	1948	1504	0.91	0.68	1955						3.8	0.0	12.9	20.5	8.0	DEC
Year	52.6	19.8	36.2	94.0	Aug 1961	-48.0	Jan 1951	10504	14.99	1.28	Jun 1947						49.5	1.5	42.9	202.9	33.8	Year

Average length of record, years (29)

Table 10.

Latitude 44°39′
Longitude 111°6′
Elev. (Ground) 6,669

Climatological Summary

Station West Yellowstone

Means and Extremes for Period 1941-1970

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days[a]	Precipitation totals (inches): Mean	Greatest daily	Year	Snow, Sleet: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip .10 or more	Temperatures (°F) Max.: 90° and above	32° and below	Min.: 32° and below	0° and below	Month
JAN	24.2	-1.4	11.4	44.0	1953	-60.0	1963	1662	2.44	1.66	1943	35.2	67.8	1965	24.0	1962	7.6	0.0	25.2	30.9	15.0	JAN
FEB	31.3	2.2	16.7	56.0	1947	-52.0	1951	1350	1.63	1.05	1962	25.8	54.0	1961	12.0	1962	5.8	0.0	15.6	28.2	11.8	FEB
MAR	37.8	6.5	22.2	61.0	1966	-43.0	1955	1333	1.63	1.08	1967	24.0	48.0	1957	13.0	1967	5.5	0.0	7.9	29.7	9.4	MAR
APR	47.5	19.5	33.5	72.0	1946	-17.0	1945	942	1.48	0.96	1954	10.5	33.5	1963	10.0	1941	4.8	0.0	0.6	28.7	0.6	APR
MAY	58.9	28.8	43.8	83.0	1954	0.0	1954	654	2.33	1.47	1945	4.0	24.0	1942	7.0	1966	7.3	0.0	0.0	22.2	0.0	MAY
JUN	67.5	35.3	51.4	91.0	1970	19.0	1951	411	2.77	1.33	1952	0.9	8.5	1954	4.5	1951	8.3	0.0	0.0	9.3	0.0	JUN
JUL	79.9	39.4	59.6	95.0	1960	20.0	1948	176	1.24	1.37	1951		T	1953	0.0		3.7	1.2	0.0	3.7	0.0	JUL
AUG	77.2	37.4	57.3	96.0	1961	18.0	1956	245	1.42	1.36	1951	0.2	4.0	1960	4.0	1960	4.4	0.7	0.0	6.8	0.0	AUG
SEP	66.0	29.6	47.8	91.0	1950	11.0	1965	516	1.50	1.13	1961	1.5	7.8	1945	6.5	1944	3.9	0.1	0.1	20.9	0.0	SEP
OCT	52.9	22.0	37.5	79.0	1957	- 4.0	1951	853	1.72	1.46	1961	7.9	33.5	1956	14.0	1956	4.7	0.0	0.9	28.9	0.2	OCT
NOV	35.0	10.8	22.9	64.0	1962	-36.0	1952	1263	2.03	0.89	1955	22.5	45.5	1960	12.0	1951	6.4	0.0	12.0	29.5	6.4	NOV
DEC	25.9	2.0	14.0	54.0	1946	-52.0	1964	1581	2.32	1.56	1941	31.9	61.4	1964	13.0	1966	8.0	0.0	24.4	30.7	13.0	DEC
Year	50.3	19.3	34.8	96.0	Aug 1961	-60.0	Jan 1963	10986	22.50	1.66	Jan 1943	164.4	67.8	Jan 1965	24.0	Jan 1962	70.3	2.0	86.7	269.4	56.4	Year

Average length of record, years (30)

a = Base 65 F (estimated)
b = Current data unavailable
T = Trace, an amount too small to measure
* = More than 0 but less than one-half day
+ = Also on earlier dates, months or years

Table 11.
Climatological Summary

Latitude 44°58'
Longitude 110°42'
Elev. (Ground) 6,241

Station Yellowstone Park, YNP-HQ (MAMMOTH)

Means and Extremes for Period 1951-1974

	Temperature (°F)								Precipitation totals (inches)								Mean number of days					
	Means			Extremes								Snow, Sleet						Temperatures (°F)				
																		Max.		Min.		
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days[a] (1941-1970)	Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip. .10 or more	90° and above	32° and below	32° and below	0° and below	Month
JAN	28.7	9.8	19.3	50	1974	-36	1963	1429	1.41	0.90	1968	17.9	40.2	1954	32.0	1968	5	0	18	30	7	JAN
FEB	34.2	13.3	23.8	55	1958	-29	1962	1168	0.84	0.70	1972	11.7	20.6	1971	24.0	1968	3	0	11	27	4	FEB
MAR	38.9	15.2	27.1	64	1972	-25	1956	1187	1.07	1.17	1974	13.2	31.5	1952	23.0	1955	4	0	8	29	4	MAR
APR	48.8	24.9	36.9	74	1962	3	1966	825	1.29	0.87	1958	6.7	23.0	1958	19.0	1955	4	0	1	26	0	APR
MAY	61.1	33.5	47.3	83	1954	9	1954	558	1.88	1.20	1960	1.2	6.0	1959	5.0	1965	6	0	0	12	0	MAY
JUN	69.9	40.6	55.3	90	1974	21	1966	333	2.19	0.92	1952	0.1	1.0	1973	1.0	1973	7	0	0	3	0	JUN
JUL	81.0	45.5	63.3	95	1967	25	1968	99	1.16	0.89	1952	0.0					4	1	0	1	0	JUL
AUG	78.7	44.7	61.7	94	1961	24	1968	147	1.44	0.94	1968	0.1	2.0	1964	2.0	1964	4	1	0	1	0	AUG
SEP	67.9	36.3	52.1	90	1967	12	1965	394	1.26	1.54	1966	1.2	6.2	1970	4.0	1957	4	0	0	9	0	SEP
OCT	56.3	28.8	42.6	79	1968	1	1971	691	0.98	0.74	1964	3.4	11.0	1951	8.0	1964	3	0	1	21	0	OCT
NOV	39.4	19.3	29.4	65	1965	-27	1959	1065	1.12	0.90	1960	8.4	21.0	1966	18.0	1966	3	0	6	28	2	NOV
DEC	30.9	11.8	21.4	52	1962	-34	1964	1330	1.23	1.70	1955	16.2	31.3	1951	19.0	1967	4	0	17	31	5	DEC
Year	53.0	27.0	40.0	95	Jul 1967	-36	Jan 1963	9226	15.87	1.70	Dec 1955	80.1	40.2	Jan 1954	32.0	1968	51	2	62	218	22	Year

Average length of record, years (25)

TEMPERATURE

Monthly temperature probabilities for several Wyoming stations have been determined by Becker and Alyea (1964). Figures 2-5 show the expected midmonth temperatures for Jackson, Lake Yellowstone, Moran, and YNP-HQ (Mammoth). Similar graphs have been determined for Tower Falls and Lamar and are reproduced by Dirks (1974).

The elevation of a station has a great influence on its temperature. On summer afternoons when the lower atmosphere is well mixed by convection from the solar-heated ground, temperatures are expected to decrease with height at about the rate of 5.4°F per 1,000 feet, the dry adiabatic lapse rate. Figure 6 illustrates this height dependence of temperature for stations in the Parks region. This height dependence can normally be extrapolated to high mountain elevations.

Temperature inversions occur in the lower atmosphere when the air aloft is warmer than air close to the ground. Surface temperature inversions are primarily due to nighttime radiative cooling of the earth's surface. The colder surface air drains down slope surfaces and collects in the valleys and basins so that the inversion layer may be deep in the valleys and quite shallow on the plateau and mountain slopes. During winter outbreaks, cold arctic air may intrude into the Parks' valleys or even the plateau, producing persistent, deep inversion layers. Nighttime and early morning inversions are common all year, but persistent inversions that linger into afternoon occur mainly in the winter months. The frequency of inversions near Gardiner is shown in Table 12. This is the only location in the Parks region where such data have been obtained in a relatively complete fashion. The data are from the special UW wind-thermograph instruments (UW11, 12, and 13 in Table 1) situated at three elevations along the slopes above the Yellowstone River. These data should be representative of the inversion frequency for most deep valleys in the Parks.

Mean temperatures at three elevations on Rendezvous Mountain at the Jackson Hole Ski Area immediately south of GTNP are presented in Table 13 from the data of Poulson (1974). The Upper Rendezvous station, at 9,600 feet, is the highest place where winter temperatures have been recorded and may generally represent conditions at high elevations in the Parks.

The season between late spring and early autumn frosts is very brief in the Parks. The average dates of the last occurrence of freezing and subfreezing temperature thresholds in spring and the first occurrence in autumn are presented in Table 14, which is condensed from Becker et al. (1961). Frosts occur at high elevations even in midsummer.

Average diurnal temperature ranges for ten stations are shown in Table 15. The spread between the daily maximum and minimum temperature is greatest in summer and least in winter. The narrow spread in

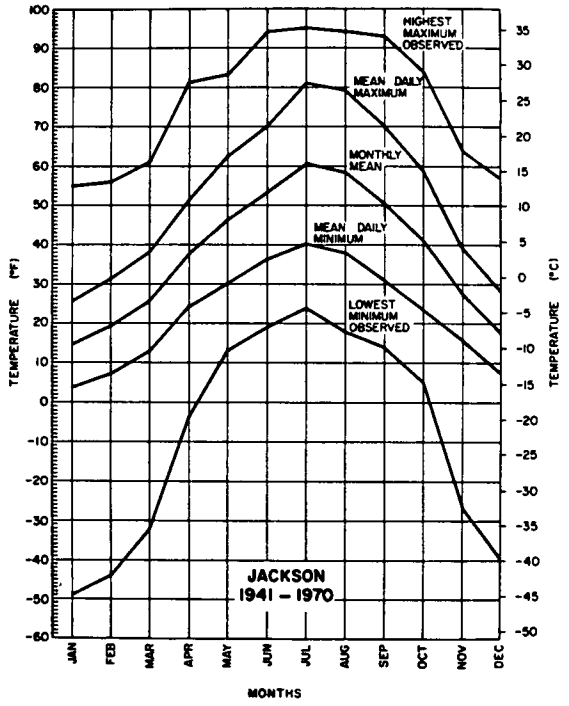

Fig. 2. Monthly mean and extreme temperatures for Jackson (1941–1970).

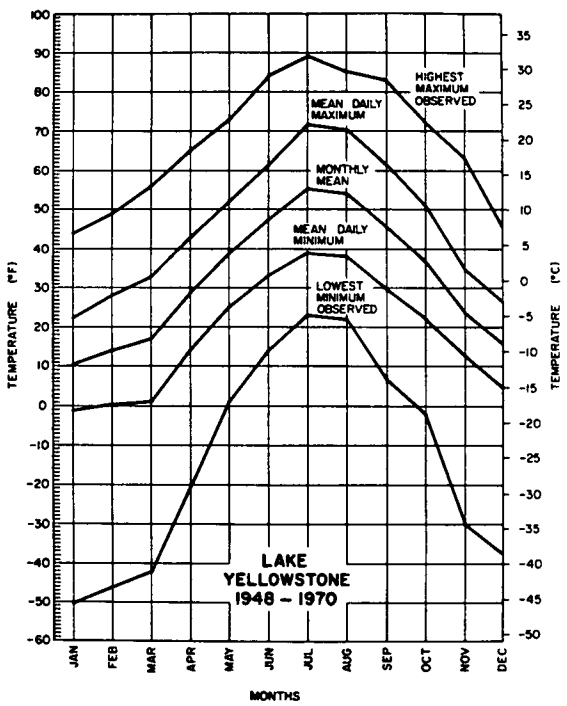

Fig. 3. Monthly mean and extreme temperatures for Lake Yellowstone (1948–1970).

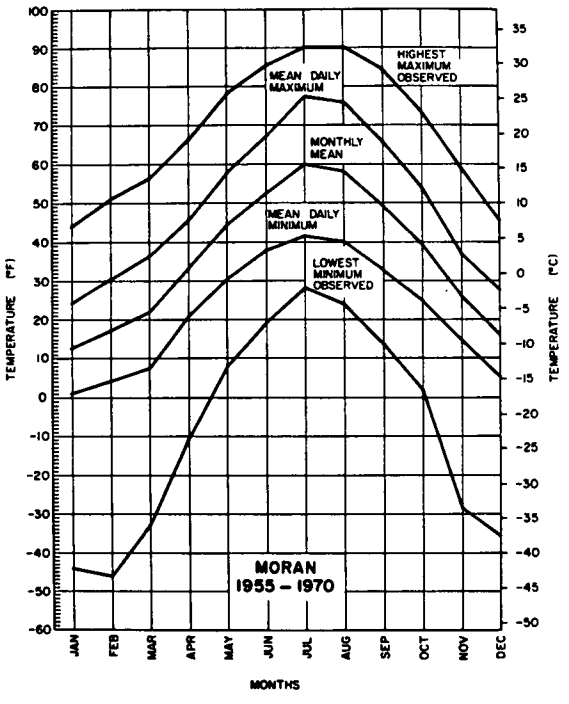

Fig. 4. Monthly mean and extreme temperatures for Moran (1955–1970).

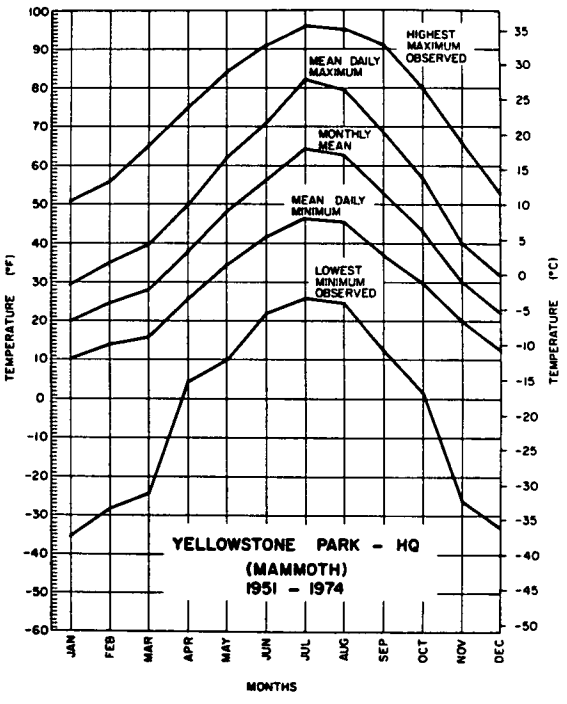

Fig. 5. Monthly mean and extreme temperatures for Yellowstone Park, YNP–HQ (1951–1974).

winter is due to reduced daytime warming during the short daylight periods, low sun angles, the high albedo (reflectivity) of snow cover, and the frequent occurrence of winter storms.

Dirks (1974) lists the monthly mean temperatures for numerous stations for 1887 to 1972 and Martner (1977) gives the same information for 1973 to 1976.

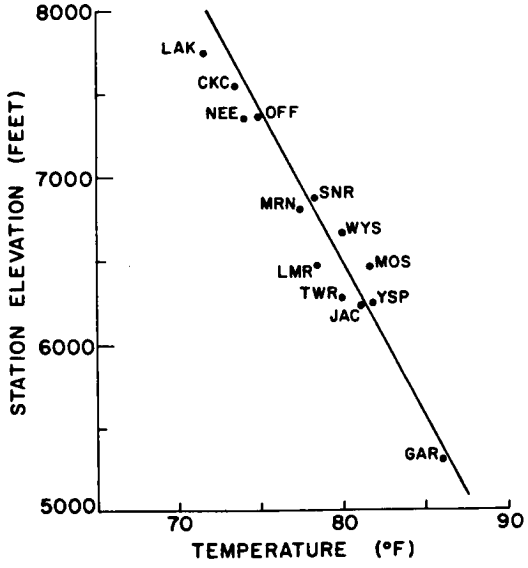

Fig. 6. Mean maximum July temperatures (°F) for Parks region stations plotted against station elevation (feet). Solid line is dry adiabatic lapse rate (-5.4°F per 1,000 feet).

Table 12. Early morning*stable air at the three station transect near Gardiner, Montana.

	Percent of days per month with:					
	deep isothermal layers	inversions =	deep inversions +	shallow inversions +	elevated inversions	inversions persisting into afternoon
JAN	6	46	2	29	15	22
FEB	0	29	5	12	12	16
MAR	3	20	0	20	0	13
APR	3	20	0	9	11	9
MAY	0	14	2	0	12	2
JUN	4	41	1	3	37	1
JUL	0	51	0	2	49	0
AUG	0	35	0	8	27	5
SEP	0	45	0	2	43	0
OCT	2	46	0	2	44	6
NOV	2	48	2	34	12	4
DEC	6	67	11	25	31	53

*Data of first five columns pertain only to observations at the time of minimum temperatures, which is usually during the early morning hours of each day. Period included is May 1974 to May 1977.

Classification of inversion types

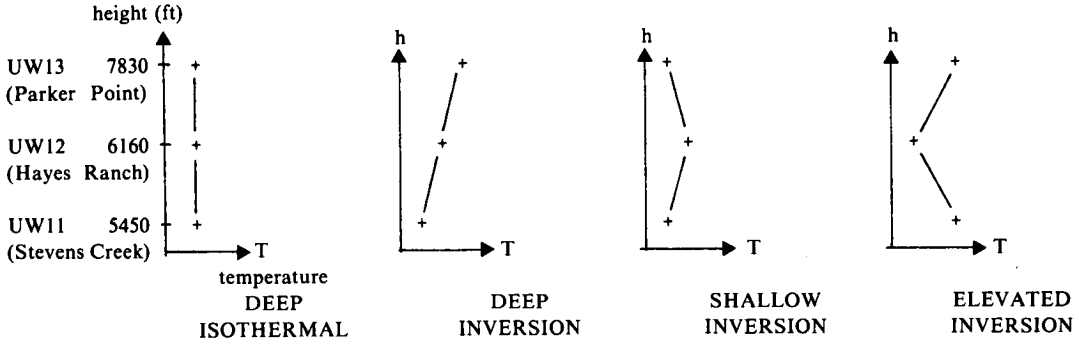

Table 13. Rendezvous Mountain temperatures, 1967-1973.

	Mean maximum temperature (°F)			Mean minimum			Mean temperature (°F)		
	Upper	Mid-way	Lower	Upper	Mid-way	Lower	Upper	Mid-way	Lower
Dec	15.8	18.0	22.0	5.2	6.8	7.1	10.9	12.6	14.6
Jan	16.0	19.3	22.4	6.5	8.5	8.7	11.4	13.8	19.7
Feb	21.4	25.2	28.2	9.9	11.6	10.4	14.9	19.1	19.3
Mar	24.0	31.1	35.4	10.7	15.2	15.1	14.8	23.4	21.6
Apr	29.1	36.9	43.5	14.1	19.2	20.8	21.9	28.4	33.1

Station elevations: Upper = 9,600 ft; Mid-way = 8,500 ft; Lower = 6,300 ft. Data from Poulson (1974).

Table 14. Freeze threshold dates in greater parks area.

AVERAGE DATE OF LAST FREEZE IN SPRING

Station	Elevation (ft)	Temperature category (°F) 32	28	24	20	16
Afton	6115	*	*	May 23	May 8	Apr 17
Buffalo Bill Dam	5156	May 8	Apr 25	Apr 12	Apr 6	Mar 27
Cody A.P.	5080	May 22	May 9	Apr 27	Apr 15	Apr 9
Moose	6467	*	*	May 21	May 4	Apr 21
Moran	6798	*	*	May 31	May 15	Apr 30
Pinedale	7190	*	*	May 25	May 12	Apr 30
Yellowstone Park (YNP-HQ)	6239	Jun 8	May 21	May 5	Apr 23	Apr 14

AVERAGE DATE OF FIRST FREEZE IN AUTUMN

Station	Elevation (ft)	Temperature category (°F) 32	28	24	20	16
Afton	6115	*	*	Sep 11	Sep 24	Oct 10
Buffalo Bill Dam	5156	Oct 6	Oct 17	Oct 27	Nov 5	Nov 13
Cody A.P.	5080	Sep 19	Oct 1	Oct 12	Oct 23	Oct 30
Moose	6467	*	*	Sep 21	Oct 6	Oct 25
Moran	6798	*	*	Sep 9	Sep 24	Oct 10
Pinedale	7190	*	*	Sep 10	Sep 20	Oct 2
Yellowstone Park (YNP-HQ)	6239	Sep 7	Sep 19	Oct 3	Oct 15	Oct 26

AVERAGE NUMBER OF DAYS BETWEEN LAST SPRING FREEZE AND FIRST AUTUMN FREEZE

Station	Length of record (yrs)	Temperature category (°F) 32	28	24	20	16
Afton	29	18	54	110	138	176
Buffalo Bill Dam	30	151	176	198	214	231
Cody A.P.	44	120	145	168	191	204
Moose	15	29	65	123	155	187
Moran	44	14	52	101	142	163
Pinedale	20	34	69	108	131	155
Yellowstone Park (YNP-HQ)	30	91	120	151	176	196

* = Indicated temperature threshold or lower can occur at any time. From Becker et al. (1961).

Table 15. Average daily temperature range (maximum-minimum) for Park area stations in degrees F, 1968-1972.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LTA (6,430 ft.)	19.0	24.5	24.0	23.8	28.3	28.5	34.1	34.9	29.7	26.3	21.7	20.0
COOKE CITY (7,553 ft.)	18.6	24.8	27.2	27.8	28.3	30.7	36.2	36.8	30.8	26.6	21.8	19.5
JACKSON (6,244 ft.)	16.1	20.8	23.4	24.2	32.8	32.0	41.1	40.8	34.4	28.5	20.1	19.1
LAKE Y. (7,741 ft.)	20.5	28.4	31.2	29.7	30.3	28.2	33.9	34.7	32.0	26.4	21.6	21.6
LAMAR (6,470 ft.)	22.4	27.5	30.4	29.3	34.9	36.6	43.2	44.6	40.1	35.5	27.2	28.1
MORAN (6,798 ft.)	19.6	27.6	28.3	24.7	28.9	29.3	36.5	36.3	30.8	26.4	21.6	21.2
SNAKE R. (6,882 ft.)	17.8	26.9	26.7	25.0	32.8	33.2	40.8	43.9	35.9	28.6	25.1	22.2
TOWER (6,266 ft.)	22.6	25.6	30.4	29.2	34.0	33.6	40.7	42.0	36.7	32.2	24.7	23.8
WEST Y. (6,644 ft.)	20.2	25.7	27.9	25.4	30.4	30.6	37.9	38.3	31.3	26.3	21.9	21.3
YNP-HQ (6,241 ft.)	18.4	20.0	24.5	24.1	28.0	28.0	33.3	32.9	28.2	23.8	18.6	17.3

PRECIPITATION

The annual precipitation totals for 12 stations in the Parks region are shown in Table 16. The monthly totals for these and other stations can be found in Dirks (1974) for 1887 to 1972 and in Martner (1977) for 1973-1976. Maps of mean annual precipitation and snowfall estimated by Farnes (1974) from snow course measurements in YNP are presented in Figures 7 and 8. Farnes' technique relates annual precipitation amounts to the water equivalent of snow cover measurements and is further related to elevation and exposure (Farnes 1971). These estimates show good correlation with standard precipitation gages and provide the best available estimates of precipitation throughout YNP's remote areas.

Table 17 presents the mean and extreme snow depth measurements from 1958 to 1972 at most of the snow courses in the Parks. Locations of the snow courses are shown on the map in Figure 1. Monthly winter snow depths and water equivalents for these and other stations, and for earlier years, are documented by Peak and Clagett (1972) and reproduced in Martner (1977).

Smoothed plots of annual and seasonal precipitation for Lake Yellowstone, Moran, and YNP-HQ are shown in Figure 9. The curves were produced by calculating a binomial 7-year weighted running mean from the data of individual years. This data smoothing technique reduced the year-to-year extreme fluctuations and made prolonged wet or dry periods more obvious than unsmoothed annual precipitation curves would. Precipitation records have been examined to identify periods of drought by Dirks (1975) and Martner (1976). The drought in the Great Plains during the early 1930's also affected the Parks region, as nearly all stations in the Parks recorded subnormal precipitation during this period. Other periods of drought have affected regions of the Parks on a shorter and more localized basis.

The frequency of extreme single-day precipitation events is indicated in Table 18. The Snake River station vicinity receives heavy rainfall or snowfall more often than other stations in the Parks. It also receives the greatest annual precipitation (cf. Table 16).

Table 16. Annual precipitation (inches).

Year	Alta	Cody	Jackson	Lake Yellowstone	Lamar	Moose	Moran	Cooke City	Snake River	Tower Falls	West Yellowstone	YNP-HQ (Mammot
1889												20.68
1890												28.61
1891												23.35
1892												19.05
1893												15.18
1894												18.30
1895												17.64
1896												20.77
1897												15.57
1898												17.06
1899												25.82
1900												16.72
1901												19.79
1902												16.83
1903												7.95
1904												13.70
1905			16.23									14.98
1906			20.48								17.30	15.10
1907									21.32			20.35
1908				42.15								19.64
1909				27.41								13.31
1910	16.53			20.67					27.20			15.39
1911	23.39			17.69					28.87	13.63		19.65
1912	25.14						24.83		33.77	19.29		20.28
1913	22.30	7.41		27.88					50.10	19.58		20.76
1914	18.71	8.10		20.54			20.24			8.34		11.74
1915	24.77	11.34		20.17			21.23			15.69		14.94
1916	19.94	7.18					22.78					20.27
1917	16.70	8.99	16.08				28.29					16.03
1918	22.02	11.81					21.50					20.84
1919	14.75	5.47					14.61					15.69
1920	19.78	6.05					22.76		24.38			15.25
1921	14.43	10.29	17.61				18.81		25.25			18.82
1922	18.37	10.33					17.99		25.86			12.46
1923	16.84	14.24	21.47		15.59		21.52		28.77			14.34
1924	11.31	11.39		15.12			17.14		27.36		20.98	17.51
1925	23.44	12.19		26.49	27.33		24.89				22.00	20.41
1926	9.47	12.34		14.14	19.14		23.57		26.10		20.20	14.12
1927	16.19	11.23		20.91	26.38		29.32				25.98	19.56
1928	14.15	9.68		16.11	17.96		22.00				14.89	12.97
1929	16.34	7.72		17.26	17.08		21.33				11.52	14.39
1930	17.50	8.75	21.18	15.44	22.21		20.75		26.64		15.68	15.45
1931	12.63	8.15	14.48	10.56	11.39		15.97		24.06	12.71		10.92
1932	14.96	12.04	15.10	15.64	12.84		20.40		34.80	15.04	21.30	12.41
1933	10.47	8.87	11.70	12.17	7.86		17.22		26.75	11.41	16.16	12.64
1934	13.91	6.03	14.31	16.02	12.46		22.34		26.86	13.48	15.68	11.97
1935	12.73	6.25	12.74	10.28	7.66		17.01		23.44	10.07	18.12	10.31
1936	15.93	8.59	18.69	15.08	11.86	29.98	26.34		35.34	12.36	22.40	14.00
1937	20.92	6.93	17.46		13.98	26.10	24.99		35.10	14.89	23.95	14.31
1938	24.43	11.02	18.64		16.87	32.34	25.31	26.64	33.65	20.81	27.88	17.14
1939	15.86	9.06	11.12		9.67	17.70	17.85	18.50	21.57	11.86	15.31	10.63

Year	Alta	Cody	Jackson	Lake Yellowstone	Lamar	Moose	Moran	Cooke City	Snake River	Tower Falls	West Yellowstone	YNP-HQ (Mammoth)
1940	24.88	9.55	18.07	17.96	14.73	27.07	24.20	25.24	33.92	17.89	26.59	16.81
1941	22.85	14.70	17.93	20.03		28.73	25.78	29.09	34.31		23.45	18.03
1942	21.71	9.55	15.48	16.57	14.89	25.16	21.44	24.40	27.59		21.94	15.15
1943	18.83	9.16	15.47	27.28	14.52	22.13	17.54	23.00			25.63	17.78
1944	22.69	14.43	15.67		17.98	22.54	20.42	24.40	29.52	10.90	20.11	17.51
1945	28.02	14.62	19.58	25.68		32.73	26.78		41.29	21.27	24.98	19.50
1946	17.95	10.67	15.07	18.87	14.14	26.83	20.47	24.29	28.50	18.15	22.78	18.92
1947	20.23	8.53	14.22		15.21	25.70	20.68	26.59	32.96			20.34
1948	17.48	9.66	15.63		15.15	26.05	21.50	31.07	39.23	18.89		17.85
1949		7.73	14.88	20.30	13.29	24.56	18.55	21.63		12.94		14.99
1950	18.46		15.79	25.12	13.00	32.36	24.40	26.37				19.29
1951	21.43	11.16	16.42	23.48	16.02	32.94	22.53	31.42		21.10	28.13	17.73
1952	11.05	7.69	10.93	17.57	11.33	22.06	13.51	22.96	24.29	16.52	19.70	14.36
1953	14.26	8.89	11.12	15.49	11.79	27.94	18.92	26.27	32.59	15.88	18.19	12.54
1954	17.07	7.92	14.36	19.07	13.73	29.80	18.75	25.22	33.10	18.20	21.66	15.53
1955	18.82	10.20	16.70	24.47	14.67	37.07	27.66	29.87	41.64	19.36	29.32	18.98
1956	16.17	3.58	10.68	17.14	12.02	25.04	20.73	23.16	29.33	13.08	21.24	14.27
1957	24.48	12.17	12.43	16.71	13.44	31.50	25.74	24.80	36.16	17.20	25.16	14.93
1958	15.65	11.14	11.69	19.06	11.47		20.69	27.70		15.36	20.21	17.68
1959	17.54	6.24	12.35	16.72	11.61		19.45	25.81		16.24	19.90	14.88
1960	17.03	6.14	14.35	17.77	10.95	20.79	21.24	20.74		15.68	20.18	12.07
1961	18.33	10.39	13.70	23.29	13.24	21.58	26.52	25.68		20.06	25.04	15.55
1962	16.90	12.24	12.85	23.64	18.85	16.77	19.27	26.84		21.04	23.72	16.80
1963	26.33	8.63	20.31	20.04	17.90	26.85	25.69	28.31		20.79	28.56	18.56
1964	25.37	8.43	19.94	22.78	15.02	24.70	30.14	27.17		18.40	28.60	17.72
1965	19.73	8.89	16.88	20.94	13.84	22.19	21.56	27.33		18.67	25.82	15.32
1966	13.28	6.82	13.90	18.52	12.20	16.54	20.60	25.00		14.93	18.85	10.69
1967	26.86	10.61	20.04	23.48	15.80	23.17	25.81			20.20	26.14	18.35
1968	27.26		15.68		17.34	19.02	24.35	30.07		22.87	26.45	20.26
1969	18.75		14.58	20.64	14.56	18.79	20.87	25.99	31.70	14.69	17.64	16.04
1970	26.63	9.22	17.06	26.16	16.49	19.95	29.26	29.03	41.54	21.54	24.68	15.29
1971	26.37	10.97	20.92	20.89		26.85	29.14	25.76	33.97	17.22	22.91	14.28
1972	27.14	10.56	20.68	19.53	18.01	20.57	27.87	27.35	34.26	18.91	22.09	20.28
1973	26.43	10.05	17.82	15.88		22.05	23.72	19.34	29.40	13.56	25.07	13.14
1974	21.73	8.98	11.41	15.83	10.27	17.74	23.09	24.25	26.23	12.47	16.78	12.52
1975	28.57	12.37	17.42	24.83	11.85	24.72	31.14	29.75	38.26	17.38	22.61	14.45
1976	19.71	8.82	15.64	12.62	12.12	16.45	21.43	26.86	27.36	13.39	19.13	17.00

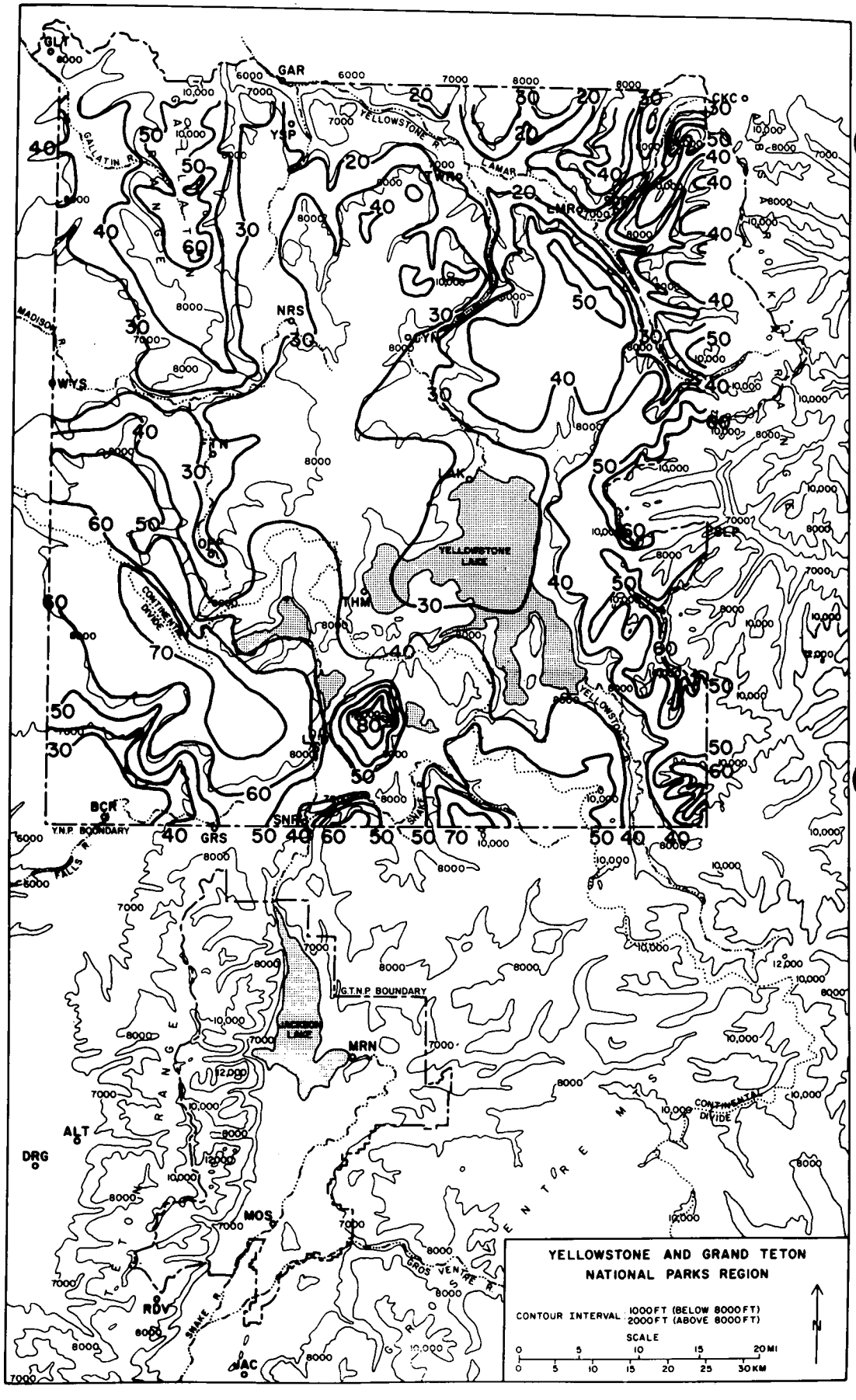

Fig. 7. Mean annual precipitation (inches) for Yellowstone National Park (1953–1967), by Farnes (1973).

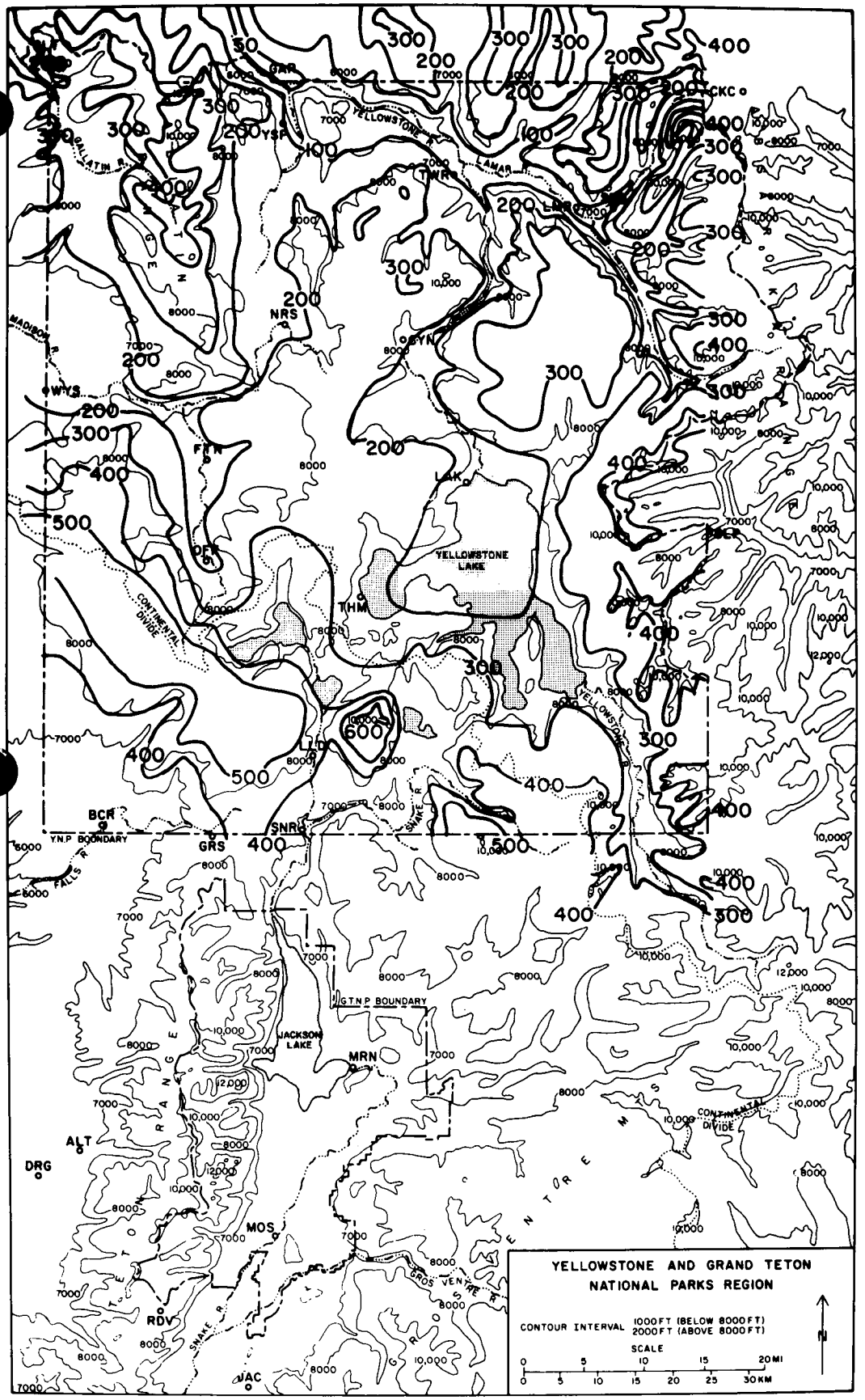

Fig. 8. Mean annual snowfall (inches) for Yellowstone National park (1958–1972), by Farnes (1974).

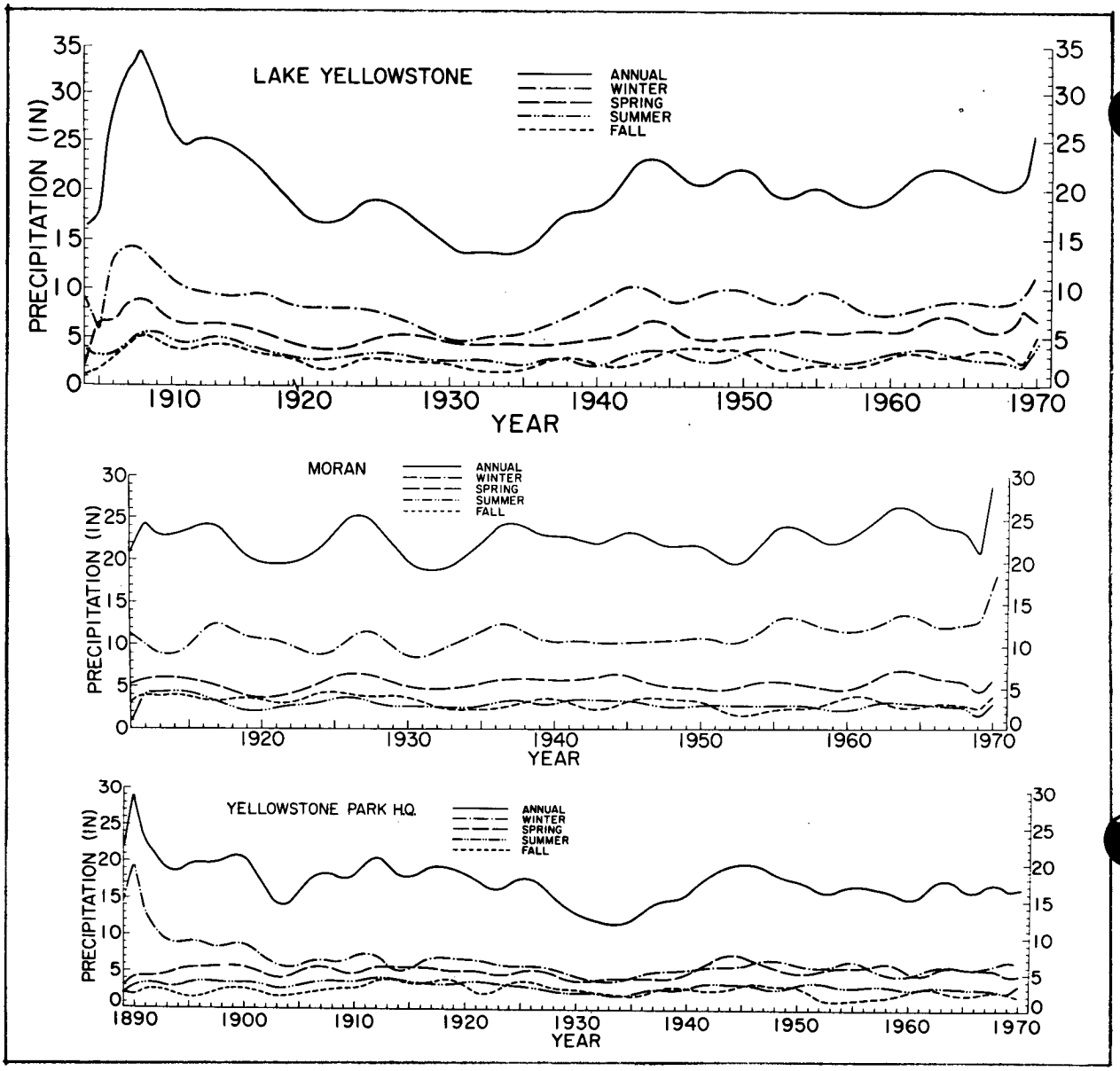

Fig. 9. Seven-year weighted seasonal and annual precipitation. Winter = Nov.-Feb., Spring = Apr.-Jun., Summer = Jul.Aug., Fall = Sep.-Oct. Calculations by Ruth L. Legg.

Table 18. Number of extreme 1-day precipitation events.

	No. of days with 1 or more inches of precipitation	No. of days with 2 or more inches of precipitation	No. of years included in record*
Alta	58	2	67 (1)
Jackson	47	3	61 (6)
Lake Yellowstone	59	2	72 (5)
Lamar R.S.	27	3	54 (5)
Moose	51	2	41 (1)
Moran	59	0	65 (1)
Snake River	101	6	60 (14)
Tower Falls	30	1	53 (3)
West Yellowstone	64	3	71 (6)
YNP-HQ (Mammoth)	30	0	77 (0)

*In parenthesis are the number of years included in the record for which m ore than 100 days of data are missing.

Table 17. Snow depth, averages and extremes, 1958-1972. Measurements on the first day of the month (inches).

STATION No., Name	ELEVATION (ft)	JANUARY A (H/L)	FEBRUARY A (H/L)	MARCH A (H/L)	APRIL A (H/L)	MAY A (H/L)
9E5, East Entrance	7000	22 (32/9)	31 (42/18)	35 (48/24)	31 (44/18)	9 (38/0)
0D7, NE Entrance	7400	18 (27/10)	29 (45/14)	32 (41/22)	32 (47/16)	22 (42/8)
10E1, Lupine Creek	7300	21 (31/12)	31 (49/18)	36 (46/24)	37 (50/23)	23 (45/0)
10E2, Norris Basin	7500	22 (45/12)	35 (54/20)	38 (48/29)	36 (50/25)	19 (42/0)
10E3, Canyon	7750	28 (48/14)	41 (74/23)	50 (65/35)	52 (67/33)	44 (60/25)
10E4, Lake Camp	7850	20 (32/10)	29 (49/17)	35 (48/23)	36 (52/20)	27 (43/9)
10E5, Sylvan Pass	7100	27 (42/12)	38 (54/23)	41 (59/32)	45 (62/29)	30 (56/3)
10E7, Thumb Divide	7900	37 (67/18)	56 (85/32)	61 (79/39)	66 (96/43)	
10E8, Aster Creek	7700	48 (85/21)	72 (106/42)	80 (119/49)	85 (126/56)	
10E9, Lewis Lake Divide	7900	61 (111/26)	88 (124/51)	103 (150/66)	104 (156/71)	98 (136/68)
10E12, Snake River	6780	32 (55/14)	51 (69/33)	59 (77/44)	60 (79/43)	
10E13, Glade Creek	7200	36 (61/13)	53 (71/33)	61 (79/44)	63 (89/44)	
10E14, Huckleberry Div.	7300	34 (50/16)	50 (66/33)	55 (70/42)	57 (76/38)	
10E15, Grassy Lake	7265	53 (76/21)	77 (103/46)	88 (116/63)	91 (125/54)	76 (109/52)
10F1, Arizona	6850	33 (50/15)	48 (67/30)	54 (70/37)	57 (79/33)	
10F2, Base Camp	6900	34 (54/15)	52 (81/30)	56 (80/40)	56 (86/37)	
10F3, Moran Bay	6800		50 (74/35)	60 (78/45)	56 (81/39)	
10F4, Moran	6800	25 (37/11)	38 (52/25)	41 (52/29)	38 (51/25)	
10F5, Turpin Meadows	6930		33 (48/17)	35 (42/25)	34 (44/22)	
10F6, Four Mile Meadows	7770		39 (50/24)	43 (52/33)	45 (57/34)	
10F7, Blackrock	8600		55 (77/39)	62 (80/46)	66 (94/47)	
10F19, Gros Ventre	8750		38 (58/19)	43 (56/31)	43 (61/30)	35 (57/20)
11E7, W. Yellowstone	6700	23 (41/9)	34 (55/18)	38 (55/23)	37 (53/19)	19 (41/0)

A = average; H = highest; L = lowest; -- = no measurements.

WIND

Wind measurements in the Parks region are scarce. Semi-hourly spot measurements are recorded at the second order weather stations of West Yellowstone and the Jackson airport. One or two daily recordings are made during the summer at the fire weather stations. Special totalizing anemometers were erected at a few locations in the Parks by the University of Wyoming (the UW sites in Fig. 1) to augment the existing wind data. The instruments were maintained by National Park Service and U.S. Forest Service personnel from 1974 to 1977.

The mean wind conditions at a particular location are strongly shaped by the surrounding topography and can be a function of the time of day and season of the year. Fire weather station data given in Dirks (1975) show that the prevailing summertime winds in the Parks are from the southwest; this is confirmed by UW station measurements.

Frequency distributions of wind direction[1] and speed are shown in Figures 10-15. The data at Hayden Valley (Figs. 10, 11) should be reasonably representative of exposed areas of the Yellowstone Plateau, including Yellowstone Lake. The data for Upper Rendezvous Mountain (Figs. 12, 13) illustrate the strong winds at exposed mountain elevations during both winter and summer. A prevailing westerly flow is evident; however, local exposure may distort the direction significantly. This is shown in the data for Sylvan Pass (Fig. 14) where air is channeled through an exposed mountain gap parallel to its axis, producing northwest and southeast prevailing wind directions. Seasonal and time of day stratifications of the data for these and other stations are given by Martner (1977).

In the valleys and basins of the Parks, local topography largely dominates the airflow data, both seasonally and diurnally. Diurnal changes in wind distributions are illustrated in Figure 15 for the Stevens Creek station (UW11) near Gardiner. This station was near the bottom of the broad Yellowstone River valley, which is oriented northwest-southeast at this point, with northwest being the lower end. The air normally flows along the open valley parallel to its axis. At night and in the morning dense cold air drains downhill through the valley from the higher elevations

[1]Wind directions are always stated as the direction **from** which the air is flowing.

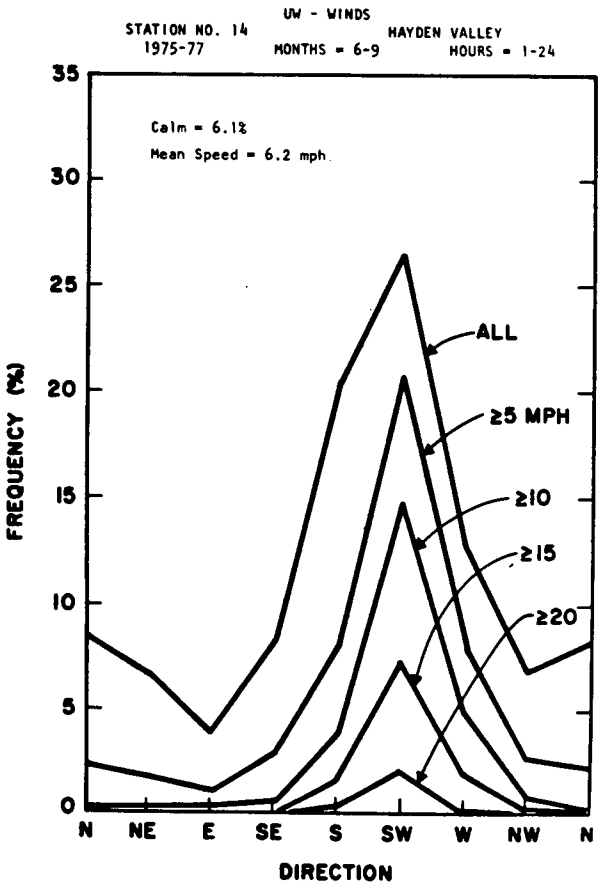

Fig. 10. Distribution of wind velocity at Hayden Valley in summer.

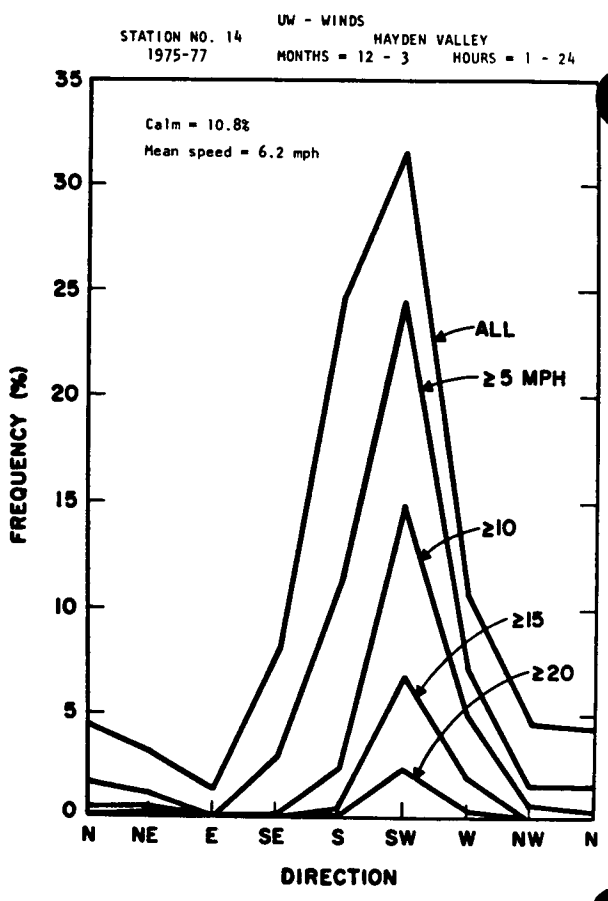

Fig. 11. Distribution of wind velocity at Hayden Valley in winter.

of YNP toward the lower elevations in the northwest, like water running down through a ravine. The cold drainage creates the predominantly southeast winds at Stevens Creek. Surface heating in the summer creates a 180 degree shift in the wind direction by afternoon as warm air rises up the valley slope from the lower elevations, creating northwest winds at Stevens Creek. In the wintertime there is insufficient afternoon heating to create the uphill winds; thus southeast winds dominate the distribution all day long. Cold air drainage winds undoubtedly dominate the winter airflow in most other valleys and basins in the Parks.

The wind chill index or factor is the air temperature required in calm or light wind conditions to produce the same rate of heat loss from exposed human skin as that which occurs for a given temperature-with-wind combination. Table 19 is a typical wind chill index chart. In the Parks region strong winds and cold winter temperatures sometimes combine to create extremely dangerous wind chill conditions. Wind chill is normally coldest at high exposed places. Wind chill factors as low as -76°F have been recorded at the Upper Rendezvous Mountain station in GTNP. Colder conditions probably occur. Winds are often light or calm in closed basins and valleys during the periods of coldest temperatures. This is due to temperature inversions which stabilize the air and trap it within the confines of the basin or valley. Hence, wind chill factors in such locations are not as extreme as on higher open terrain.

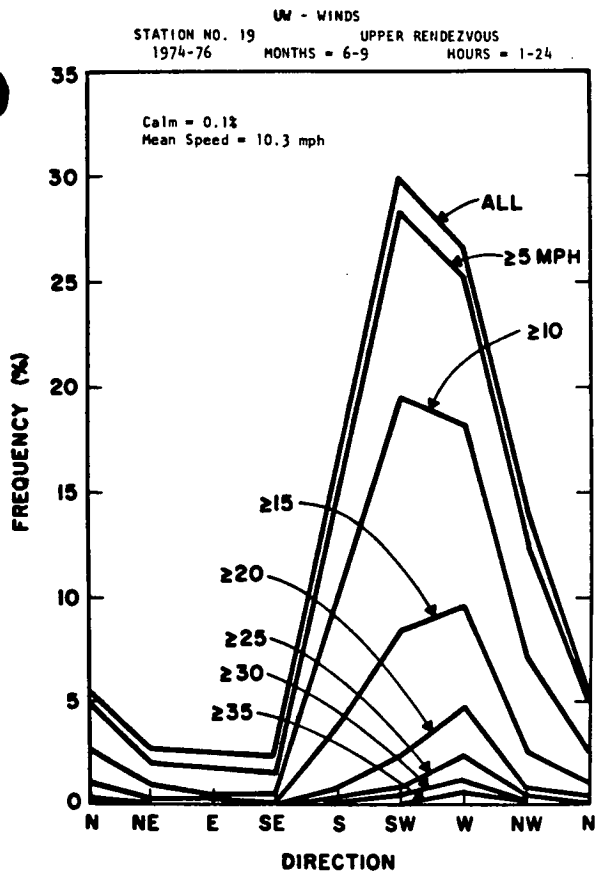

Fig. 12. Distribution of wind velocity at Upper Rendezvous in summer.

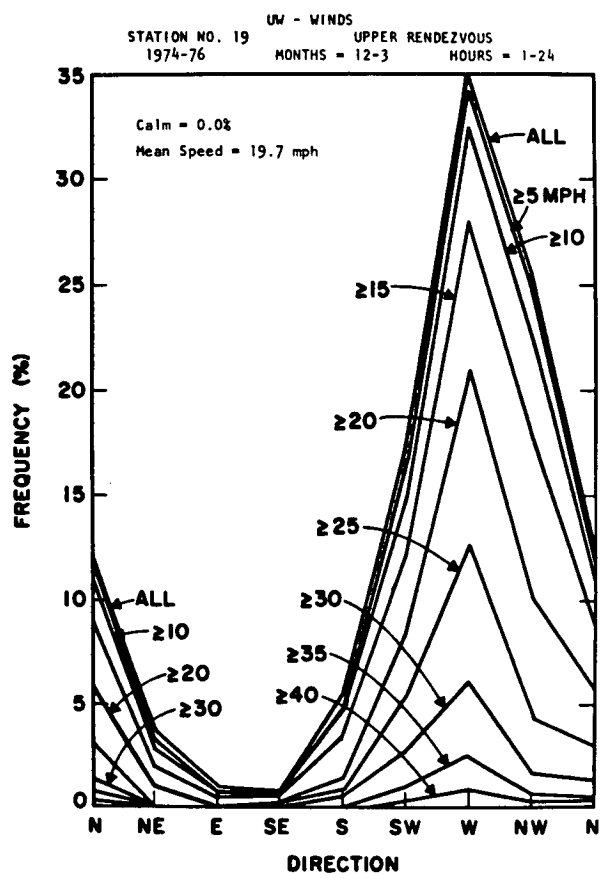

Fig. 13. Distribution of wind velocity at Upper Rendezvous in winter.

Table 19. Wind-Chill Factor—an index of the cooling power of the wind.
It is expressed in terms of the equivalent temperature without wind.

Wind speed	Actual thermometer reading (°F)											
mph	Equivalent temperature (°F)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-21	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-36	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-124
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148

Wind speeds greater than 40 mph have little additional effect

LITTLE DANGER (for properly clothed person)

INCREASING DANGER

GREAT DANGER

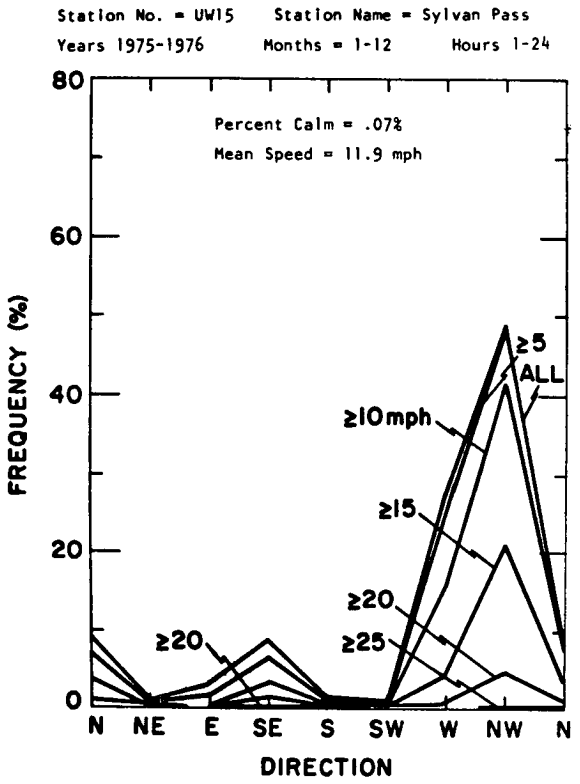

Fig. 14. Mean annual distribution of wind velocity at Sylvan Pass showing strong NW-SE channeling of the airflow through the pass.

SUNSHINE AND HUMIDITY

Sunshine and relative humidity measurements in the Parks are extremely sparse. The most complete measurements were made at YNP-HQ during the operation of the first order Weather Bureau station from 1903 to 1941. A summary of those records as compiled by Howard (1939) is shown in Table 20. The sun shines on about 70-75% of the daylight hours in July and August, but only 40% of the time in winter, when frequent storms move through the area.

Relative humidity depends strongly on temperature; generally, it inversely follows the diurnal temperature cycle. The diurnal range of relative humidity is greatest in the summer and in the valleys, where the daily range of temperature is widest (Table 15). Summer afternoons are seldom humid; the average relative humidity is about 35% at YNP-HQ on July afternoons.

CONCLUSION

The high elevation of the Parks region is responsible for the generally cold and moderately moist climate of the area. However, the complex topography creates significant localized departures. Winds are especially influenced by local topographic features. Spring and autumn are brief transition seasons between pleasant, mild summers and very cold, snowy, long winters in Yellowstone and the Tetons.

Table 20. Relative humidity and sunshine at YNP-HQ (Mammoth), 1903-1938.

	Relative Humidity (%) average values at			Total daylight hours	Sunshine Ave. percent sunshine	relative cloudiness*
	6 am	Noon	6 pm			
January	77	66	72	286	39	6.9
February	78	64	67	292	51	6.4
March	77	57	60	370	55	6.4
April	76	49	51	405	57	6.1
May	76	42	47	461	56	6.3
June	74	39	42	467	63	5.4
July	74	34	37	472	73	4.3
August	72	35	37	435	71	4.3
September	73	41	44	376	65	4.9
October	74	50	55	339	57	5.4
November	74	60	65	287	45	6.4
December	77	66	72	274	38	6.8
Annual	75	50	54	4464	56	5.8

*Scale of 0 (clear) to 10 (overcast)
From the data of Howard (1939).

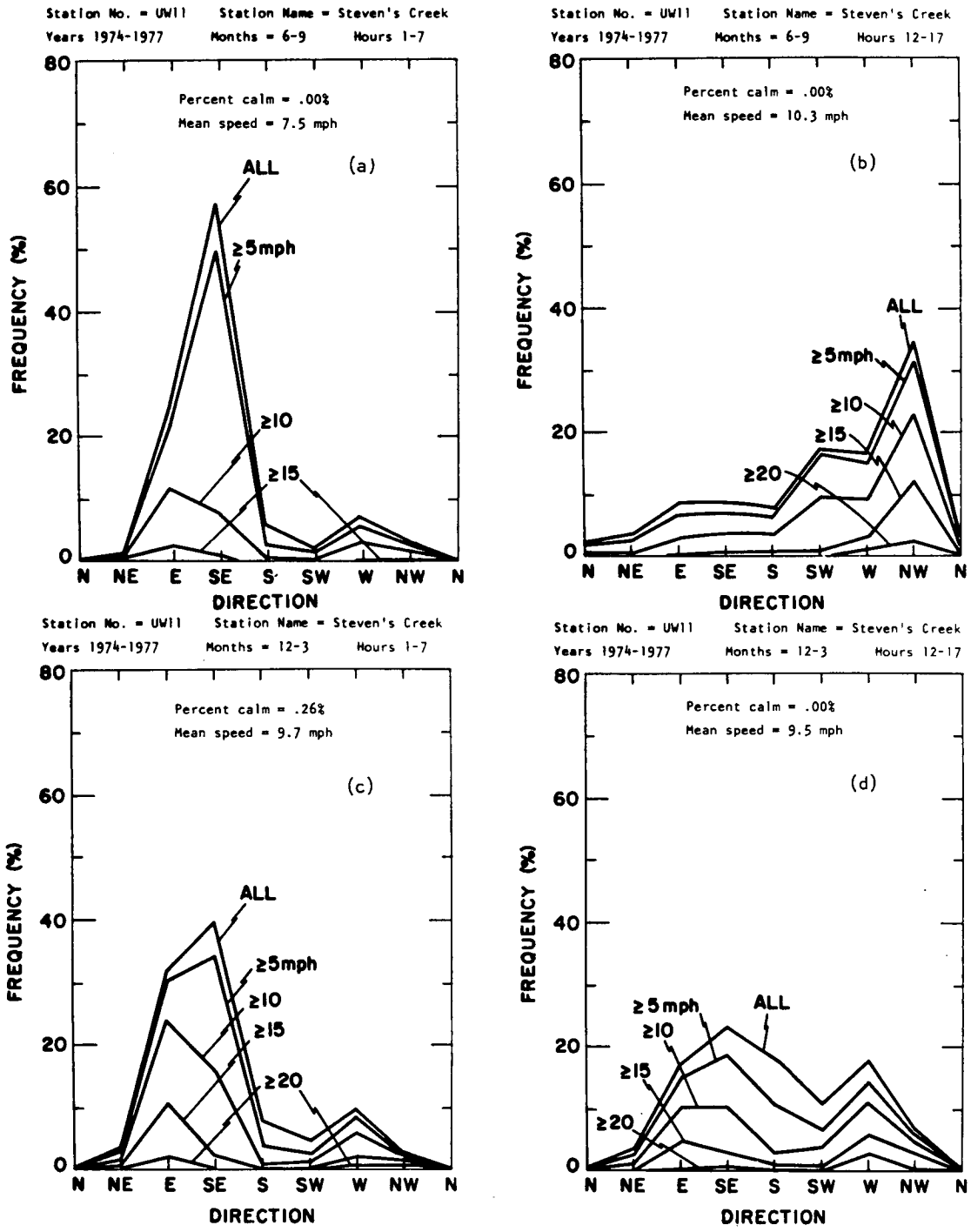

Fig. 15. Diurnal and seasonal changes of wind distribution at Stevens Creek.
(a) Summer-early morning (b) Summer-afternoon
(c) Winter-early morning (d) Winter-afternoon

REFERENCES

BECKER, C. F., J. ALYEA and H. EPPSON. 1961. Probabilities of freeze in Wyoming. Bulletin 381, Agricultural Experiment Station, University of Wyoming, Laramie. 16 p.

BECKER, C. F. and J. D. ALYEA. 1964. Temperature probabilities in Wyoming. Bulletin 415, Agricultural Experiment Station, University of Wyoming, Laramie, Wyoming. 157 p.

DIRKS, R. A. 1974. Climatological studies of Yellowstone and Grand Teton National Parks. Annual report, contract CX600-3-0078, National Park Service. Department of Atmospheric Science, University of Wyoming, Laramie. 167 p.

———. 1975. Climatological studies of Yellowstone and Grand Teton National Parks. Annual report, contract CX-12004B030, National Park Service. Department of Atmospheric Science, University of Wyoming, Laramie. 103 p.

———. 1976. Climatological studies of Yellowstone and Grand Teton National Parks. Annual report, contract CX-12004B030, National Park Service. Department of Atmospheric Science, University of Wyoming, Laramie. 104 p.

FARNES, P. E. 1971. Mountain precipitation and hydrology from snow surveys. Proceedings of the Western Snow Conference, Billings, Montana. April, pp. 44-49.

———. 1974. Preliminary analysis of mean annual precipitation and mean annual snowfall for Yellowstone National Park. Unpublished. Soil Conservation Service, Bozeman, Montana.

HOWARD, C. L. 1939. Annual meteorological summary with comparative data for Yellowstone Park, Wyoming. U.S. Weather Bureau, Salt Lake City, Utah.

MARTNER, B. E. 1976. Drought index and winter severity index for Yellowstone National Park. Department of Atmospheric Science, University of Wyoming, Laramie. 53 p.

———. 1977. Climatological studies of Yellowstone and Grand Teton National Parks. Annual/final report, contract CX-12004B030, National Park Service. Department of Atmospheric Science, University of Wyoming, Laramie. 198 p.

PEAK, G. W. and CLAGETT. 1972. Summary of snow survey measurements—Wyoming 1919-1972. U.S. Department of Agriculture, Soil Conservation Service. 206 p.

POULSON, G. 1974. Compiled weather, snow, and avalanche data for Jackson Hole ski area. Unpublished. Teton National Forest, U.S. Forest Service.

SCHAEFER, V. J. 1964. Final Report, Fourth Yellowstone Research Expedition. Publication No. 22. Atmospheric Sciences Research Center, State Univ. of New York, Albany, N.Y. May 1964. 124 p.

STOCKTON, C. W. 1973. A dendroclimatic analysis of the Yellowstone National Park region, Wyoming-Montana. Project report, National Park Service. Labaoratory of Tree Ring Research, University of Arizona, Tucson. 56 p.

WIRSHBORN, J. F. 1978. Climate of Yellowstone Park. Mountain States Weather Services, Fort Collins, Colorado. 11 p.

APPENDIX

Conversions to Metric Units

Length:	1 inch = 2.54 cm = 0.0254 meters 1 foot = 0.3048 meters 1 mile (statute) = 1609.3 meters = 1.6093 kilometers
Area:	1 square mile (statute) = 2.59 square kilometers
Speed:	1 mile per hour = 0.868 knots = 0.447 meters per second
Temperature:	°C = (5/9) (°F-32)

Sources of Additional and Current Data

Precipitation and temperature	U.S. Department of Commerce National Climatic Center Federal Building Asheville, North Carolina 28801
Wyoming Snow Survey:	Soil Conservation Service P.O. Box 2440 Casper, Wyoming 82601
Montana Snow Survey:	Soil Conservation Service P.O. Box 98 Bozeman, Montana 59715


U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849


NATIONAL
PARK
SERVICE