Report No. NPS D-748

Annual Data Summary

YELLOWSTONE NATIONAL PARK

1998

National Park Service
Gaseous Air Pollutant Monitoring Network

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ACKNOWLEDGEMENTS

The National Park Service Air Resources Division (ARD) recognizes the level of effort required by individual park units, site operators, auditors, cooperating state and local agencies, and ARD contractors. ARD sincerely appreciates the contributions of all participants in assisting with the collection, validation, and reporting of these air quality and meteorological data.

At Yellowstone National Park, ARD specifically recognizes Darcy Berger and Gary Youngblood for performing the technical and administrative skills required to help produce the data presented within this report.

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1.0 INTRODUCTION

1.1 THE NATIONAL PARK SERVICE GASEOUS POLLUTANT MONITORING NETWORK

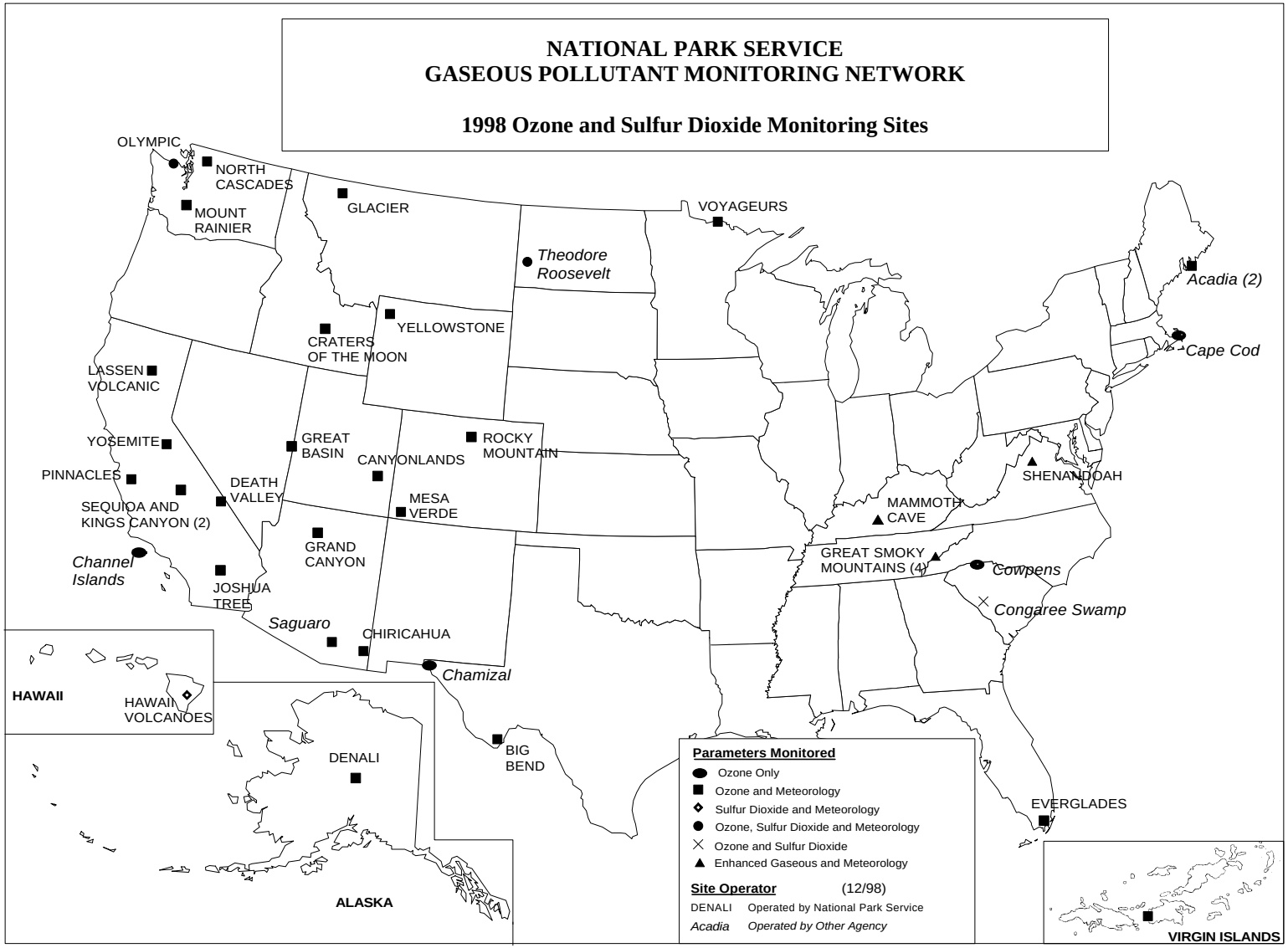
Gaseous air pollutants, including ozone and sulfur dioxide, are of concern to the National Park Service (NPS). Pollutants like these can affect park unit biological resources as well as the health of park unit residents and visitors. The NPS established a gaseous pollutant monitoring program for several pollutants linked to effects on NPS resources. This program was designed to meet certain resource management objectives.

The primary objective of this monitoring program is to establish the status and trends of park unit air quality conditions and to determine if a park unit is exceeding the National Ambient Air Quality Standards established by the U.S. Environmental Protection Agency (EPA) to protect public health and welfare. In addition, such monitoring is designed to detect changes or trends in pollution levels over time. A monitoring station may also be established if there is documented biological injury due to air pollution in a park unit. Information on ambient air pollution levels is an important part of research on effects of air pollutants on NPS resources, and can help confirm suspected causes of observed effects.

Other monitoring objectives call for the collection of data to support the National Park Service's required involvement in both the development of state air quality control plans, and the evaluation of permit applications for new or expanding air pollution sources wishing to locate near park units. The Clean Air Act gives federal land managers and superintendents an affirmative responsibility to protect air quality related values in Class I areas and to assess whether new sources will have an adverse impact on park unit resources and values. Information on air quality levels in NPS units can also be used to evaluate the performance of atmospheric models that simulate how pollutants are transported into park units and predict impacts on the park unit caused by air pollution sources.

The National Park Service Gaseous Pollutant Monitoring Network site locations and measured parameters collected in this reporting year are shown on the map on the following page. During this reporting period, 40 monitoring sites in 35 units of the National Park System had some combination of ozone, sulfur dioxide, meteorological, and CASTNet dry deposition monitoring. Monitoring methods and quality assurance procedures used in the national park network meet the applicable 40 CFR Part 58 EPA requirements. This allows for the direct comparison of NPS collected data with that collected by the EPA, and state and local air pollution control agencies. Data collected by this network are incorporated in the EPA Aerometric Information Retrieval System (AIRS) database which is a national database of all air quality data collected throughout the country. These data are also stored in the NPS Air Resources Division’s Information Management Center (IMC) that allows for easy access and analysis of data.

This report includes a variety of data summaries for data collected at an individual monitoring site at a national park unit during this reporting period. These summaries highlight the average range and frequency of the data collected during the year. A PC-compatible diskette containing a digital copy of all data collected during the year and data summary products included in this report is available. Individual reports are generated for each site where monitoring was conducted in the national park network.


NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK
1998 Ozone and Sulfur Dioxide Monitoring Sites
OLYMPIC
NORTH CASCADES
MOUNT RAINIER
GLACIER
VOYAGEURS
Theodore Roosevelt
Acadia (2)
Cape Cod
YELLOWSTONE
CRATERS OF THE MOON
LASSEN VOLCANIC
YOSEMITE
GREAT BASIN
ROCKY MOUNTAIN
CANYONLANDS
PINNACLES
DEATH VALLEY
SEQUOIA AND KINGS CANYON (2)
MESA VERDE
SHENANDOAH
MAMMOTH CAVE
GRAND CANYON
Channel Islands
JOSHUA TREE
GREAT SMOKY MOUNTAINS (4)
Cowpens
Congaree Swamp
Saguaro
CHIRICAHUA
Chamizal
HAWAII
HAWAII VOLCANOES
DENALI
BIG BEND
EVERGLADES
ALASKA
VIRGIN ISLANDS
Parameters Monitored
Ozone Only
Ozone and Meteorology
Sulfur Dioxide and Meteorology
Ozone, Sulfur Dioxide and Meteorology
Ozone and Sulfur Dioxide
Enhanced Gaseous and Meteorology
Site Operator (12/98)
DENALI Operated by National Park Service
Acadia Operated by Other Agency

1.2 YELLOWSTONE NATIONAL PARK

Yellowstone National Park, a Class I area, is primarily located in northwestern Wyoming with portions extending into southwestern Montana and southeastern Idaho. Its location and site specifications are presented on the following page.

Yellowstone National Park was created by an act of Congress in 1872 and became the world's first national park. It was "dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people" and "for the preservation, from injury or spoilation, of all timber, mineral deposits, natural curiosities, or wonders...and their retention in their natural condition." In 1972, Yellowstone became the first American area to be designated as a Biosphere Reserve by the United Nations Educational, Social, and Cultural Organization (UNESCO). In 1978, UNESCO designated Yellowstone a World Heritage Site.

The park is situated on a large mountainous plateau in the northern Rocky Mountains. Elevations range from 5,200 feet to over 11,000 feet and average 8,000 feet. Yellowstone is characterized by several broad, forested, volcanic plateaus surrounded by the Absaroka Mountain Range on the east, the Gallatin Mountain Range on the north, and the Red Mountains on the south. Lakes such as Yellowstone, Shoshone, Lewis, and Heart are prominent features in the park, as are the Yellowstone, Snake, Lewis, Madison, Gibbon, Firehole, Gardner, and Lamar rivers. The park contains the world's largest and most active geothermal areas. Approximately 120 thermal areas in nine major basins have been identified. These areas include geysers, hot springs, mud pots, and fumaroles.

The Yellowstone and Lamar river valleys are covered by dry grasslands and sagebrush steppe communities with Douglas fir found on the north-facing slopes. These treeless areas make up nearly 20 percent of the park. The mountains and high plateaus are generally covered by conifer forests or moist meadows. Lodgepole pine occupies approximately 80 percent of the forested area of Yellowstone.

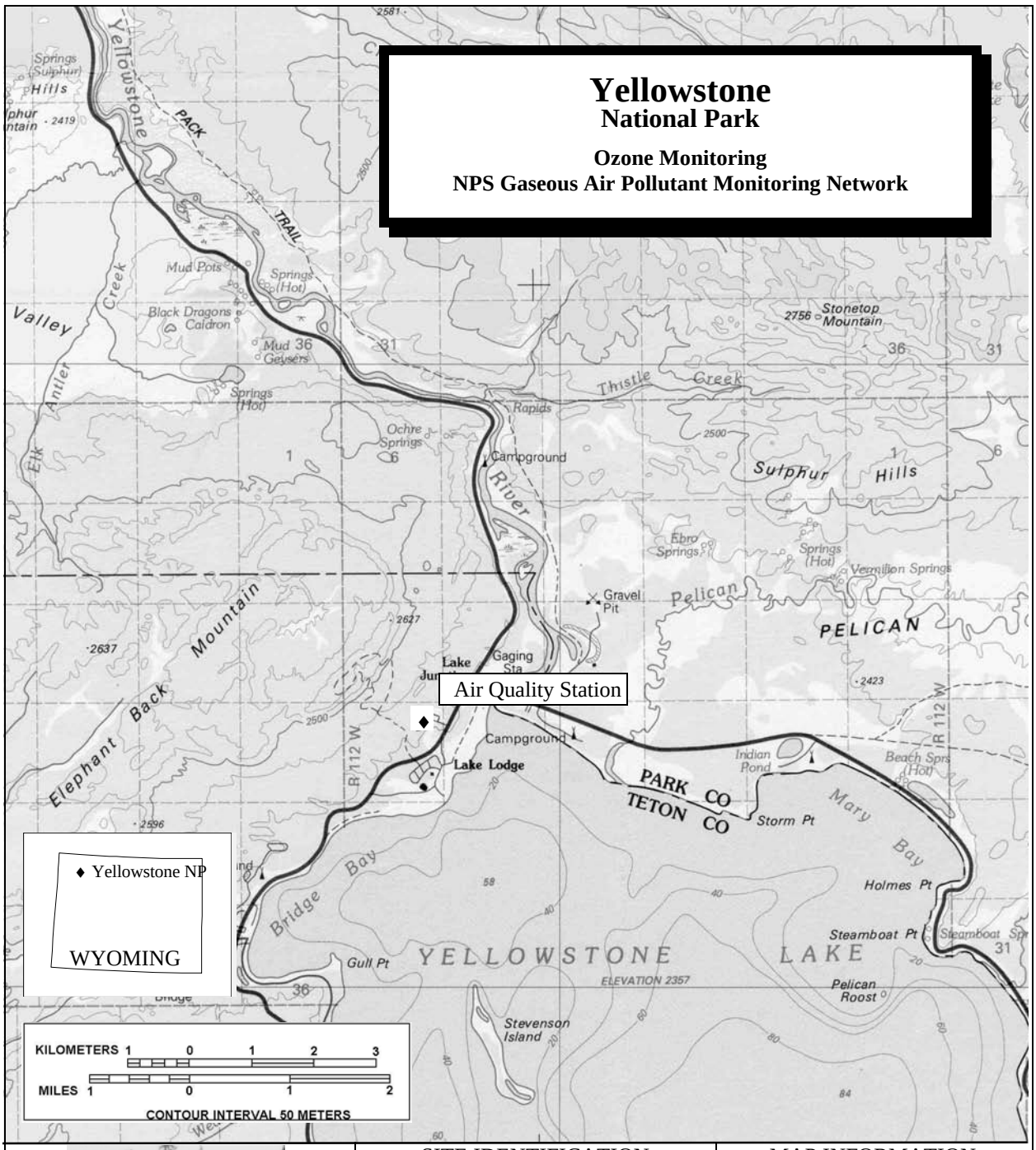
Yellowstone is home to such wildlife species as black bear, elk, bison, moose, pronghorn antelope, mule deer, bighorn sheep, coyote, mountain lion, badger, porcupine, snowshoe hare, river otter, marten, long-tailed weasel, red squirrel, beaver, golden eagle, osprey, trumpeter swan, harlequin duck, American white pelican, loon, sandhill crane, great gray owl, Steller's jay, red crossbill, sagebrush lizard, rubber boa, Arctic grayling, and cutthroat trout.

Human occupation in the greater Yellowstone area began at least 10,000 years ago. American Indian hunting and gathering camps, trails, and obsidian quarries are among the archeological sites found. Also found within the greater Yellowstone area are Euro-American archaeologic sites such as roads, building foundations and dumps. A number of historic structures, such as Old Faithful Inn, have been designated as National Historic Landmarks.

Yellowstone's air and water quality are considered very good.

Yellowstone
National Park

Ozone Monitoring
NPS Gaseous Air Pollutant Monitoring Network



SITE IDENTIFICATION	
Site Abbreviation:	YELW
AIRS ID NO.:	56-039-1011

INSTRUMENTATION	
O_3 Analyzer	Temperature
Calibrator	Solar Radiation
Wind Speed	Precipitation
Wind Direction	Delta Temperature
Relative Humidity	

MAP INFORMATION	
Mean Elevation:	2468 m
Longitude:	110° 24' 00"W
Latitude:	44° 33' 55"N
UTM Zone:	12
Easting:	547647 m
Northing:	4934618 m
Map Reference:	Yellowstone Natl. Park N. 44110-E1 1:100,000

2.0 DATA SUMMARY

2.1 OVERVIEW

Based on the site specifications during this annual reporting period, data summaries and statistics are provided in this section.

Data Collection Statistics
Yellowstone National Park

Final Data

01/01/98 - 12/31/98

Parameter	Par Code	Data Recovery			Valid Data	
		No. Possible	No. Collected	% Collected	No. Valid	% Valid
Ozone Analyzer	O3	8760	8245	94.1	8138	92.9
Scalar Wind Speed	SWS	8760	8693	99.2	8693	99.2
Vector Wind Speed	VWS	8760	8693	99.2	8693	99.2
Vector Wind Direction	VWD	8760	8693	99.2	8693	99.2
Standard Deviation for Wind Direction	SDWD	8760	8688	99.2	8688	99.2
Ambient Temperature (aspirated)	TMP	8760	8692	99.2	8692	99.2
Delta Temperature	DTP	8760	8692	99.2	8692	99.2
Relative Humidity	RH	8760	8694	99.2	8694	99.2
Precipitation	RNF	8760	8653	98.8	8652	98.8
Wetness Sensor	WET	3737	3722	99.6	3722	99.6
Solar Radiation	SOL	8760	8697	99.3	8697	99.3
Filter Pack Flow Rate	FLOW	8760	8671	99.0	8671	99.0

Notes: All statistics are for hourly averages.

The number collected does not include normal maintenance or events beyond the control of the network.

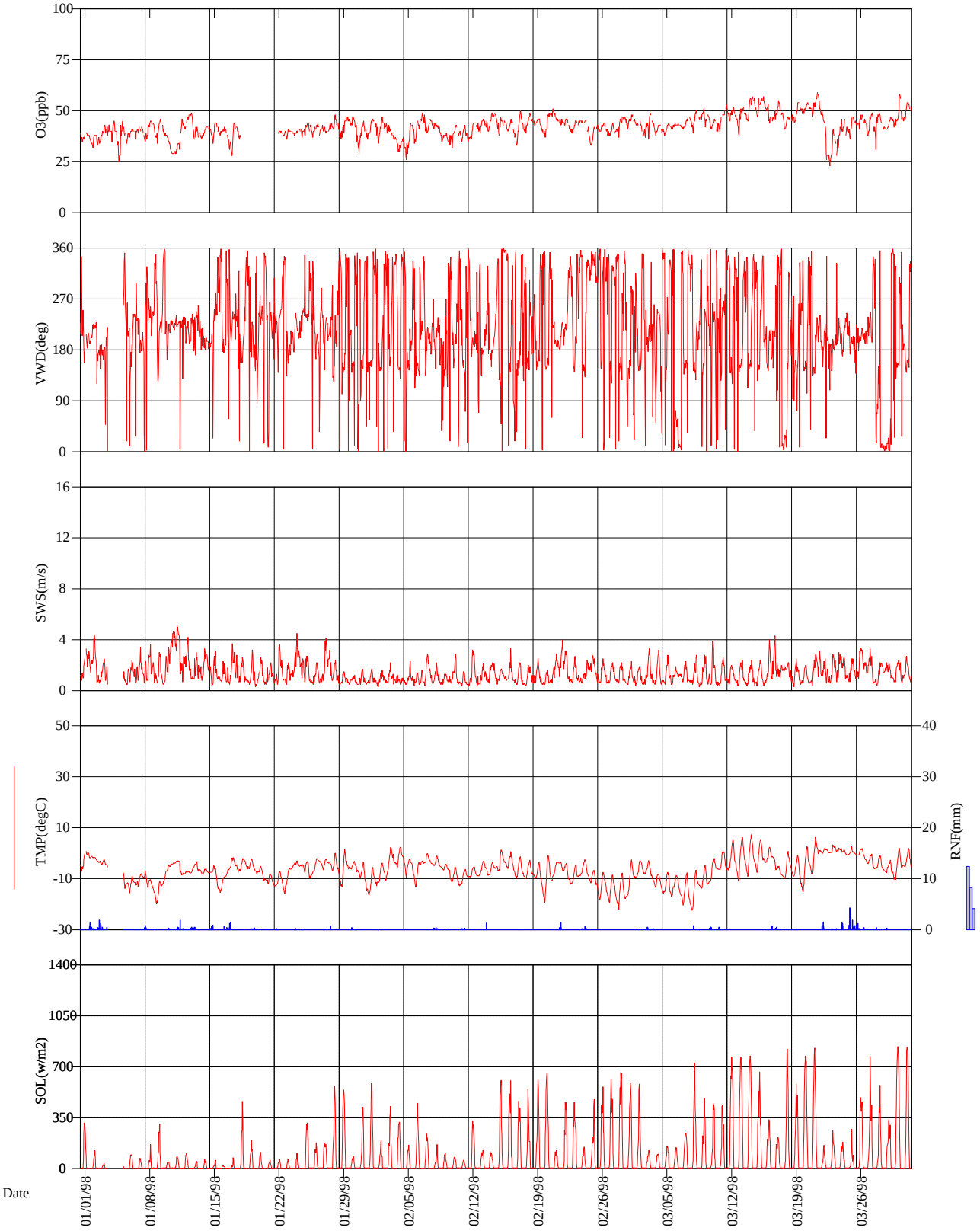
The percent valid is calculated against the number possible.

Automatic zeros and spans are performed daily on most ambient gas analyzers, therefore, no ambient data can be collected during this time. As a result, the maximum percent valid for ambient gas data typically can not be greater than 95.8.

NPS Performance Goals:

Quarterly Criteria:	Monthly Criteria:
100% of sites, >= 85% valid data capture	100% of sites, >= 60% valid data capture
90% of sites, >= 90% valid data capture	90% of sites, >= 75% valid data capture
80% of sites, >= 95% valid data capture	80% of sites, >= 85% valid data capture

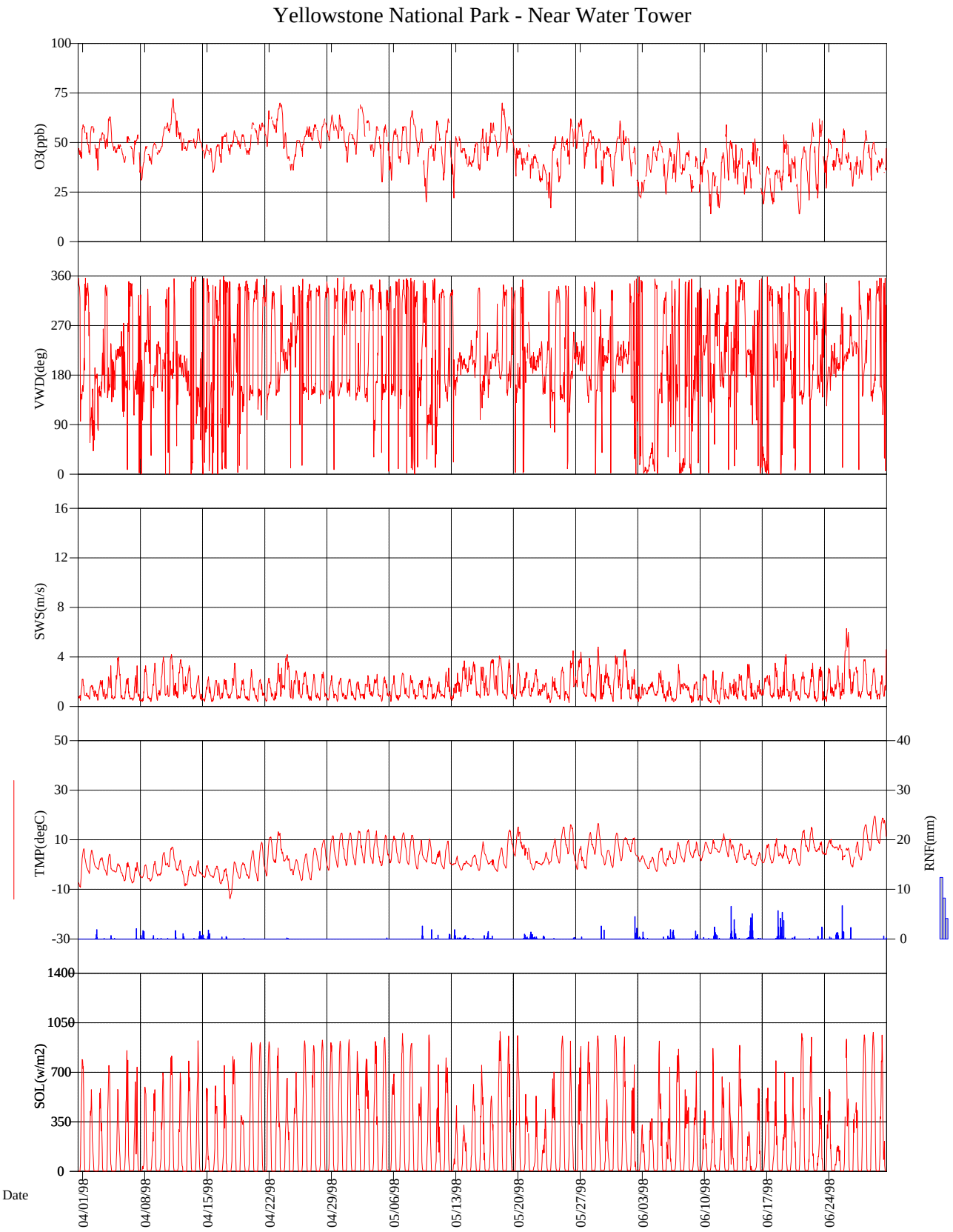
Yellowstone National Park - Near Water Tower



Final Validation

First Quarter 1998

yelw-wt.stk - yelw98.dat 08-23-1999

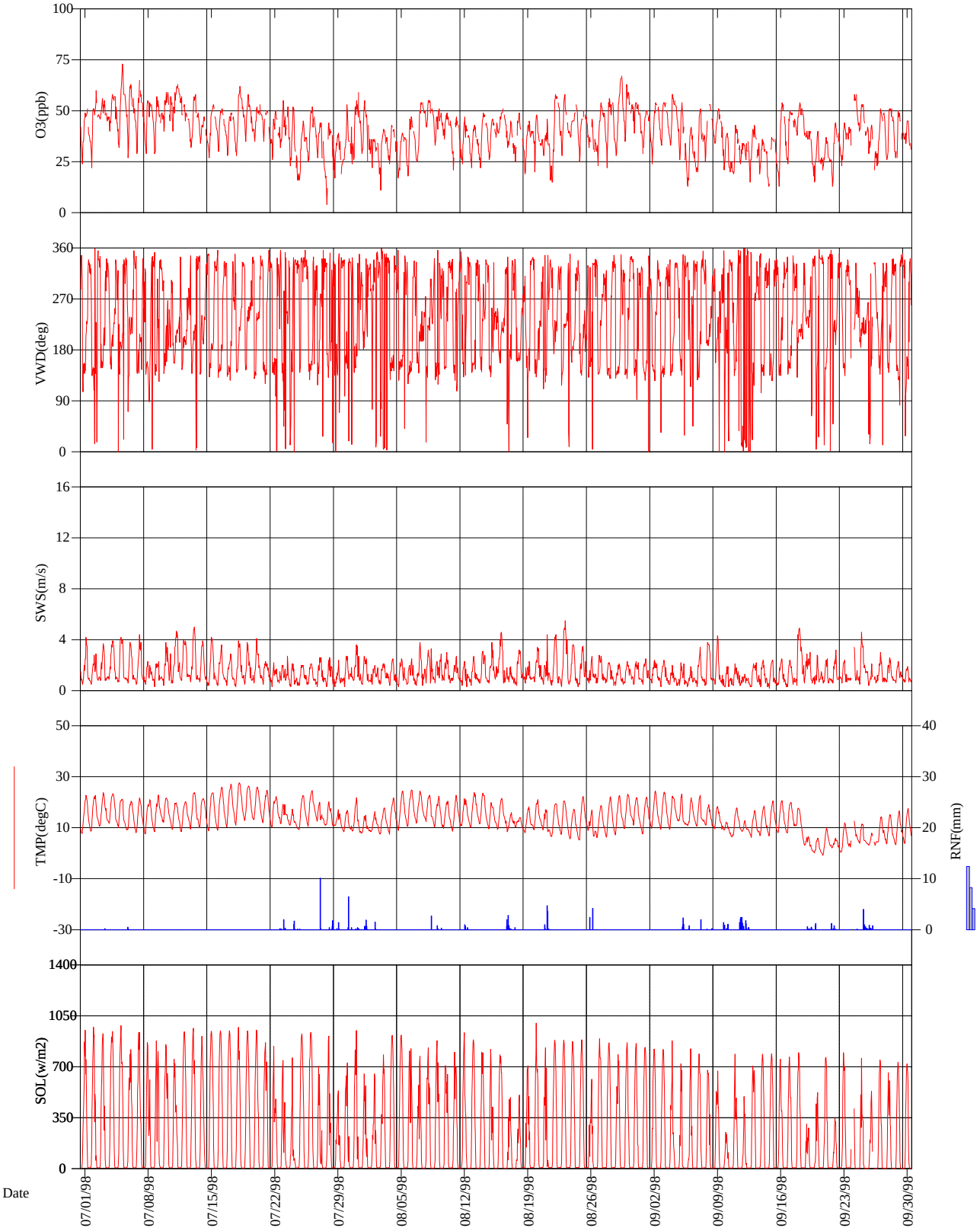


Final Validation

Second Quarter 1998

yelw-wt.stk - yelw98.dat 08-23-1999

Yellowstone National Park - Near Water Tower

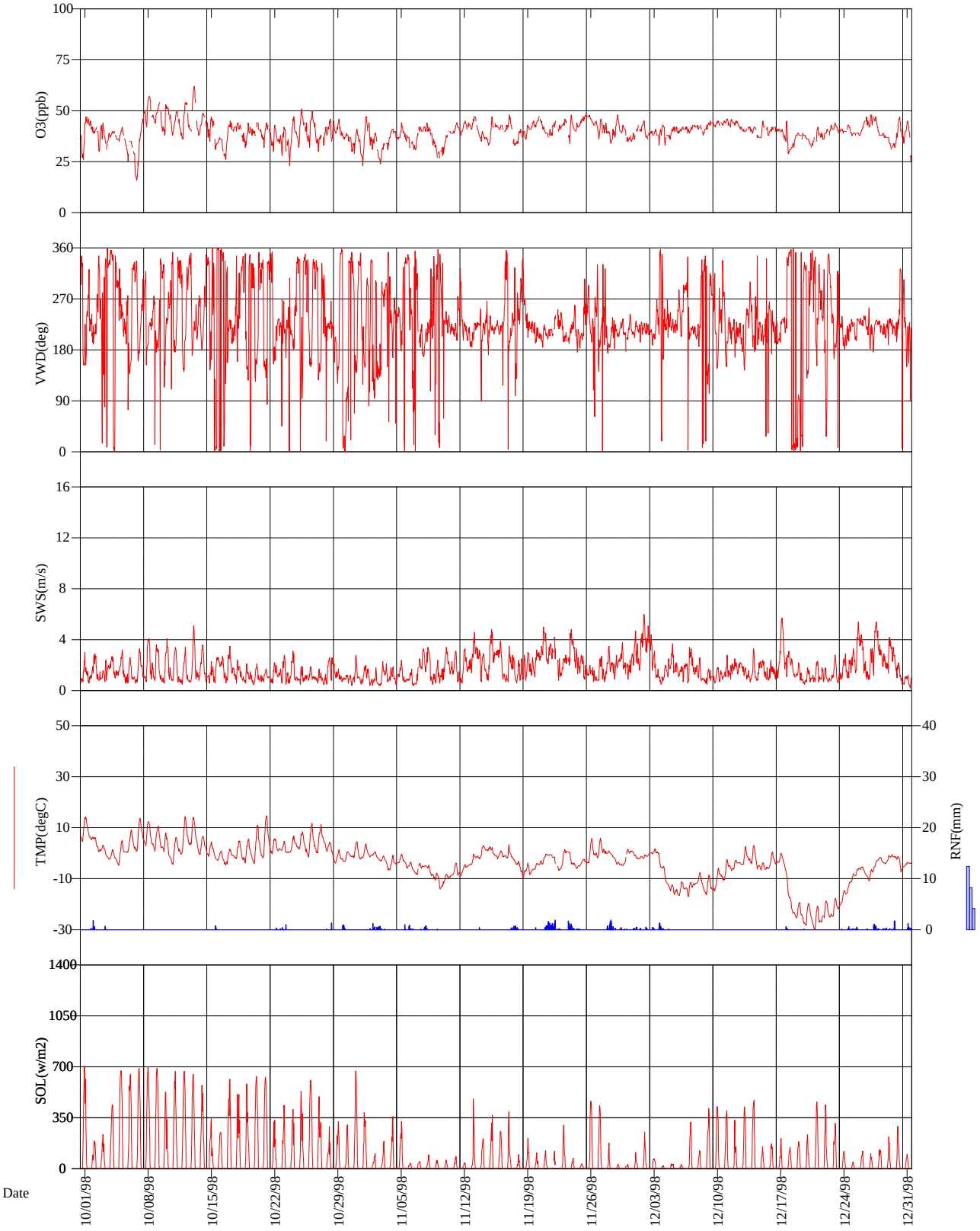


Final Validation

Third Quarter 1998

yelw-wt.stk - yelw98.dat 08-23-1999

Yellowstone National Park - Near Water Tower



Final Validation

Fourth Quarter 1998

yelw-wt.stk - yelw98.dat 08-23-1999

2.2 OZONE DATA SUMMARY

Ozone Quick Look Annual Summary Statistics
Yellowstone National Park

01/01/98 - 12/31/98

STATISTIC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MAY-SEP	ANNUAL
DAILY 1-HR MAXIMUM	49	51	59	72	70	62	73	67	58	62	48	48	73	73
NO. OF DAYS	(28)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(362)
AVERAGE DAILY MAXIMUM	43	45	50	58	56	49	55	50	48	46	44	43	52	49
NO. OF DAYS	(28)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(362)
MAXIMUM DAILY MEAN	45	47	53	63	58	50	55	51	47	50	46	45	58	63
NO. OF DAYS	(26)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(29)	(31)	(29)	(31)	(152)	(358)
AVERAGE DAILY MEAN	40	42	45	51	47	39	43	40	37	40	39	40	41	42
NO. OF DAYS	(26)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(29)	(31)	(29)	(31)	(152)	(358)
MAX PEAK:MIN RATIO	1.800	1.692	2.077	1.778	3.118	3.471	11.000	3.867	4.154	2.875	2.043	1.800	11.000	11.000
NO. OF DAYS	(26)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(29)	(31)	(29)	(31)	(152)	(358)
AVERAGE PEAK:MIN RATIO	1.282	1.247	1.287	1.327	1.694	1.918	2.214	2.058	2.150	1.448	1.281	1.200	2.006	1.598
NO. OF DAYS	(26)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(29)	(31)	(29)	(31)	(152)	(358)
MAX 9AM-4PM AVERAGE	46	47	54	65	62	55	61	57	52	58	46	46	62	65
NO. OF DAYS	(26)	(28)	(30)	(30)	(31)	(29)	(31)	(30)	(28)	(31)	(29)	(31)	(149)	(354)
MONTHLY 9AM-4PM AVERAGE	41	42	47	54	51	43	49	44	42	43	41	41	46	45
NO. OF DAYS	(26)	(28)	(30)	(30)	(31)	(29)	(31)	(30)	(28)	(31)	(29)	(31)	(149)	(354)
MAX 7AM-7PM AVERAGE	45	46	54	65	59	51	57	54	49	56	46	45	59	65
NO. OF DAYS	(27)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(29)	(31)	(29)	(31)	(152)	(359)
MONTHLY 7AM-7PM AVERAGE	40	42	46	53	50	42	46	42	40	42	40	40	44	44
NO. OF DAYS	(27)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(29)	(31)	(29)	(31)	(152)	(359)
MONTHLY MEAN	40	42	45	51	47	39	43	40	37	40	40	40	41	42
NO. OF HOURS	(608)	(637)	(701)	(680)	(697)	(673)	(704)	(701)	(669)	(703)	(668)	(697)	(3444)	(8138)
SUM0 EXPOSURE INDEX	24051	26496	31886	34773	32993	26041	30592	28040	24828	28083	26394	27894	142494	342071
NO. OF HOURS	(608)	(637)	(701)	(680)	(697)	(673)	(704)	(701)	(669)	(703)	(668)	(697)	(3444)	(8138)
SUM60 EXPOSURE INDEX	-	-	-	4073	3408	244	1511	452	-	244	-	-	5615	9932
NO. OF HOURS	(0)	(0)	(0)	(64)	(54)	(4)	(24)	(7)	(0)	(4)	(0)	(0)	(89)	(157)
SUM80 EXPOSURE INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO. OF HOURS	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
W126 EXPOSURE INDEX	890	1260	2627	5813	4501	1491	3192	1976	1365	1433	1020	1052	12526	26621
NO. OF HOURS	(608)	(637)	(701)	(680)	(697)	(673)	(704)	(701)	(669)	(703)	(668)	(697)	(3444)	(8138)

Concentrations in parts per billion (ppb)
Exposures in parts per billion-hours (ppb-hr)

* Statistics defined in the Quick Look subsection of the Glossary

Frequency Distribution
Ozone Analyzer

Yellowstone National Park

Monitoring Season: 04/01/98 - 10/31/98[1]

Averaging Period	% Obs.[3]	# Obs.[2]	Min. Obs.[4]	Percentile[5] 10	30	50	70	90	95	99	Max. Obs.	2nd Max.	Arith. Mean	Geo. Mean	Geo. Stdv.
1-Hour	95	4827	0.035	0.042	0.048	0.051	0.056	0.062	0.064	0.070	0.073	0.072	0.0516	0.0511	1.16

Concentrations in parts per million (ppm)

[1] Records for this report are selected in accordance with the AIRS Geo-Common file criteria. These criteria are based on the state-specific Monitoring Season defined in AIRS.

[2] The number of observations (# Obs.) includes all valid observations recorded within the Monitoring Season.

[3] The percent of valid observations (% Obs.) is the percentage of valid days to the number of possible monitoring days during the Monitoring Season. A valid day is defined as a day with 9 or more valid observations between 9:00 a.m. and 9:00 p.m..

[4] The minimum observation value (Min. Obs.) is the minimum daily maximum recorded during the Monitoring Season.

[5] The percentiles and other statistics are derived from the daily maximums.

Ozone Standards Report and
Daily Maximum 1-Hour Concentrations (ppm)

Yellowstone National Park

01/01/98 - 12/31/98

Day	Jan-98		Feb-98		Mar-98		Apr-98		May-98		Jun-98		Jul-98		Aug-98		Sep-98		Oct-98		Nov-98		Dec-98	
1		T	.046	S	.048	S	.059	W	.055	F	.061	M	.051	W	.055	S	.050	T	.047	T	.047	S		T
2	.038	F	.047	M		M	.058	T		S	.049	T	.060	T	.036	S	.054	W	.045	F	.040	M	.045	W
3	.043	S	.044	T	.049	T	.055	F	.066	S	.035	W	.056	F	.041	M	.054	T	.044	S	.034	T	.041	T
4	.045	S	.037	W	.044	W	.063	S	.058	M	.048	T	.058	S	.043	T	.058	F	.040	S	.041	W	.043	F
5	.045	M	.044	T	.044	T	.049	S	.059	T	.051	F	.073	S	.039	W	.054	S	.042	M	.044	T	.042	S
6	.041	T	.046	F	.044	F	.053	M	.057	W	.047	S	.063	M	.047	T	.042	S		T	.038	F	.042	S
7		W	.049	S	.047	S	.054	T	.058	T	.055	S	.065	T	.054	F	.051	M	.046	W	.042	S	.043	M
8	.045	T	.045	S	.050	S	.048	W	.066	F	.046	M	.055	W	.055	S		T	.057	T	.044	S	.043	T
9	.046	F	.039	M	.051	M	.050	T	.057	S		T	.057	T	.051	S	.051	W	.054	F	.036	M	.045	W
10	.041	S	.043	T	.047	T	.058	F	.049	S	.047	W	.059	F	.049	M	.042	T	.053	S	.040	T	.045	T
11	.043	S	.043	W	.053	W	.072	S	.061	M	.035	T	.063	S		T	.043	F	.050	S	.044	W	.046	F
12	.048	M	.044	T	.052	T	.061	S	.062	T	.059	F	.058	S	.047	W	.035	S	.054	M	.045	T	.046	S
13	.049	T	.046	F	.052	F	.051	M	.053	W	.051	S	.058	M	.043	T	.043	S	.062	T	.047	F	.042	S
14	.042	W	.049	S	.057	S	.057	T	.051	T	.049	S	.049	T	.049	F	.036	M	.049	W	.041	S	.042	M
15	.044	T	.047	S	.057	S	.049	W	.050	F	.050	M	.053	W	.046	S	.037	T	.047	T	.047	S	.045	T
16	.042	F	.046	M	.055	M	.049	T	.057	S		T	.051	T	.051	S	.054	W	.037	F	.043	M	.042	W
17	.044	S	.050	T	.055	T	.055	F	.060	S	.038	W	.049	F	.046	M	.050	T	.045	S	.048	T	.041	T
18		S	.049	W	.049	W	.056	S	.070	M	.036	T	.062	S	.049	T	.054	F	.044	S	.041	W	.045	F
19		M	.046	T	.054	T	.054	S	.063	T	.054	F	.058	S	.045	W	.048	S	.044	M	.043	T	.039	S
20		T	.049	F	.054	F	.060	M	.050	W	.043	S	.053	M	.048	T	.040	S		T	.047	F	.038	S
21		W	.051	S	.059	S	.060	T	.049	T	.048	S	.050	T	.046	F	.037	M	.044	W	.045	S	.042	M
22	.040	T	.046	S	.054	S		W	.044	F	.060	M	.050	W	.058	S	.044	T	.043	T		S	.041	T
23	.041	F	.045	M	.041	M	.070	T	.039	S	.062	T	.055	T	.058	S	.044	W	.042	F	.046	M	.044	W
24	.041	S	.045	T	.046	T	.064	F	.053	S	.052	W	.052	F	.053	M		T	.047	S	.048	T	.043	T
25	.044	S	.042	W	.047	W	.051	S	.053	M	.047	T	.045	S	.050	T	.053	F	.051	S	.048	W	.043	F
26	.044	M	.044	T	.048	T	.058	S	.062	T	.057	F	.052	S	.047	W	.043	S	.050	M	.048	T	.045	S
27	.043	T	.044	F	.049	F	.059	M	.062	W		S	.044	M	.054	T	.051	S	.041	T	.046	F	.048	S
28	.048	W	.047	S	.049	S	.062	T	.056	T	.056	S	.044	T	.056	F	.051	M	.046	W	.044	S	.047	M
29	.047	T			.047	S	.064	W	.053	F	.050	M	.039	W	.067	S	.050	T	.046	T	.048	S	.038	T
30	.047	F			.058	M	.064	T	.048	S	.047	T	.053	T	.063	S	.045	W	.039	F	.043	M	.047	W
31	.045	S			.054	T			.059	S			.059	F	.054	M			.041	S			.045	T
Valid Days	25		28		30		29		30		27		31		30		28		29		29		30	
Maximum	.049		.051		.059		.072		.070		.062		.073		.067		.058		.062		.048		.048	
Violations	0		0		0		0		0		0		0		0		0		0		0		0	

8138 Total Samples	0 Daily-maxima exceeding the standard of .12 ppm (starred[*])
92.9 % Possible	15 Missing days assumed to be less than the standard
346 Valid daily maxima	0 Daily maximas exceed the alert level of .200 ppm

Concentrations in parts per million (ppm)

Yellowstone National Park

1998 Attainment Status With U.S. Environmental Protection Agency (EPA)
PRIMARY Ozone National Ambient Air Quality Standard

Ozone Season: April through October

The primary National Ambient Air Quality Standard for ozone is designed to protect human health. The level of the primary ozone standard promulgated by the EPA on July 18, 1997 is 0.08 parts per million (ppm) [80 parts per billion, (ppb)], daily maximum 8-hour average. The primary ozone standard is met at an ambient monitoring site when the 3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentration is less than or equal to 0.08 ppm. This standard is not met when the 3-year average is greater than 0.08 ppm. Using the EPA's rounding convention, a computed 3-year average ozone concentration of 0.085 ppm (85 ppb) is the smallest value that is greater than the level of the 0.08 ppm standard.

The primary standard requires 90 percent data completeness, on average, during the 3-year period, with no single year within the period having less than 75 percent data completeness. This data completeness requirement would have to be satisfied in order to determine that the standard has been met at a monitoring site. However, calendar years with less than 75 percent data completeness are included in the computation if the annual fourth-highest daily maximum 8-hour concentration is greater than the level of the standard. A site could be found not to have met the standard with less than complete data. The percent data completeness is the percent of valid ozone monitoring days. A day is valid if valid 8-hour averages are available for at least 75 percent of possible hours in the day (i.e., at least 18 of the 24 averages). An 8-hour average is considered valid if at least 75 percent (or 6) of the hourly averages for the 8-hour period are available.

The table below lists the 3-year average fourth-highest daily maximum 8-hour ozone concentration based on data collected during the reported year and the two previous years. This is the number to compare to the level of the new primary standard. The 3-year average data completeness percent and the reported year highest five daily maximum 8-hour averages are also tabulated. A 'No' in the Data Comp % Met? column indicates EPA data completeness requirement was not met for the three-year period.

Year	3-Year Avg 4th High Daily Max 8-hr Ozone (ppb)	3-Year Avg Data Complete %	Data Complete % Met?	Annual 1st High Daily Max 8-hr Ozone (ppb)	Annual 2nd High Daily Max 8-hr Ozone (ppb)	Annual 3rd High Daily Max 8-hr Ozone (ppb)	Annual 4th High Daily Max 8-hr Ozone (ppb)	Annual 5th High Daily Max 8-hr Ozone (ppb)
1998	64	81%	No	69	69	67	67	64

Ozone
Ten Highest Daily 1-Hour Average Maximum Concentrations

Yellowstone National Park

Final Data
01/01/98 - 12/31/98

Rank	Date	Hour	Concentration (ppb)
1	07/05/98	16	73*
2	04/11/98	16	72*
3	04/23/98	17	70*
4	05/18/98	18	70*
5	05/02/98	18	69*
6	08/29/98	21	67*
7	04/22/98	11	66
8	05/03/98	0	66*
9	05/08/98	14	66*
10	07/07/98	13	65

* Other high value(s) were also recorded during one or more hours in the day.

Episodes with 1-Hour Ozone Concentrations
≥ 100 ppb and > 124 ppb
Yellowstone National Park

Final Data
01/01/98 - 12/31/98

Date	Beginning Hour	No. Hours		Max (ppb)
		> 100 ppb	>124 ppb	
No values exceeded 100 ppb during this period				
Total		0	0	

Note: The primary and secondary national ambient air standard for ozone that applied in 1996 is 0.12 ppm over a one hour period not to be exceeded more than once per year. (A value greater than .12 ppm, 124 ppb, or 235 ug/m^3 exceeds the standard.) (40 CFR 50.9 with reference to Appendix D and H.)

Episodes with 8-Hour Average Ozone Concentrations > 84 ppb
Yellowstone National Park

Final Data
01/01/98 - 12/31/98

Date	Start and End Time of Daily Maximum 8-Hour Average > 84 ppb (hr)	Daily Maximum 8-Hour Average (ppb)	Number of 8-Hour Averages > 84 ppb During the Day
No values exceeded 84 ppb during this period			
0	Days with 8-hour average concentrations > 84 ppb		

Note: This table presents episodes of high ozone based on running 8-hour averages. In 1997, the EPA published new primary and secondary national ambient air quality standards for ozone based on 8-hour average ozone concentrations. Attainment of the new primary standard is reached if the annual fourth highest daily maximum 8-hour ozone concentration, averaged over three years, does not exceed 0.08 ppm (84 ppb or 157 ug/m). (40 CFR 50.10.)

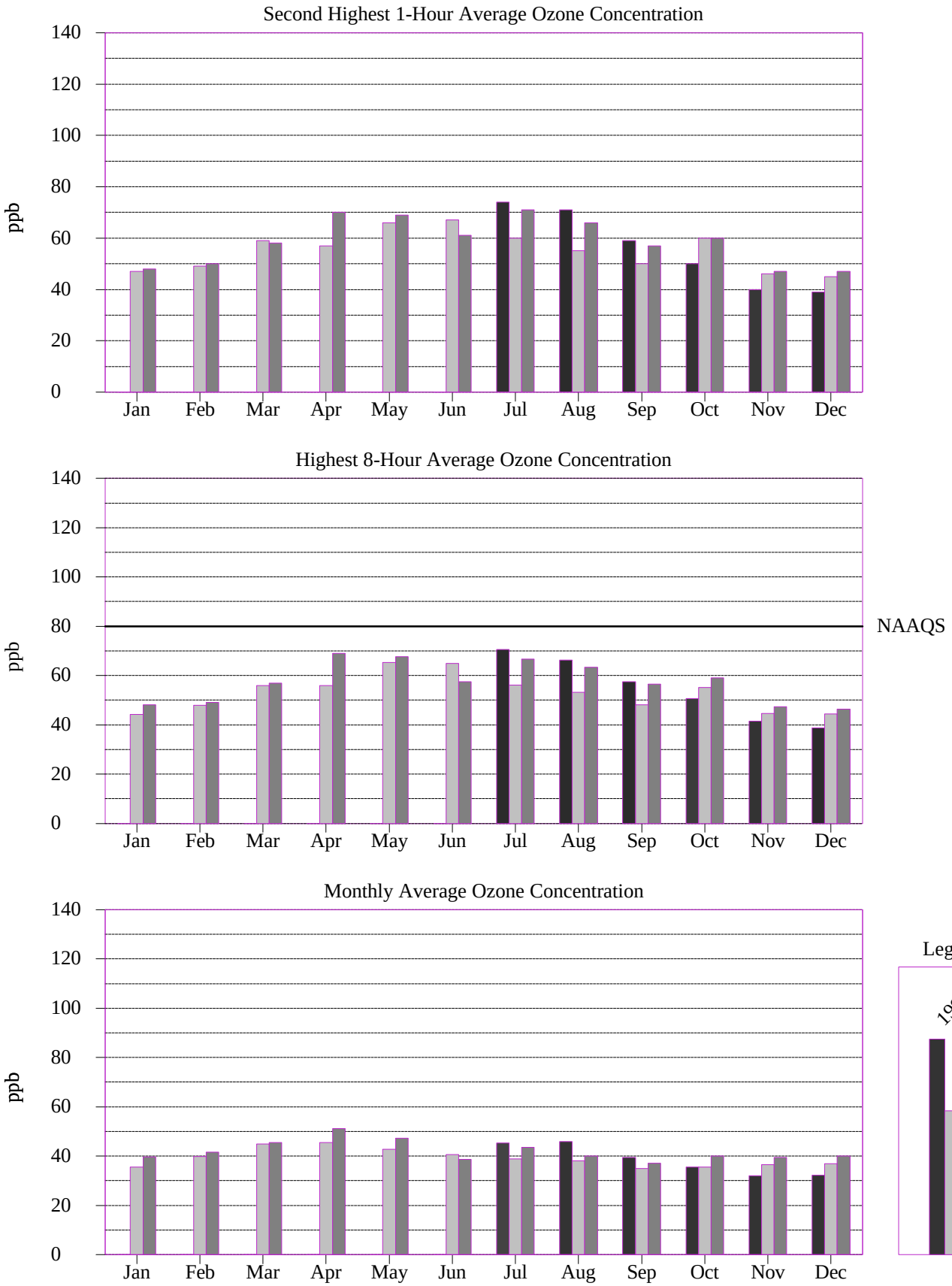
Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, 4th Highest 8-Hour Average Concentrations, and Annual SUM60 Exposure Index for All NPS Monitoring Sites

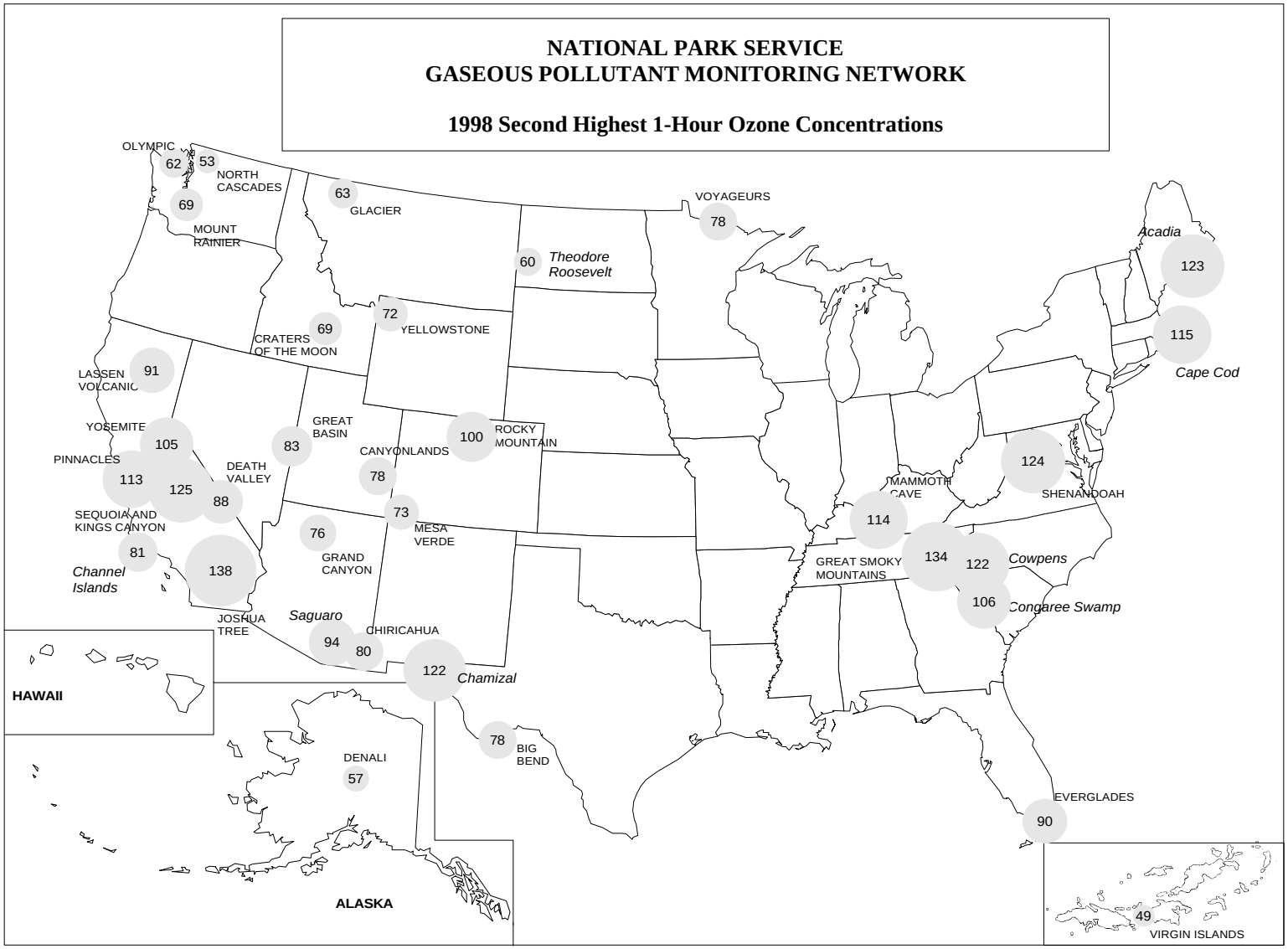
01/01/98 - 12/31/98

Second Highest 1-Hour Average Concentration		
Site	Rank	Concentration (ppb)
JOTR-YV	1	138
GRSM-LR	2	134
SEKI-LK	3	125
SHEN-BM	4	124
ACAD-CM	5	123
GRSM-CM	6	123
CHAM-XX	7	122
COWP-XX	8	122
GRSM-CD	9	117
SEKI-LP	10	117
CACO-XX	11	115
MACA-HM	12	114
PINN-ES	13	113
COSW-XX	14	106
GRSM-CC	15	105
YOSE-TD	16	105
ROMO-LP	17	100
SAGU-PC	18	94
LAVO-ML	19	91
EVER-BC	20	90
DEVA-PV	21	88
GRBA-MY	22	83
CHIS-XX	23	81
CHIR-ES	24	80
BIBE-KB	25	78
CANY-IS	26	78
VOYA-SB	27	78
GRCA-AS	28	76
MEVE-MY	29	73
YELL-WT	30	72
CRMO-VC	31	69
MORA-TW	32	69
GLAC-WG	33	63
OLYM-VC	34	62
THRO-VC	35	60
DENA-HQ	36	57
NOCA-MM	37	53
VIIS-LP	38	49

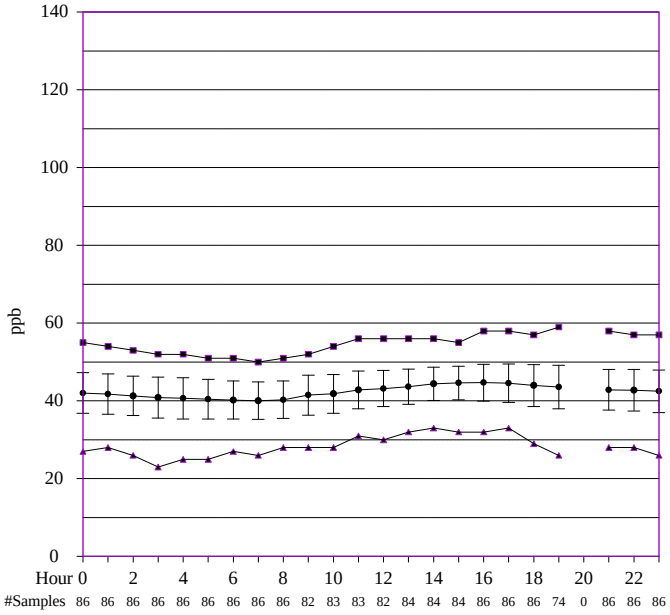
4th Highest 8-hour Average Concentration		
Site	Rank	Concentration (ppb)
GRSM-LR	1	110
JOTR-YV	2	110
GRSM-CM	3	107
SHEN-BM	4	107
GRSM-CD	5	106
SEKI-LP	6	99
MACA-HM	7	98
COWP-XX	8	97
ACAD-CM	9	95
SEKI-LK	10	94
YOSE-TD	11	94
CHAM-XX	12	89
PINN-ES	13	88
GRSM-CC	14	86
CACO-XX	15	84
COSW-XX	16	82
DEVA-PV	17	82
ROMO-LP	18	80
LAVO-ML	19	78
SAGU-PC	20	77
GRCA-AS	21	73
CANY-IS	22	72
EVER-BC	23	72
GRBA-MY	24	71
BIBE-KB	25	70
CHIR-ES	26	68
MEVE-MY	27	68
VOYA-SB	28	68
YELL-WT	29	67
CHIS-XX	30	66
CRMO-VC	31	66
GLAC-WG	32	58
DENA-HQ	33	55
THRO-VC	34	55
MORA-TW	35	51
OLYM-VC	36	46
NOCA-MM	37	43
VIIS-LP	38	39

Annual Sum60 Exposure Index			
Site	Rank	Sum60	Count
GRSM-CM	1	198342	2702
GRSM-CD	2	187437	2577
SHEN-BM	3	170745	2387
GRSM-LR	4	164447	2231
JOTR-YV	5	127317	1769
DEVA-PV	6	93818	1403
YOSE-TD	7	92922	1338
SEKI-LP	8	92214	1230
SEKI-LK	9	84666	1144
MACA-HM	10	82293	1162
COWP-XX	11	70877	970
CANY-IS	12	68500	1075
GRCA-AS	13	63994	996
ROMO-LP	14	59083	897
SAGU-PC	15	57929	869
GRSM-CC	16	52679	742
ACAD-CM	17	45061	638
CACO-XX	18	44769	651
PINN-ES	19	43209	609
CHIR-ES	20	35885	565
GRBA-MY	21	35229	551
LAVO-ML	22	33289	501
MEVE-MY	23	32220	511
CHAM-XX	24	31595	434
BIBE-KB	25	26226	409
COSW-XX	26	26019	364
CRMO-VC	27	17194	274
EVER-BC	28	16065	239
YELL-WT	29	9932	157
CHIS-XX	30	9696	150
VOYA-SB	31	8985	137
GLAC-WG	32	1407	23
MORA-TW	33	638	10
OLYM-VC	34	307	5
THRO-VC	35	181	3
DENA-HQ	36	0	0
NOCA-MM	37	0	0
VIIS-LP	38	0	0

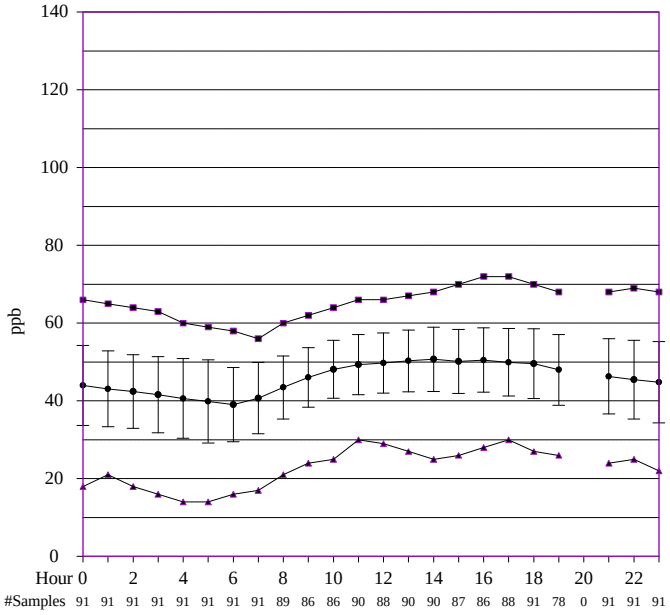

Second Highest 1-Hour Average Ozone Concentration
ppb
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Highest 8-Hour Average Ozone Concentration
NAAQS
Monthly Average Ozone Concentration
Legend
1996
1997
1998


NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK
1998 Second Highest 1-Hour Ozone Concentrations
OLYMPIC
62
53
NORTH CASCADES
69
MOUNT RAINIER
63
GLACIER
VOYAGEURS
78
60
Theodore Roosevelt
Acadia
123
72
YELLOWSTONE
69
CRATERS OF THE MOON
115
Cape Cod
LASSEN VOLCANIC
91
YOSEMITE
105
PINNACLES
113
125
88
SEQUOIA AND KINGS CANYON
81
Channel Islands
138
DEATH VALLEY
GREAT BASIN
83
CANYONLANDS
78
73
MESA VERDE
76
GRAND CANYON
JOSHUA TREE
Saguaro
94
CHIRICAHUA
80
122
Chamizal
100
ROCKY MOUNTAIN
124
MAMMOTH CAVE
SHENANDOAH
114
GREAT SMOKY MOUNTAINS
134
122
Cowpens
106
Congaree Swamp
HAWAII
DENALI
57
78
BIG BEND
EVERGLADES
90
ALASKA
49
VIRGIN ISLANDS

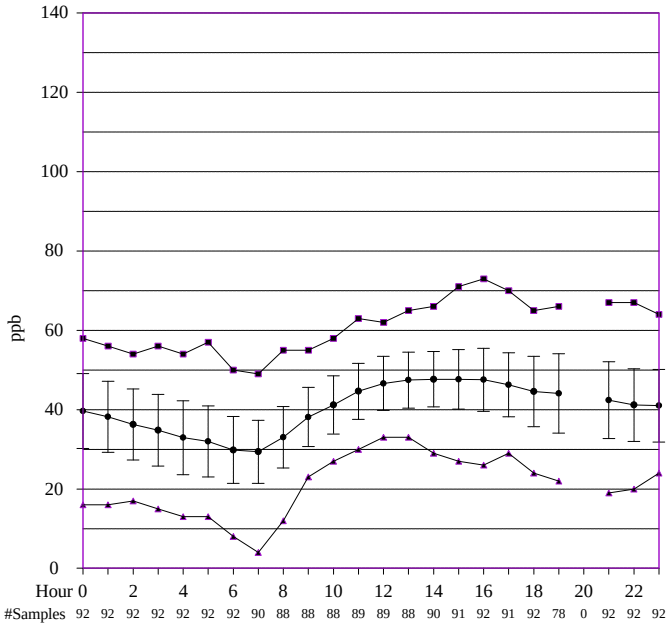
FIRST QUARTER (JAN-MAR)



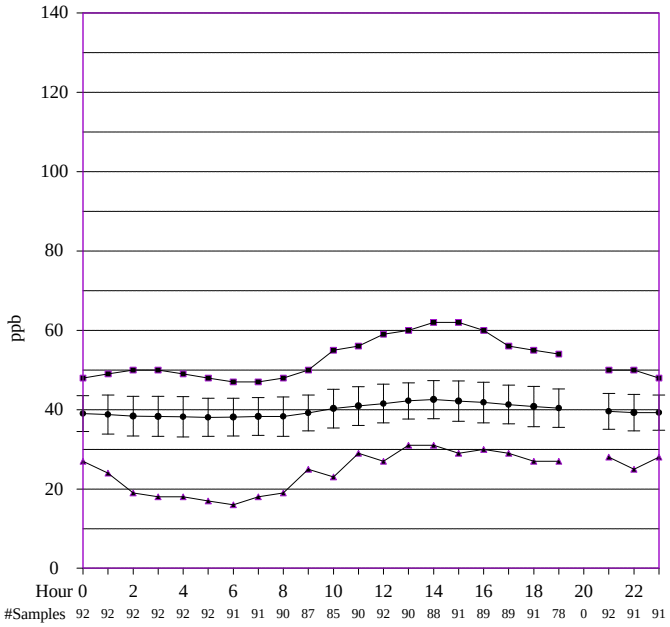
SECOND QUARTER (APR-JUN)

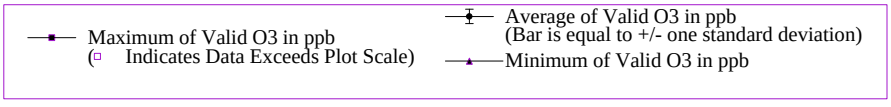


THIRD QUARTER (JUL-SEP)

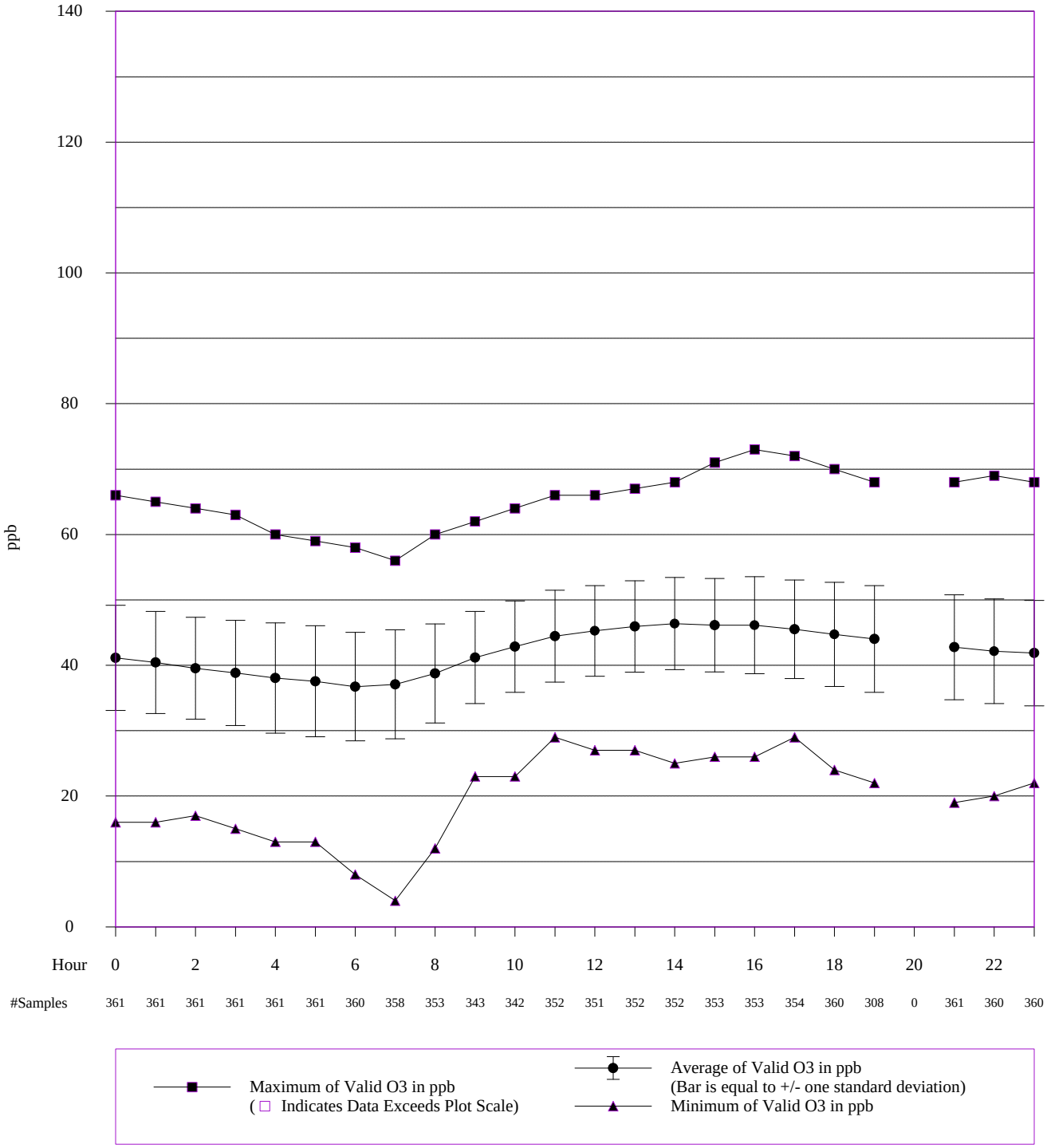


FOURTH QUARTER (OCT-DEC)



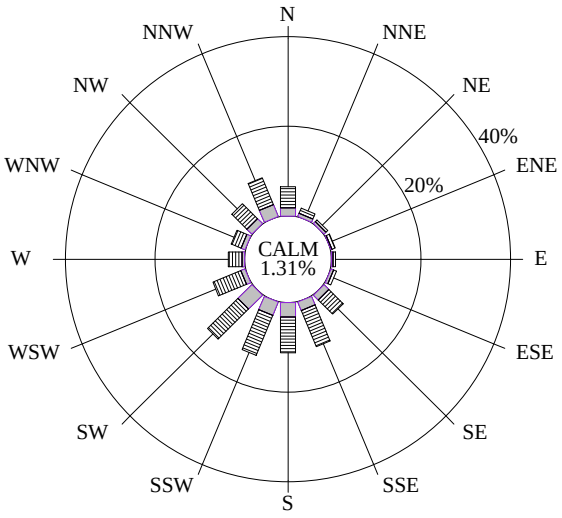


Yellowstone National Park | Annual Diurnal Ozone Plot | 1998



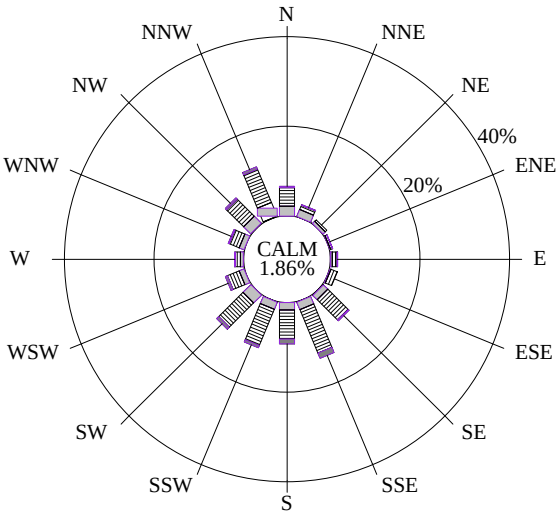
Final Validation 07-14-1999

FIRST QUARTER (JAN-MAR)



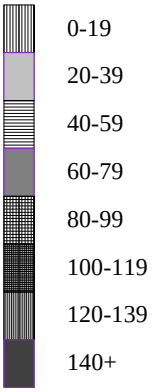
92.6% Collected 88.3% Valid
2160 Possible /2001 Collected /1907 Valid

SECOND QUARTER (APR-JUN)

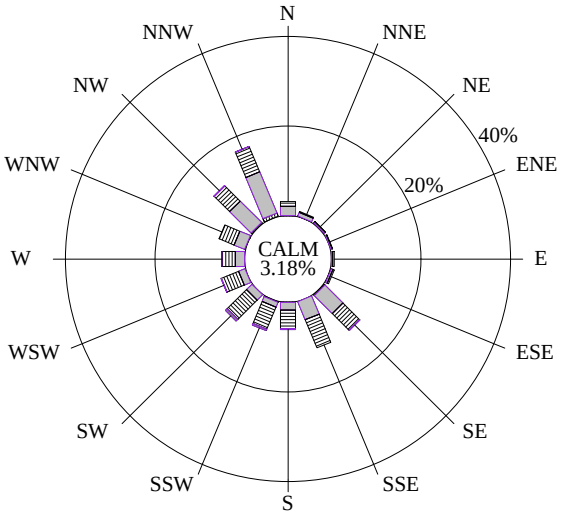


94.2% Collected 93.8% Valid
2184 Possible /2057 Collected /2048 Valid

Ozone (ppb)

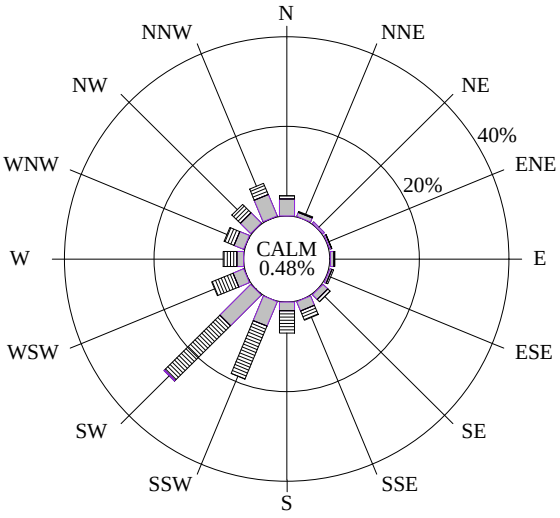


THIRD QUARTER (JUL-SEP)

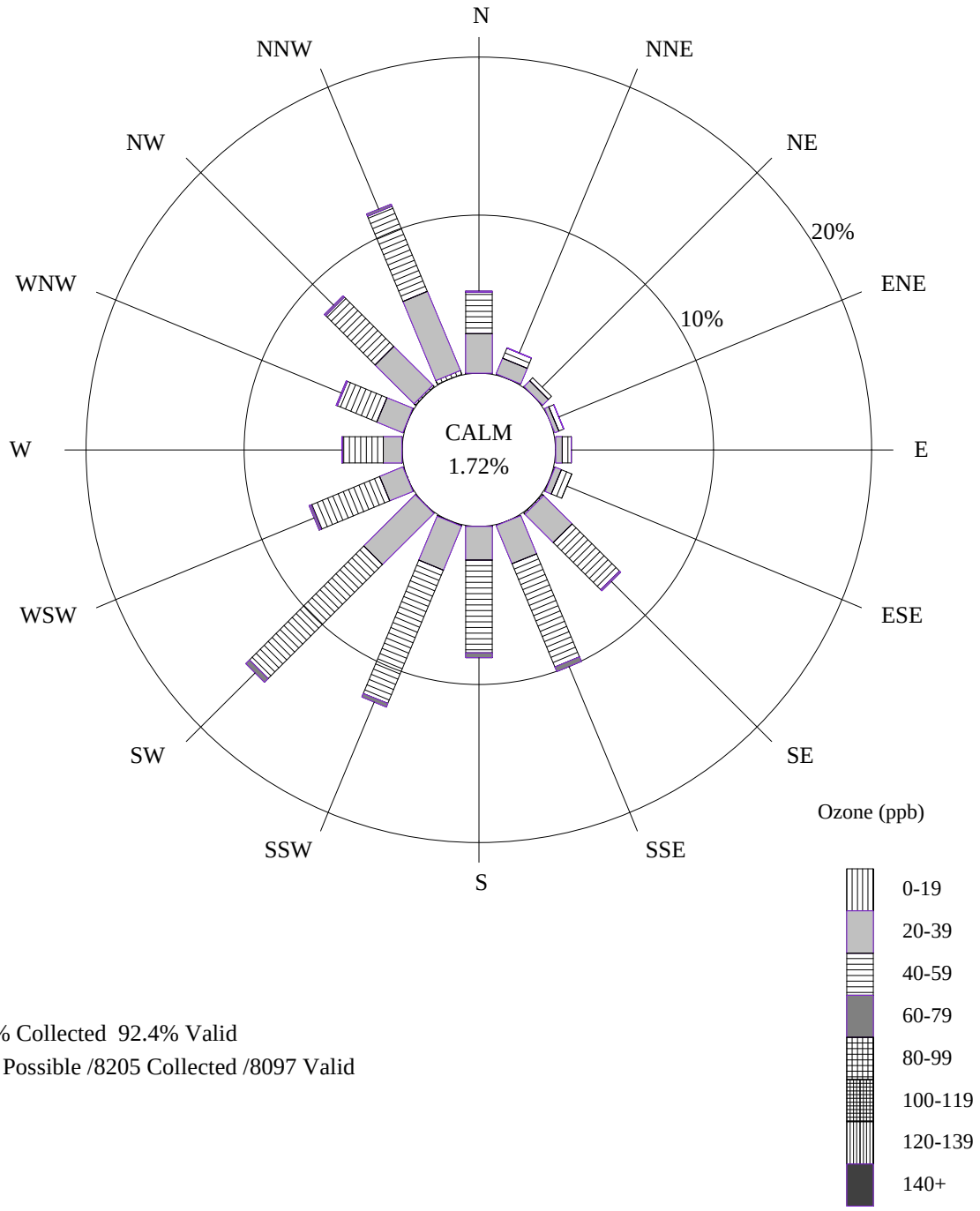


93.9% Collected 93.9% Valid
2208 Possible /2074 Collected /2074 Valid

FOURTH QUARTER (OCT-DEC)



93.9% Collected 93.7% Valid
2208 Possible /2073 Collected /2068 Valid



93.7% Collected 92.4% Valid
8760 Possible /8205 Collected /8097 Valid

Ozone Precision Check Summary
Yellowstone National Park

Precision checks are required by the Environmental Protection Agency (EPA) of all monitoring instruments collecting data which are to be submitted to the EPA Aerometric Information Retrieval System (AIRS). A precision check is performed by challenging the pollutant analyzer with a known concentration of gas (between 0.08 and 0.10 ppm for ozone and sulfur dioxide) from the pollutant transfer standard. This precision check must be performed at least every 14 days of monitoring[1] operation. The percent difference between the analyzer and the transfer standard is then calculated. According to NPS Standard Operating Procedures, the pollutant analyzer must respond within 10% of the transfer standard[2]. The table below gives the number of precision checks performed during each quarter, the average of all the individual[3] precision check percent differences for the quarter, and the upper and lower 95% probability limits for precision checks. The probability limits represent the interval having a 95% chance of containing the true average percent difference. The quarterly average percent difference and probability limits should ideally be within +/- 10%.

Final Data 01/01/98 - 12/31/98				
Calendar Quarter	Number of Precision Checks	Average Percent Difference[1,2]	Lower 95% Probability Limit[3]	Upper 95% Probability Limit[3]
1	17	-0.95	-26.72	24.83
2	15	-3.04	-6.50	0.42
3	15	-8.85	-57.13	39.43
4	15	-6.66	-27.07	13.76

[1] Percent Difference= $\frac{\text{analyzer - transfer std}}{\text{transfer std}}$ X 100.

[2] Average Percent Difference is the mean of all individual precision check percent differences during the quarter.

[3] Upper/Lower 95% Probability Limits=(Average Percent Difference) +/- (1.96)(Standard Deviation of precision check percent differences in the quarter.)

2.3 METEOROLOGICAL DATA SUMMARY

Summary of Selected Meteorological Data

Yellowstone National Park

Final Data

01/01/98 - 12/31/98

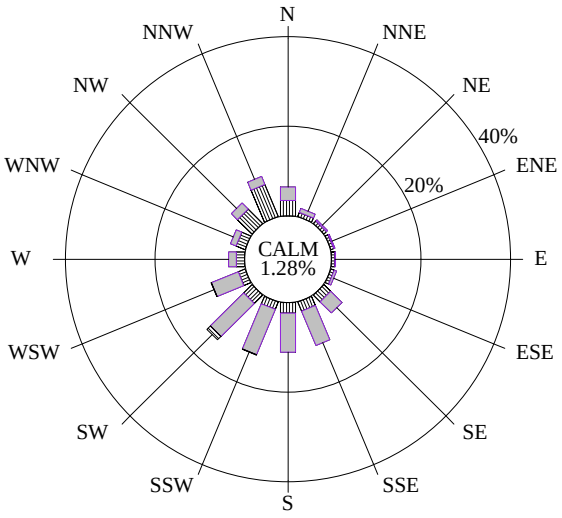
Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	1.6	m/s	8693	0.9
Maximum	6.3	m/s		
Percent calm = 1.66				
AMBIENT TEMPERATURE				
Average	1.9	degC	8692	9.7
Maximum	27.6	degC		
Minimum	-30.0	degC		
RELATIVE HUMIDITY				
Average	70	percent	8694	18
Maximum	96	percent		
Minimum	18	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	.6	mm/hr	905	.9
Maximum non-zero rate	10.1	mm/hr		
Minimum non-zero rate	.1	mm/hr		
Accumulated during period	513.6	mm		
SOLAR RADIATION				
Average Daily Total	11,677,912	joules/m2day	365	7,694,946
Maximum Daily Total	27,644,800	joules/m2day		
Minimum Daily Total	428,800	joules/m2day		

Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

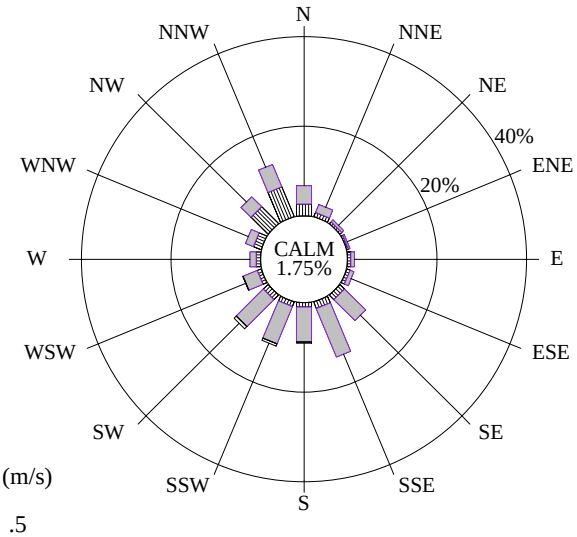
NA indicates instrument not available.

FIRST QUARTER (JAN-MAR)



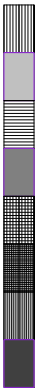
98.0% Collected 98.0% Valid
2160 Possible /2117 Collected /2117 Valid

SECOND QUARTER (APR-JUN)



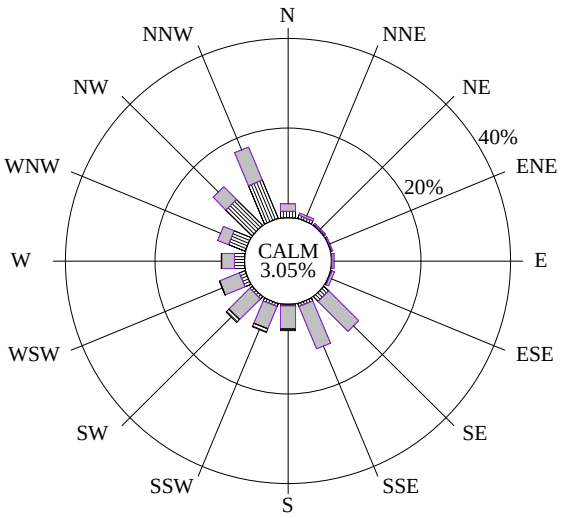
99.7% Collected 99.7% Valid
2184 Possible /2177 Collected /2177 Valid

Scalar Wind Speed (m/s)



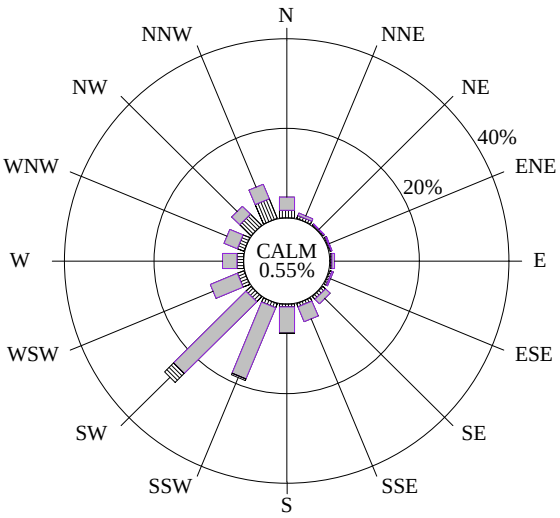
CALM < .5
0.5-0.9
1.0-3.9
4.0-6.9
7.0-9.9
10.0-12.9
13.0-15.9
16.0-18.9
19.0+

THIRD QUARTER (JUL-SEP)

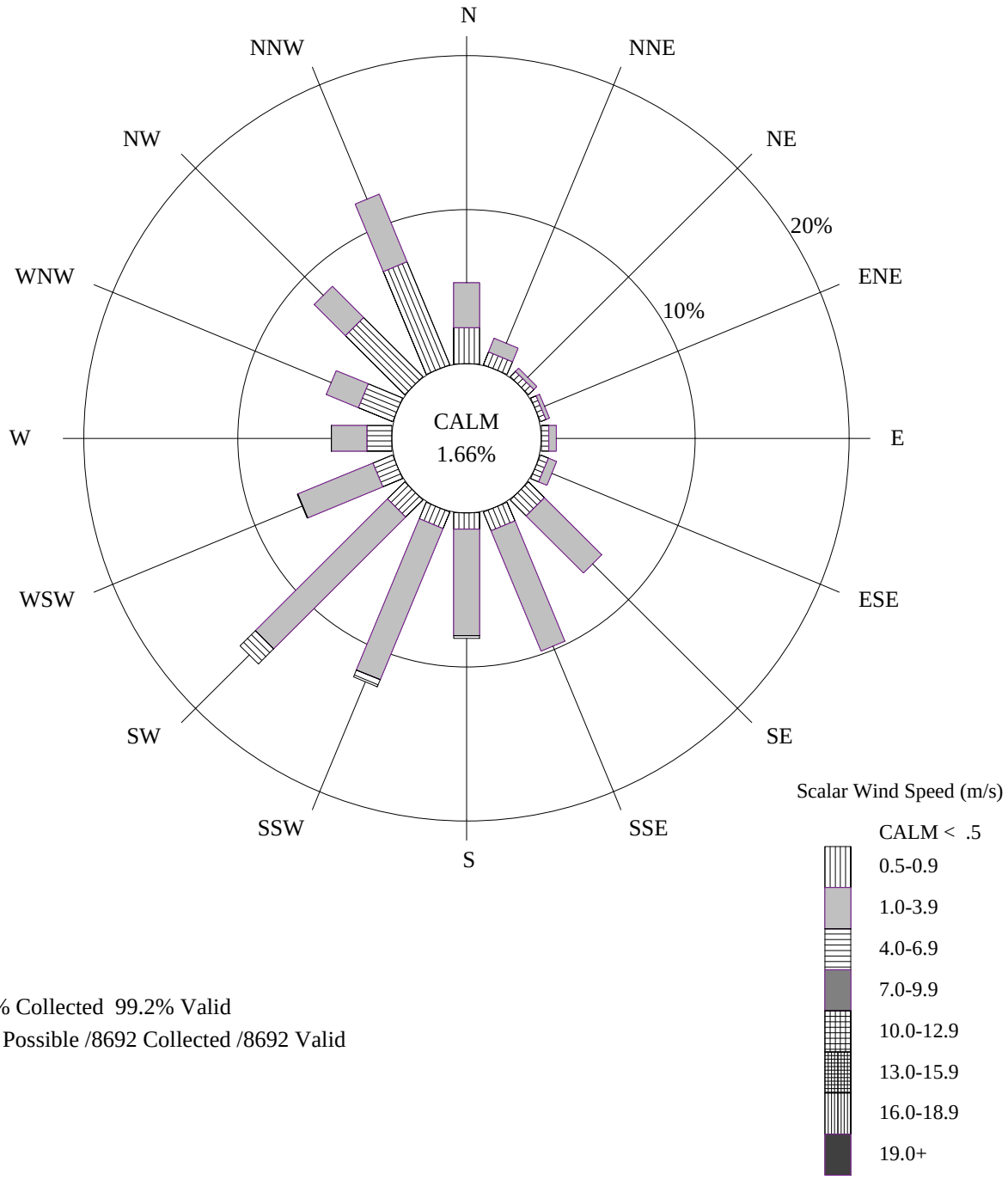


99.6% Collected 99.6% Valid
2208 Possible /2199 Collected /2199 Valid

FOURTH QUARTER (OCT-DEC)



99.6% Collected 99.6% Valid
2208 Possible /2199 Collected /2199 Valid



99.2% Collected 99.2% Valid
8760 Possible /8692 Collected /8692 Valid

2.4 DRY DEPOSITION DATA SUMMARY

Clean Air Status and Trends Network (CASTNet)
Dry Deposition Monitoring

In 1995, the National Park Service (NPS) and the Environmental Protection Agency (EPA) entered a partnership to jointly measure dry deposition in park units, mostly in the West. A portion of the 1997 data collected from this partnership is presented in this section.

Atmospheric deposition of acidic species takes two pathways: wet deposition and dry deposition. Wet deposition is the result of precipitation events (rain, snow, or fog) that remove particles and gases from the atmosphere. Dry deposition is less event driven, but still involves the transfer of particles and gases from the atmosphere to surfaces and plants. Wet deposition has been well documented for many years. In the national parks, the National Acidic Deposition Program (NADP) measures and reports wet deposition (see the web site at http://nadp.sws.uiuc.edu for further information). Dry deposition is much harder to measure and a smaller network of monitoring stations is involved. The method used to measure dry deposition is sometimes called the "inferential method" because air quality concentration data are combined with meteorological measurements and land use functions to compute deposition velocities. The CASTNet program provides long-term estimates of total acidic deposition by adding dry deposition values to wet deposition values.

This annual summary report presents the air quality concentration portion of the dry deposition inferential method, which is the only currently available data set. These data were compiled from the analyses of filters collected by CASTNet deposition filter pack systems in the parks. The filter pack analyses yielded weekly average concentrations of particulate sulfate (SO_4^{2-}), particulate nitrate (NO_3^-), particulate ammonium (NH_4^+), sulfur dioxide (SO_2), and nitric acid (HNO_3). In some cases, the positive ions Na^+, K^+, Ca^{2+}, and Mg^{2+} were also measured from the filter samples. These concentration data for the individual ionic species are presented as weekly bar charts and summarized by quarter and by year in this report. Concentration data can be used to compare sites and to indicate the amount of acidic species available for deposition. As with the continuous analyzer data, the filter pack concentration data are included on a computer diskette that accompanies this report.

Estimated dry deposition values derived from EPA modeling will be reported at a later time to complete the inferential analyses. When available, these modeling results will be posted on the NPS Air Resources Division Internet web site at http://www.aqd.nps.gov/ard1 or on the EPA CASTNet site (http://www.epa.gov/ardpublc/acidrain/castnet/about.html). Initial CASTNet results have shown that dry deposition can be a significant portion of total acidic deposition.

CASTNet Dry Deposition Monitoring
Quarterly and Annual Average Concentrations
Yellowstone National Park
1/1/98 - 12/31/98

Quarter	No.Valid Samples	p-NO_3 (ug/m^3)	HNO_3 (ug/m^3)	Total NO_3 (ug/m^3)	NH_4 (ug/m^3)	p-SO_4 (ug/m^3)	SO_2 (ug/m^3)	SO_4/SO_2 Ratio
1	12	0.136	0.179	0.313	0.199	0.406	0.854	0.475
2	13	0.187	0.214	0.397	0.231	0.566	1.103	0.513
3	13	0.118	0.382	0.494	0.282	0.688	0.938	0.733
4	13	0.178	0.221	0.395	0.218	0.458	0.675	0.678
Annual Average		0.155	0.250	0.402	0.233	0.532	0.893	0.595
Standard Deviation		0.109	0.115	0.162	0.081	0.244	0.553	

Data Recovery Table			
Total No. Filters	No. Invalidated	Data Capture	No. Valid Hours
52	1	98.1%	8536.0

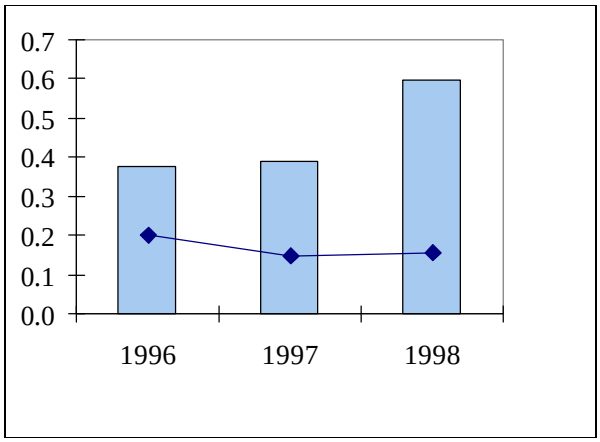
CASTNet Dry Deposition Monitoring Weekly Concentrations Report
Yellowstone National Park
1/1/98 - 12/31/98

On Date	Off Date	p-NO_3 (ug/m^3)	HNO_3 (ug/m^3)	Total NO_3 (ug/m^3)	NH_4 (ug/m^3)	p-SO_4 (ug/m^3)	SO_2 (ug/m^3)	SO_4/SO_2 Ratio
12/29/97	01/05/98							
01/05/98	01/13/98	0.087	0.105	0.191	0.113	0.164	0.278	0.591
01/13/98	01/19/98	0.087	0.096	0.182	0.102	0.175	0.259	0.674
01/19/98	01/26/98	0.146	0.148	0.291	0.164	0.227	0.258	0.879
01/26/98	02/02/98	0.132	0.153	0.282	0.145	0.237	1.212	0.195
02/02/98	02/09/98	0.064	0.147	0.209	0.174	0.350	1.255	0.279
02/09/98	02/16/98	0.039	0.211	0.246	0.214	0.397	0.670	0.594
02/16/98	02/23/98	0.060	0.215	0.272	0.244	0.583	1.066	0.547
02/23/98	03/02/98	0.140	0.176	0.314	0.205	0.489	1.057	0.463
03/02/98	03/09/98	0.100	0.147	0.245	0.290	0.686	1.092	0.628
03/09/98	03/16/98	0.190	0.399	0.582	0.238	0.452	1.314	0.344
03/16/98	03/23/98	0.377	0.282	0.655	0.374	0.770	1.027	0.750
03/23/98	03/30/98	0.214	0.068	0.281	0.124	0.338	0.764	0.443
03/30/98	04/06/98	0.281	0.322	0.598	0.323	0.734	1.303	0.564
04/06/98	04/13/98	0.328	0.315	0.638	0.265	0.563	0.521	1.081
04/13/98	04/20/98	0.108	0.194	0.299	0.238	0.624	0.752	0.830
04/20/98	04/28/98	0.174	0.096	0.269	0.163	0.424	2.929	0.145
04/28/98	05/05/98	0.599	0.194	0.791	0.347	1.175	2.662	0.441
05/05/98	05/12/98	0.251	0.229	0.476	0.351	1.020	1.667	0.612
05/12/98	05/19/98	0.090	0.205	0.292	0.138	0.345	0.605	0.569
05/19/98	05/26/98	0.154	0.352	0.500	0.261	0.656	0.964	0.681
05/26/98	06/02/98	0.238	0.285	0.519	0.178	0.430	0.583	0.738
06/02/98	06/09/98	0.038	0.128	0.164	0.179	0.386	0.928	0.416
06/09/98	06/16/98	0.055	0.154	0.206	0.198	0.390	0.361	1.080
06/16/98	06/23/98	0.051	0.122	0.172	0.164	0.307	0.503	0.610
06/23/98	06/30/98	0.060	0.182	0.240	0.197	0.299	0.555	0.538
06/30/98	07/07/98	0.202	0.507	0.701	0.289	0.843	1.213	0.695
07/07/98	07/14/98	0.121	0.478	0.592	0.308	0.610	0.820	0.744
07/14/98	07/21/98	0.100	0.414	0.508	0.216	0.428	1.511	0.283
07/21/98	07/28/98	0.102	0.324	0.422	0.312	0.742	1.111	0.668
07/28/98	08/04/98	0.068	0.261	0.325	0.256	0.616	0.782	0.788
08/04/98	08/11/98	0.101	0.382	0.476	0.281	0.663	1.036	0.640
08/11/98	08/18/98	0.063	0.391	0.447	0.131	0.339	1.123	0.302
08/18/98	08/25/98	0.143	0.353	0.491	0.268	0.660	0.577	1.143
08/25/98	09/01/98	0.125	0.402	0.521	0.355	0.730	1.227	0.595
09/01/98	09/08/98	0.091	0.523	0.606	0.368	1.157	0.996	1.162
09/08/98	09/15/98	0.058	0.347	0.400	0.323	0.835	0.522	1.599
09/15/98	09/22/98	0.107	0.269	0.372	0.272	0.676	0.752	0.898
09/22/98	09/29/98	0.257	0.314	0.567	0.281	0.644	0.526	1.225
09/29/98	10/06/98	0.204	0.200	0.401	0.348	0.825	0.688	1.199
10/06/98	10/13/98	0.178	0.416	0.588	0.210	0.519	0.699	0.742
10/13/98	10/20/98	0.210	0.325	0.530	0.179	0.439	0.719	0.611
10/20/98	10/27/98	0.111	0.313	0.420	0.283	0.754	1.894	0.398
10/27/98	11/03/98	0.066	0.155	0.218	0.318	0.716	0.658	1.089
11/03/98	11/10/98	0.030	0.219	0.245	0.041	0.073	0.701	0.105
11/10/98	11/16/98	0.421	0.248	0.665	0.364	0.567	0.343	1.651
11/16/98	11/24/98	0.111	0.189	0.297	0.196	0.359	0.300	1.198
11/24/98	12/01/98	0.105	0.156	0.259	0.129	0.267	0.249	1.070
12/01/98	12/08/98	0.190	0.083	0.272	0.160	0.258	0.279	0.924
12/08/98	12/15/98	0.231	0.199	0.426	0.198	0.370	0.556	0.665
12/15/98	12/22/98	0.278	0.230	0.504	0.234	0.444	1.429	0.311
12/22/98	12/29/98	0.176	0.139	0.313	0.178	0.358	0.264	1.358

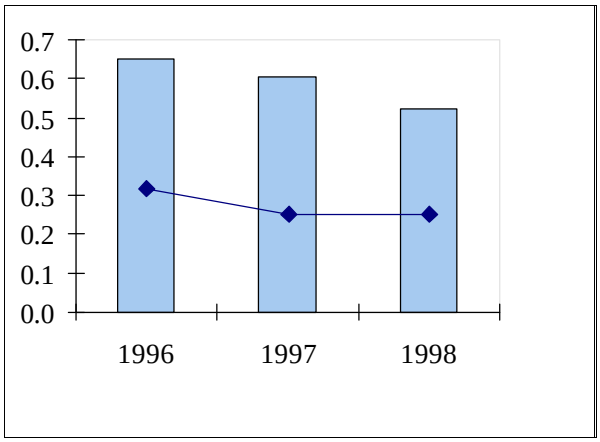
Yellowstone National Park

CASTNet Dry Deposition Monitoring
Three Year Comparison of Maximum and Average Concentrations

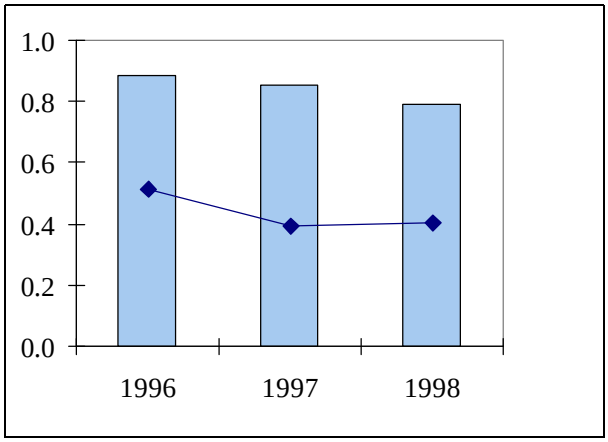
p-NO_3



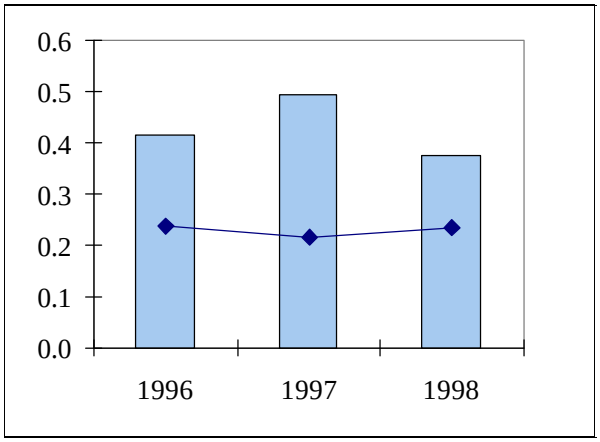
HNO_3



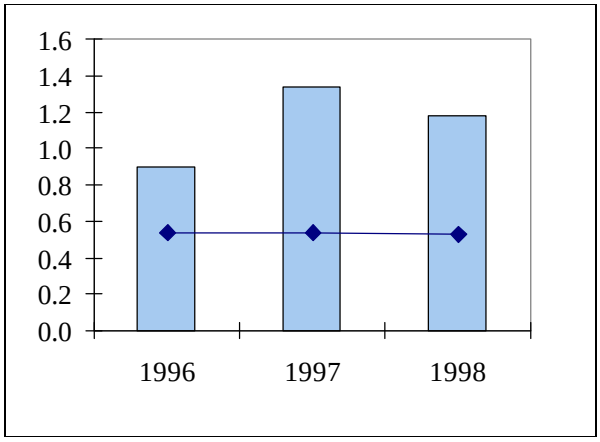
Total NO_3



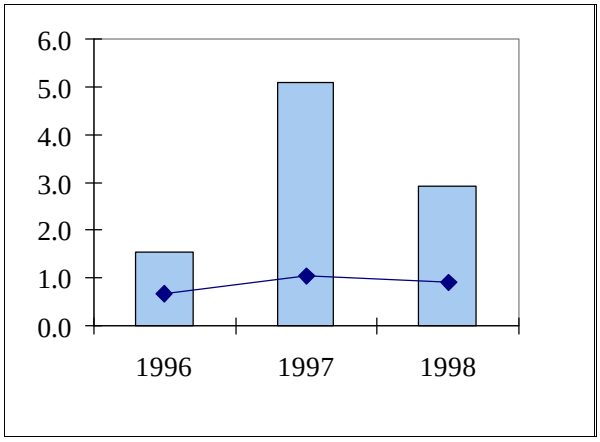
NH_4



p-SO_4

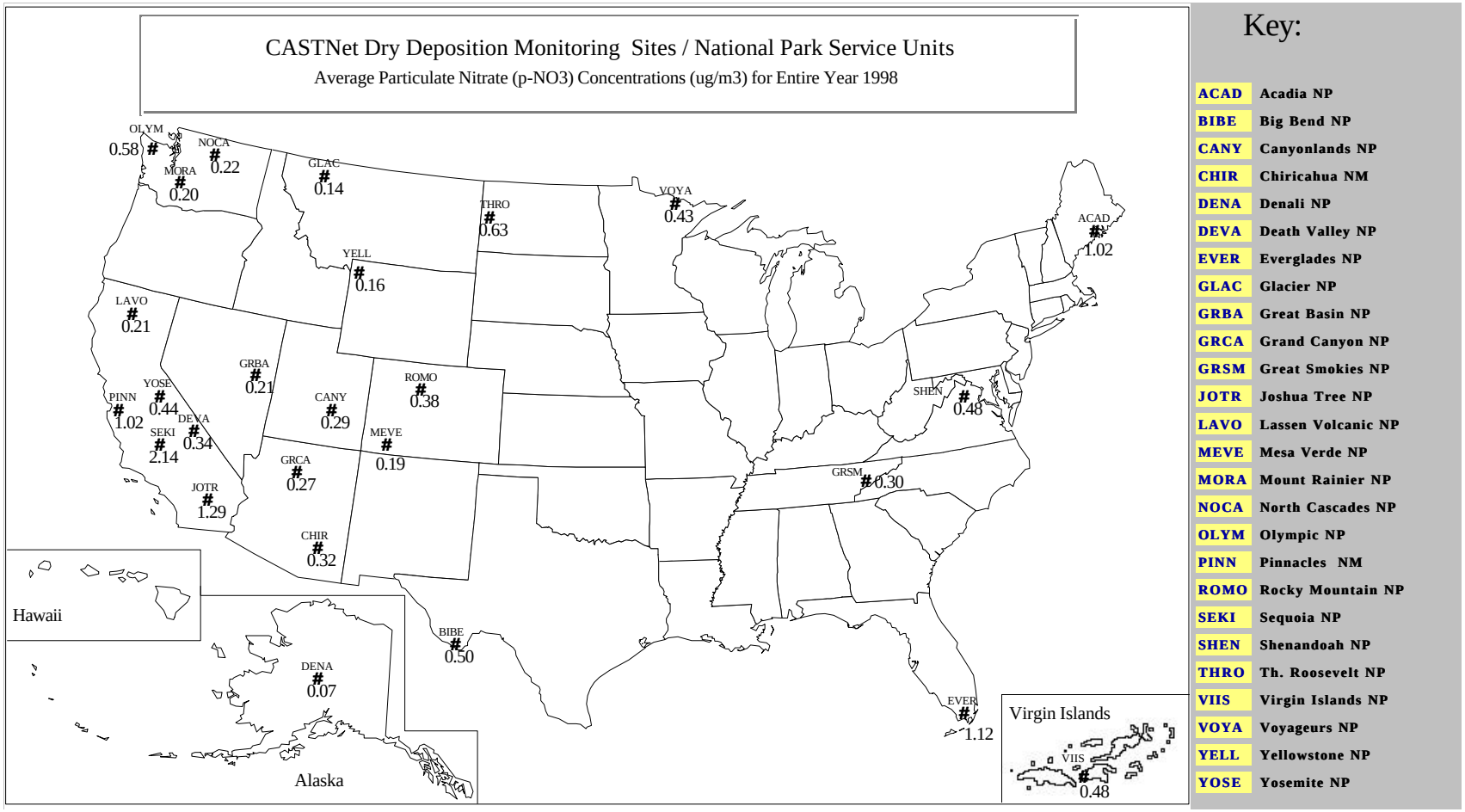


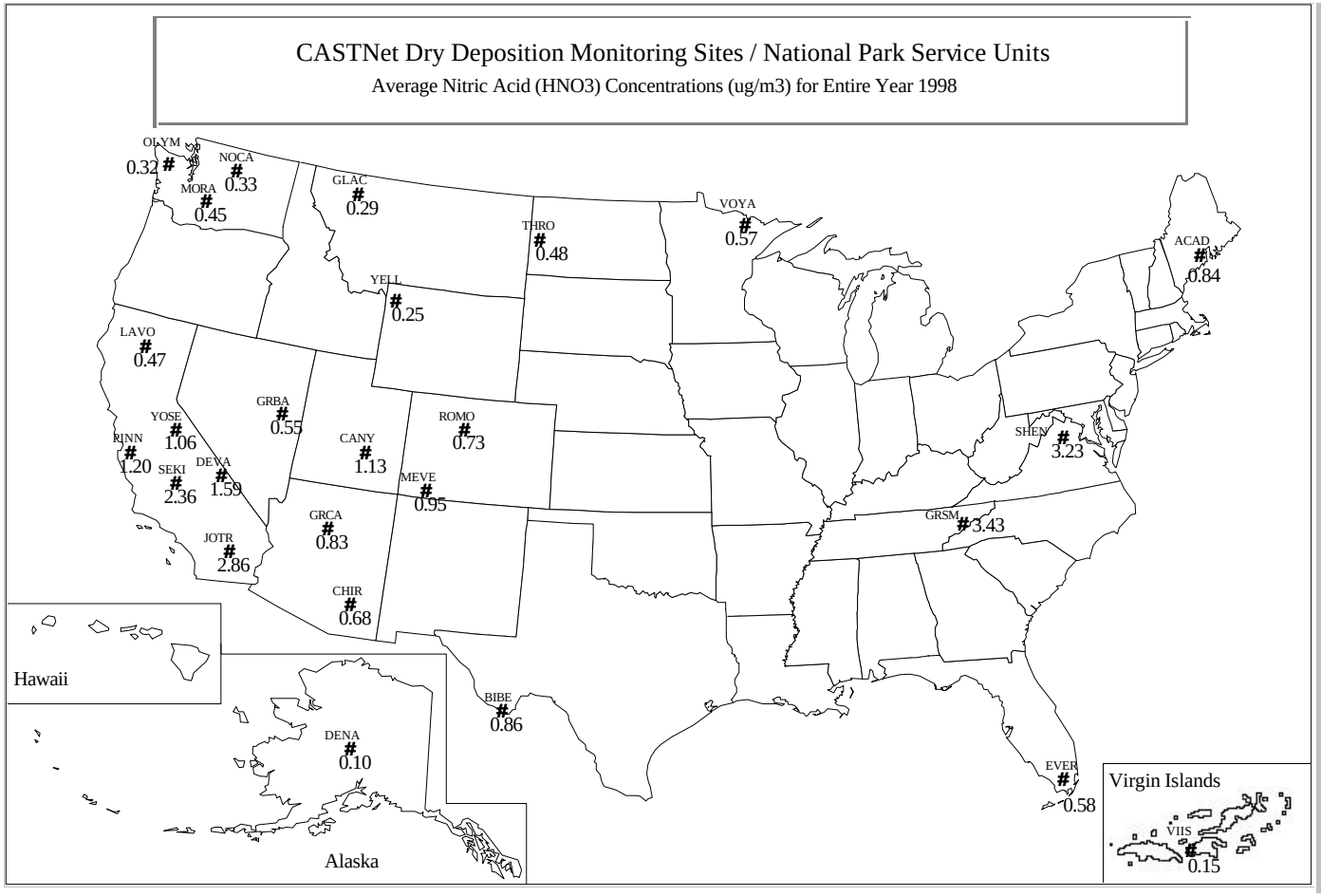
SO_2



Maximum Concentration (ug/m^3) Average Concentration (ug/m^3)

6/25/99


CASTNet Dry Deposition Monitoring Sites / National Park Service Units
Average Particulate Nitrate (p-NO3) Concentrations (ug/m3) for Entire Year 1998
OLYM 0.58
NOCA 0.22
MORA 0.20
GLAC 0.14
THRO 0.63
VOYA 0.43
ACAD 1.02
YELL 0.16
LAVO 0.21
GRBA 0.21
YOSE 0.44
PINN 1.02
DEVA 0.34
SEKI 2.14
CANY 0.29
ROMO 0.38
MEVE 0.19
SHEN 0.48
GRCA 0.27
GRSM 0.30
JOTR 1.29
CHIR 0.32
Hawaii
BIBE 0.50
DENA 0.07
EVER 1.12
Alaska
Virgin Islands
VIIS 0.48
Key:
ACAD Acadia NP
BIBE Big Bend NP
CANY Canyonlands NP
CHIR Chiricahua NM
DENA Denali NP
DEVA Death Valley NP
EVER Everglades NP
GLAC Glacier NP
GRBA Great Basin NP
GRCA Grand Canyon NP
GRSM Great Smokies NP
JOTR Joshua Tree NP
LAVO Lassen Volcanic NP
MEVE Mesa Verde NP
MORA Mount Rainier NP
NOCA North Cascades NP
OLYM Olympic NP
PINN Pinnacles NM
ROMO Rocky Mountain NP
SEKI Sequoia NP
SHEN Shenandoah NP
THRO Th. Roosevelt NP
VIIS Virgin Islands NP
VOYA Voyageurs NP
YELL Yellowstone NP
YOSE Yosemite NP



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JOTR	Joshua Tree NP
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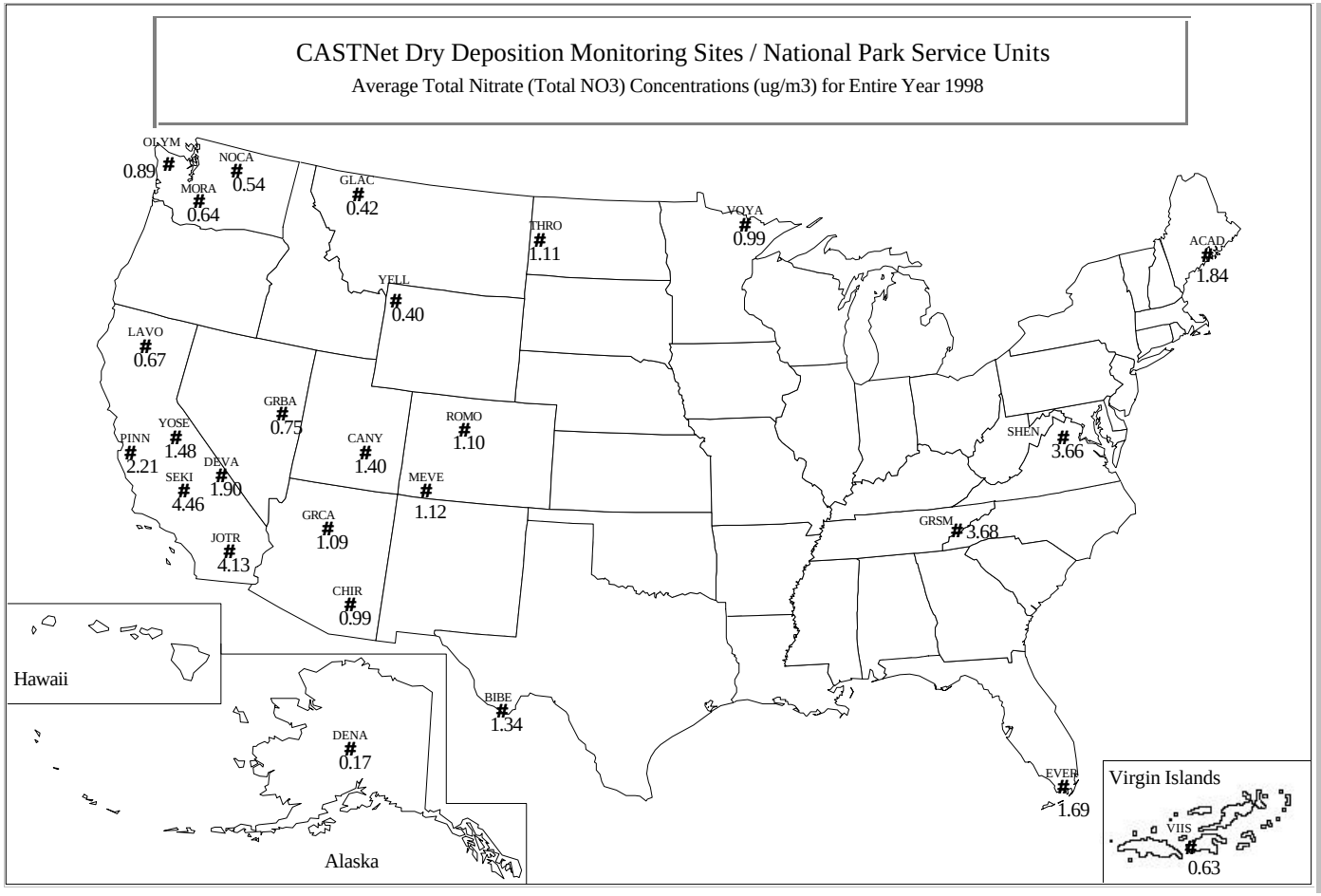
MORA	Mount Rainier NP
NOCA	North Cascades NP
OLYM	Olympic NP
PINN	Pinnacles NM
ROMO	Rocky Mountain NP
SEKI	Sequoia NP
SHEN	Shenandoah NP
THRO	Th. Roosevelt NP
VIIS	Virgin Islands NP
VOYA	Voyageurs NP
YELL	Yellowstone NP
YOSE	Yosemite NP



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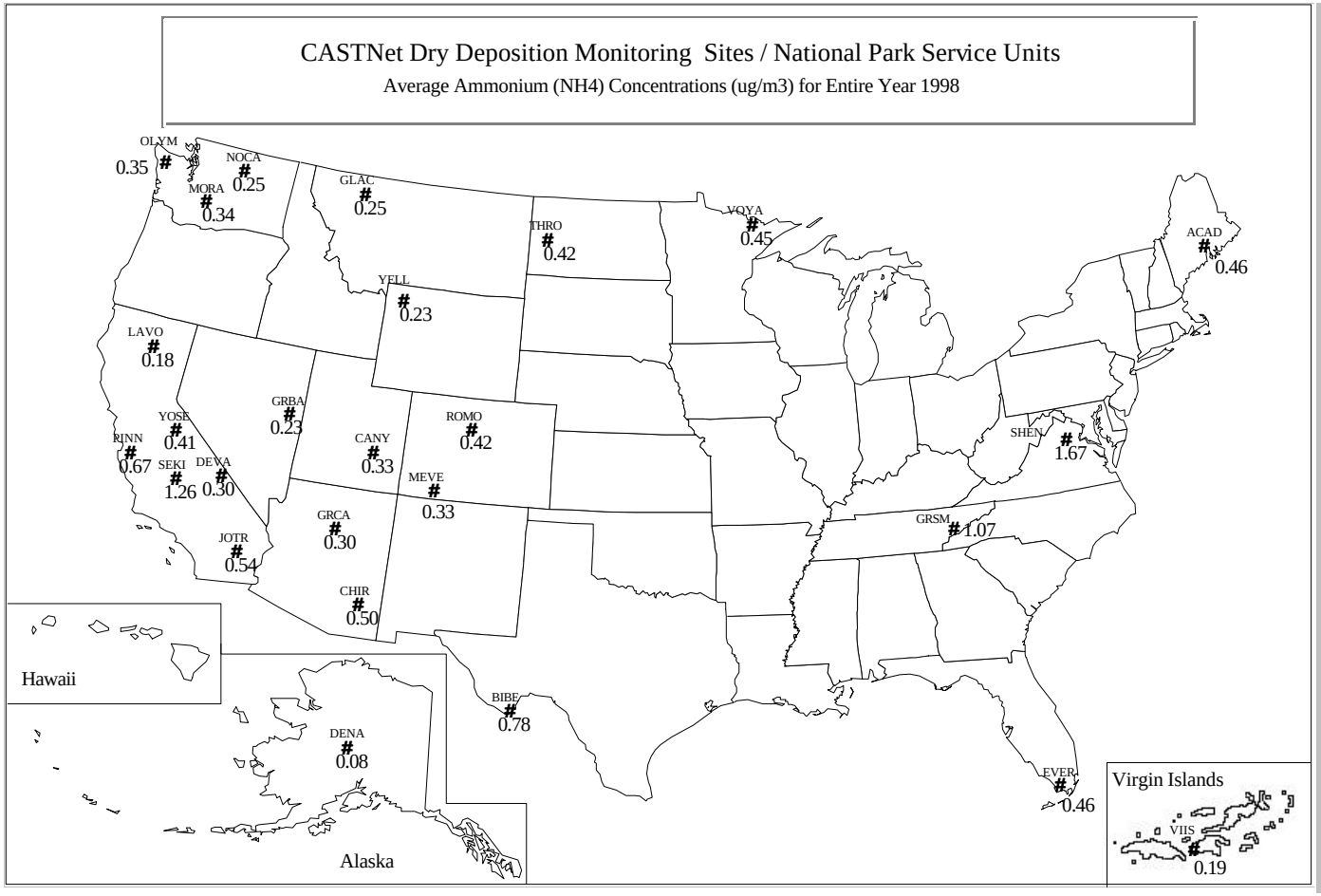

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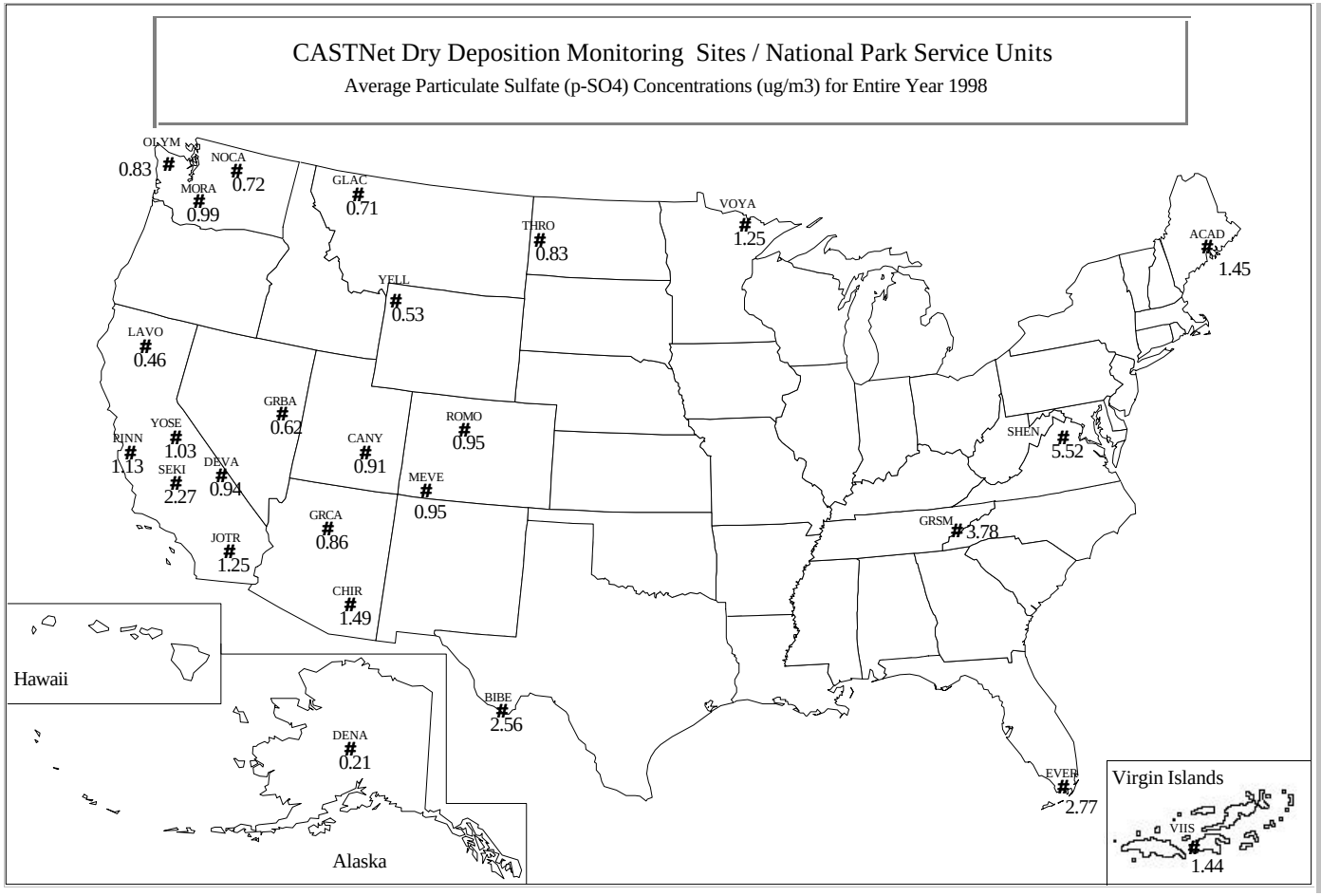

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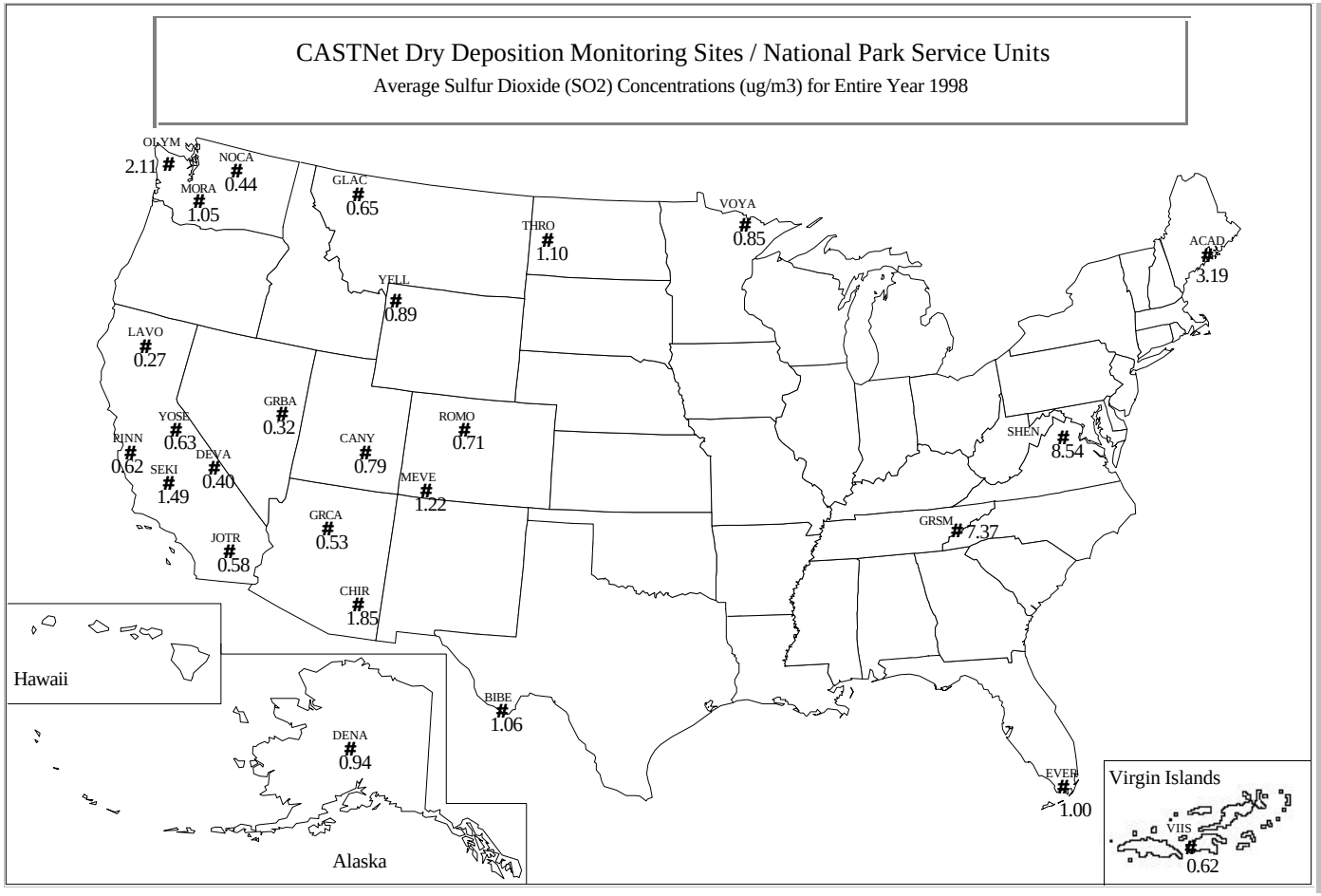

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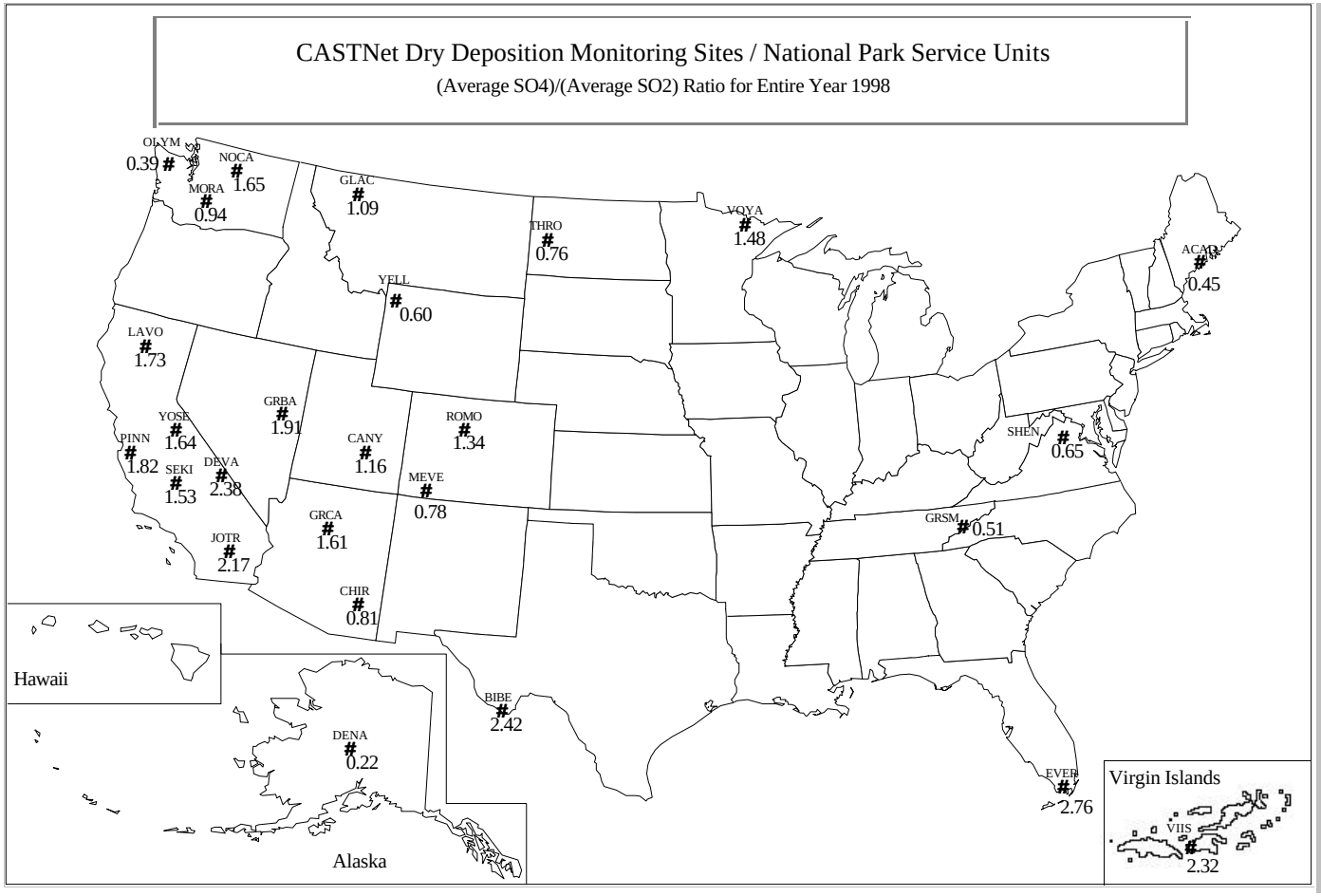

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YOSE	Yosemite NP

3.0 NATIONAL PARK SERVICE AIR RESOURCES DIVISION DATA SOURCES

3.1 GUIDE TO ATTACHED DATA DISKS

Data disks containing ASCII files of the validated hourly data, as shown in the following table are available. Please return the enclosed postcard or contact the address below. These data may be imported into other programs to perform additional data processing and analysis. The data format of each file is included within each file. The second table describes the validation codes used in the data tables to indicate why data are missing or invalid. Wind and pollutant frequency distribution tables in ASCII format are also included on the diskette if available for this site.

Data users should acknowledge the National Park Service Air Resources Division whenever using these data or any portion of this report.

3.2 OTHER SOURCES FOR RETRIEVING NATIONAL PARK SERVICE GASEOUS POLLUTANT DATA

The data contained in this report may also be obtained from the following sources:

- National Park Service AIRWeb (http://www.aqd.nps.gov/natnet/ard) - available after last quarter 1997
- EPA AIRS database
- Data requests directed to:

NPS Air Resources Division
Information Management Center
c/o Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, Colorado 80525
Telephone: (970) 484-7941
Fax: (970) 484-3423
E-Mail: AIR-IMC@AIR-RESOURCE.COM

Data Disk Contents Summary	
File Name (s)	Description
Hourly	
ssssyy.DAT	All Validated Air Quality Data
ssssyymm.ppp	Monthly Data Summary Tables
ssssAN95.Rpp	Annual Wind and Pollutant Frequency Distribution
ssssQ195.Rpp	Quarter 1 Wind and Pollutant Frequency Distribution
ssssQ295.Rpp	Quarter 2 Wind and Pollutant Frequency Distribution
ssssQ395.Rpp	Quarter 3 Wind and Pollutant Frequency Distribution
ssssQ495.Rpp	Quarter 4 Wind and Pollutant Frequency Distribution
Where: ssss = site code yy = year mm = month ppp = air quality data parameter code AN = Annual Qn = Quarter 1-4 R = Wind Frequency distribution table	
CASTNet Weekly Species Summary Data	
File Name (s)	Description
CASTNet	
ssssCNyr.ASC	Weekly averages
Where: ssss = site code CN = CASTNet yr = year asc = ascii file	

NPS IMC and AIRS Invalid Data Codes			
NPS IMC VAL CODE	REASON	AIRS CODE	AIRS REASON
TO	Sample time out of limits	9973	Sample time out of limits
IW	Instrument warmup	9978	Voided by operator
OE	Operator error	9978	
BM	Begin monitoring	9979	Miscellaneous void
TL	Station temp low	9979	
OS	Off scale	9979	
EM	End monitoring	9979	
LI	Local interference	9979	
TH	Station temp high	9979	
IM	Instrument malfunction	9980	Machine malfunction
IN	Interference	9981	Bad weather
RF	Recording system failure	9983	Collection error
NA	No data	9987	Monitoring waived
PF	Power failure	9988	Power Failure
PC	Precision check	9990	Precision Check
ZS	Instrument zero/span check	9991	QC Control Points (Zero/Span)
SA	System audit	9992	QC Audit
PA	Performance audit	9992	
MT	Maintenance	9993	Maintenance/Routine Repairs
OR	Out for repair	9993	
CA	Calibration	9995	Multipoint calibration
SC	Station check	9998	Precision/zero/span

4.0 GLOSSARY

4.1 DEFINITIONS AND COMPUTATIONAL PROCEDURES FOR NATIONAL PARK SERVICE QUICK LOOK ANNUAL SUMMARY STATISTICS REPORT

The National Park Service Quick Look Annual Summary Statistics Table (Page 2-8) provides ozone summary statistics for various indices computed on a monthly basis for an entire year. Growing season (generically defined to be May 1 - September 30) and annual statistics are also presented under the "MAY-SEP" and "ANNUAL" columns, respectively. All concentrations are expressed in the units of parts per billion (PPB) and exposures in parts per billion-hours (PPB-HR). The definitions for each of the statistics appearing on the Quick Look Annual Summary Table are given below.

(1) **Daily 1-Hr Maximum**. The maximum 1-hour average concentration recorded during each month, the growing season or the year regardless of the number of valid hourly observations recorded during a given day. The number in parentheses below this statistic, (N), indicates the number of days in the month, growing season, or year with valid data.

(2) **Average Daily Maximum**. The average of all Daily 1-Hr Maxima during the month regardless of the number of Daily 1-Hr Maxima recorded during the month. For the "MAY-SEP" column the average of all the Daily Maxima recorded during the growing season is given. For the "ANNUAL" column the average of all the Daily Maxima is given. N is as in (1) above.

(3) **Maximum Daily Mean**. The maximum of the valid daily means computed for each month, the growing season ("MAY-SEP" column), and the year ("ANNUAL" column). A valid daily mean is one for which 75% of the observations are available for each day, i.e., 18 hours. N is the number of days during each month, growing season, and year with at least 18 observations.

(4) **Average Daily Mean**. The average of all valid daily means for the month, the growing season ("MAY-SEP" column), and the year ("ANNUAL" column). N is as in (3) above.

(5) **Max Peak:Min Ratio**. The ratio of the Daily 1-Hr Maximum to the Daily 1-Hr Minimum. A ratio is computed only if a valid Daily Mean is computed and if the Daily 1-Hr Minimum is not equal to zero. N is the number of days with a valid Peak:Min ratio.

(6) **Average Peak:Min Ratio**. The average of all Peak:Min ratios for the month, growing season, or year. N is as in (5) above.

(7) **Max 9AM-4PM Average**. The maximum of all valid 9AM-4PM Averages computed for the month, growing season, or year. A valid 9AM-4PM Average is one which has 75% of the observations available during that time period (i.e., 6 hours. N is the number of days with valid averages.)

(8) **Monthly 9AM-4PM Average**. The average of all valid 9AM-4PM Averages for the month, growing season, or year. N is as in (7) above.

(9) **Max 7AM-7PM Average**. The maximum of all valid 7AM-7PM Averages computed for the month, growing season, or year. A valid 7AM-7PM Average is one which has 75% of the observations available during that time period, i.e., 9 hours. N is the number of days with valid averages.

(10) **Monthly 7AM-7PM Average**. The average of all valid 7AM-7PM averages for the month, growing season, or year. N is as in (9) above.

(11) **Monthly Mean**. The average of all 1-Hr ozone concentrations recorded during the month, growing season, or year. A mean is computed regardless of the number of hours with valid data. N is the number of hours with valid observations.

(12) **SUM0 Exposure Index**. The monthly sum of all hourly ozone concentrations. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. N is the number of hours with valid observations and is the same N as in (11) above.

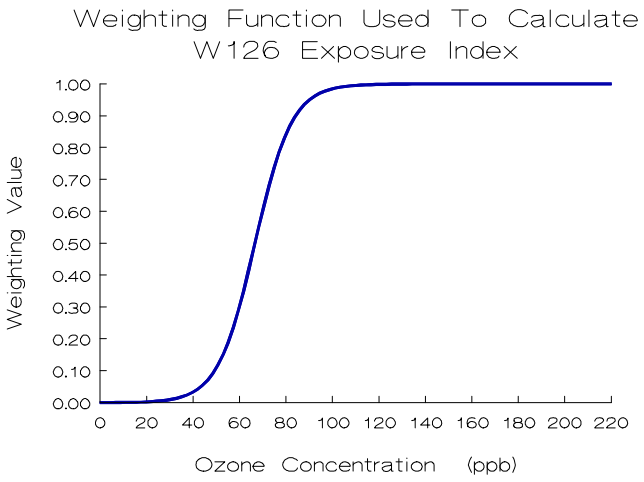
(13) **SUM60 Exposure Index**. The monthly sum of all hourly ozone concentrations equaling or exceeding 60 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. N is the number of hours equaling or exceeding 60 PPB during the month, growing season, or year.

(14) **SUM80 Exposure Index**. The monthly sum of all hourly ozone concentrations equaling or exceeding 80 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. N is the number of hours equaling or exceeding 80 PPB during the month, growing season, or year.

(15) **W126 Exposure Index**. The monthly sum of all hourly ozone concentrations where each concentration is weighted by a function that gives greater emphasis to the higher hourly concentrations while still including the lower ones. This weighting function provides a weighting value that is unique for each hourly ozone concentration. The weighting function, as described by Lefohn, Laurence, and Kohut[1] is:

$$w_i = \frac{1}{1 + 4403 \exp(-.126 c_i)}$$

where



w_i = weighting value for hourly concentration *i*, and
c_i = hourly concentration *i* in PPB.

The graph of weighting value versus ozone concentration, in the figure to the left, illustrates the greater weights given to higher hourly ozone concentrations.

Each hour's weighting value is multiplied by its corresponding hourly concentration. This product is summed over all the valid hours in each month to calculate the monthly W126 exposure.

Thus, the monthly W126 exposure is:

$$W126 = \sum_{i=1}^{n} w_i c_i$$

where

W126 = monthly W126 exposure index,
w_i = weighting value for hourly concentration *i*,
c_i = hourly concentration *i* in PPB, and
n = number of hours in the month with valid ozone concentrations.

The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. The exposure units are PPB-HR.

Because each hour contributes to this exposure index, N is the number of hours with valid observations and is the same N as in (11) and (12) above.

The U.S. Environmental Protection Agency usually considers air quality statistics, such as a mean, to be "valid" (i.e., representative of the parameter being estimated for the time interval in question) only if 75% or more of the total possible observations have been measured during that time interval. Therefore, one should exercise caution when comparing these statistics between months and sites, particularly those that are not averages (e.g., maxima and exposures) whenever the number of valid observations is less than 75% of the total possible.

References

1. Lefohn, A.S., J. A. Laurence, and R. J. Kohut. 1988. A Comparison of Indices That Describe the Relationship Between Exposure to Ozone and Reduction in the Yield of Agricultural Crops. *Atmospheric Environment* 22, 1229-1240.

4.2 AIR QUALITY GLOSSARY

Acid Deposition: Air pollution produced when acid chemicals are incorporated into rain, snow, fog, or mist.

Aerometric Information Retrieval System (AIRS): A computer-based database of U.S. air pollution information administered by the EPA Office of Air Quality Planning and Standards (U.S. Environmental Protection Agency).

AIRWeb: Air Resources Web, an air quality information retrieval system for U.S. parks and wildlife refuges developed by the Air Resources Division of the National Park Service and the Air Quality Branch of the Fish and Wildlife Service.

Air Pollutant: An unwanted chemical or other material found in the air.

Air Pollution: Degradation of air quality resulting from unwanted chemicals or other materials occurring in the air.

Air Quality: The properties and degree of purity of air to which people and natural and heritage resources are exposed (in the context of national parks).

Air Pollution Control Permitting Process: Process by which facilities are permitted to emit specified types and quantities of air pollutants.

Air Quality Related Values (AQRVs): Values including visibility, flora, fauna, cultural and historical resources, odor, soil, water, and virtually all resources that are dependent upon and affected by air quality. "These values include visibility and those scenic, cultural, biological, and recreation resources of an area that are affected by air quality." *(43 Fed. Reg. 15016)*

Ambient Air: Air that is accessible to the public.

Class I: Areas of the country set aside under the Clean Air Act to receive the most stringent degree of air quality protection.

Class II: Areas of the country protected under the Clean Air Act but identified for somewhat less stringent protection from air pollution damage than Class I, except in specified cases.

Clean Air Act: Originally passed in 1963, our current national air pollution control program is based on the 1970 version of the law. Substantial revisions were made by the 1990 Clean Air Act Amendments.

Continuous Sampling Device: An air analyzer that measures air quality components continuously.

Criteria: Information on health and/or environmental effects of pollution (in the context of criteria air pollutants).

Criteria Air Pollutant: A group of very common air pollutants regulated by EPA on the basis of criteria and for which a National Ambient Air Quality Standard is established (SO_2, NO_2, PM_{10}, Pb, CO, O_3).

Emissions: Release of pollutants into the air from a source.

Environmental Protection Agency (EPA): The federal agency responsible for regulating air quality.

Monitoring: Measurement of air pollution.

National Ambient Air Quality Standards (NAAQS): Permissible levels of criteria air pollutant established to protect public health and welfare.

Ozone (O_3): A criteria air pollutant that is a strong oxidizing agent, reactive with many other compounds and surfaces, and a health hazard in high concentrations. Ozone is formed by nitrogen oxides and organic compounds reacting in sunlight.

Source: Any place or object from which air pollutants are released. Sources that are fixed in space are stationary sources; sources that move are mobile sources.

Sulfur Dioxide (SO_2): A criteria air pollutant that is a gas produced by burning coal and some industrial processes.

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* Recent updates to this glossary may be found on the NPSARD AIRWeb - http://www.aqd.nps.gov/natnet/ard/glossary.htm.

4.3 GLOSSARY OF AIR QUALITY UNITS

Units Conversion Table			
Parameter Type	Multiply	By	To Obtain
Pollutant	ppm	1000	ppb
	ppm	1960	$\mu g/m^3$ Ozone (at 25°C)
	ppm	2615	$\mu g/m^3$ Sulfur Dioxide (at 25°C)
	ppb	0.001	ppm
	ppb	1.960	$\mu g/m^3$ Ozone (at 25°C)
	ppb	2.615	$\mu g/m^3$ Sulfur Dioxide (at 25°C)
	$\mu g/m^3$ Ozone (25°C)	0.0005102	ppm
	$\mu g/m^3$ Ozone (25°C)	0.5102	ppb
	$\mu g/m^3$ Sulfur Dioxide (25°C)	0.0003824	ppm
	$\mu g/m^3$ Sulfur Dioxide (25°C)	0.3824	ppb
Wind Speed	m/s	2.05	mph
	mph	0.489	m/s
Solar Radiation	ly/min	697	w/m^2
	w/m^2	0.00143	ly/min
Precipitation	mm/hr	0.0394	in/hr
	in/hr	25.4	mm/hr
Temperature	°C + 17.78	1.8	°F
	°F - 32	5/9	°C

Where:
ppm = parts per million
ppb = parts per billion
$\mu g/m^3$ = micrograms per cubic meter (at 25°C)
m/s = meters per second
mps = miles per hour
ly/min = langleys per minute
w/m^2 = watts per square meter
mm/hr = millimeters per hour
in/hr = inches per hour
°C = degrees centigrade
°F = degrees fahrenheit