

ACADIA NATIONAL PARK
RESOURCE MANAGEMENT DIVISION

VISIBILITY DATA SUMMARY REPORT

FOR

ACADIA NATIONAL PARK

Winter 1984 - Spring 1985

prepared for

U.S. Department of Interior
National Park Service
301 S. Howes, Room 333
Fort Collins, Colorado 80524

in partial fulfillment of the
Visibility Monitoring and Data Analysis Project
Contract No. CX-0001-3-0057

by

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November 8, 1985

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ACADIA NATIONAL PARK
RESOURCE MANAGEMENT DIVISION

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1.0 INTRODUCTION

The National Park Service (NPS) as a function of its founding legislation (Organic Act of 1916) and the Clean Air Act (P.L. 95-95), has "an affirmative responsibility" to protect air quality related values in the National Park System. Congress emphasized visibility protection in the National Parks as ^amajor goal of the Clean Air Act. The NPS manages fifty-eight areas designated as Class I by the Prevention of Significant Deterioration regulations of the Clean Air Act. To fulfill their responsibility with regard to protecting the air quality related value of visibility in these Class I areas, the NPS initiated a comprehensive visibility monitoring program. The monitoring program is designed to obtain data and develop procedures that will further the understanding of the visual resource in support of effective management decisions.

In 1983, a decision was made to convert a series of manual teleradiometer sites within the NPS Regional visibility monitoring network to automatic teleradiometer sites. Specifications for the automatic sites included using satellite data collection platform (DCP) technology to collect teleradiometer visibility measurements once every minute (in the green wavelength), calculate hourly average visibility data, and to transmit these hourly data to a central location for processing. Automatic DCP procedures were tested in several parks in 1983. Operational implementation of the systems generally began in the winter 1984 monitoring season.

Acadia National Park is one of the automatic teleradiometer sites within the NPS Regional visibility monitoring network. An experimental

automatic DCP system was installed at Acadia in June 1983. The first season that the station was considered fully operational was Spring 1984.

This report summarizes the data collected at Acadia National Park from the Winter 1984 through Spring 1985 monitoring seasons.

2.0 SITE SPECIFICATIONS

2.1 Site and Target Specifications

The site and target specifications are summarized in Table 2-1. A schematic map of the site and target is provided as Figure 2-1.

2.2 Visibility Monitoring Equipment

The following visibility related monitoring equipment existed at the site throughout the monitoring period.

- o MRI Model 30/30 multi-wavelength automatic teleradiometer
- o Handar 540 Data Collection Platform
- o Manual 35mm Camera (through 10/9/84)
- o Automatic 35mm Camera (4/20/85 until present)

Table 2-1

Site and Target Specifications for
Acadia National Park
Automatic Teleradiometer Visibility Monitoring Station
Winter 1984 - Spring 1985

Site Name: Acadia National Park
 Site Abbreviation: ACAD
 Station Type: Automatic Teleradiometer and Camera
 Longitude: 68°15'45" Latitude: 44°22'30" Elevation(m): 168

TARGET SPECIFICATIONS						
TARGET IDENTIFICATION		TARGET SPECIFICATIONS				
Target No.	Name	Dist. (km)	Elev. (m)	Bearing (°)	Elev. Angle (°)	Raleigh Coeff.
1	Blue Hill	27	229	285	.129	.0114

Target Inherent Contrasts (C_0 by Time)
 (Note: same inherent contrasts used by time for all seasons)

Target No.	Target Cover	Inherent Contrasts Per Local Time								
		0800	0900	1000	1100	1200	1300	1400	1500	1600
1	Deciduous Forest	-.70	-.74	-.80	-.80	-.80	-.80	-.84	-.86	-.86

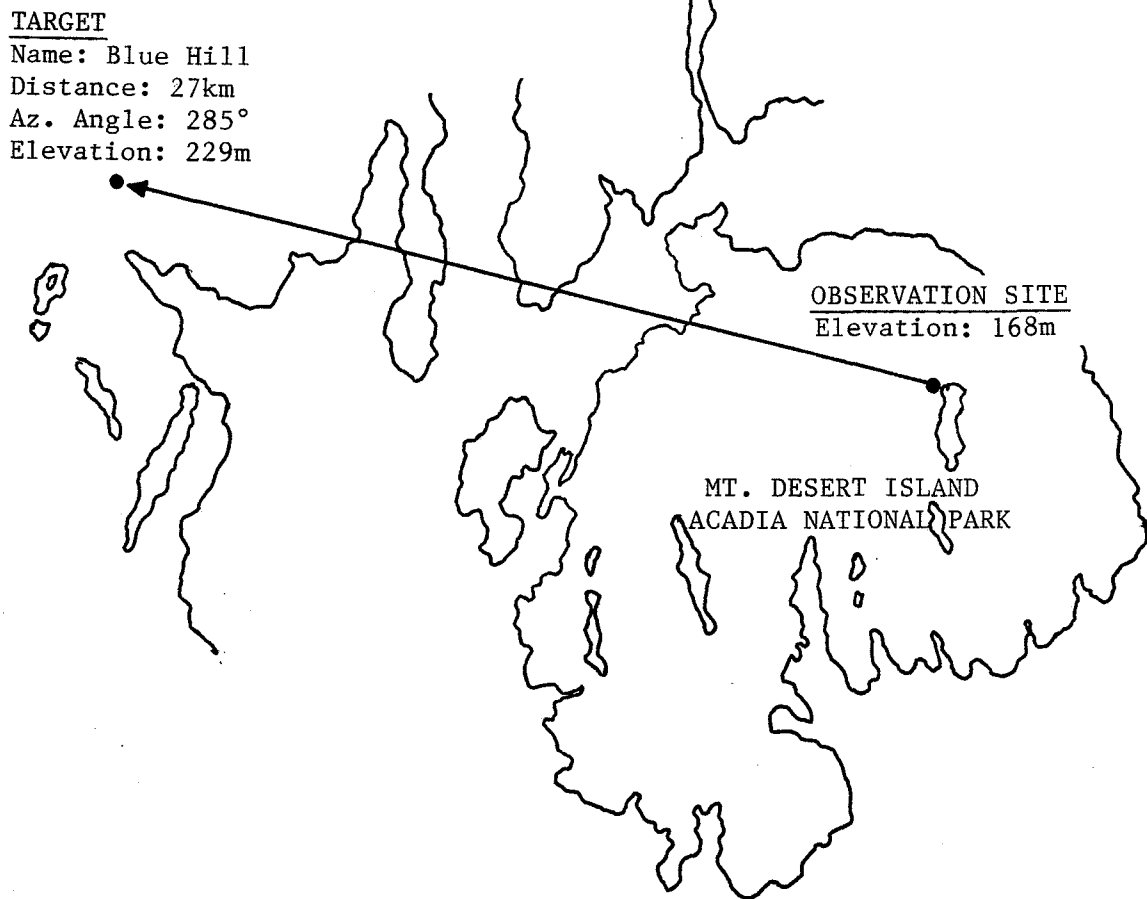


Figure 2-1. Schematic Map of Visibility Monitoring Site and Target:
Acadia National Park
Spring 1984 - Spring 1985

3.0 DATA COLLECTION AND ANALYSIS

3.1 Data Collection

Teleradiometer radiance measurements of a distant target, automatically taken once every minute, were averaged and stored as hourly values. These hourly values were transmitted via satellite every three hours and were retrieved by earth stations at either Colorado State University or NOAA/NESS Wallops Island. The Colorado State University Station was used as the primary downlink until November 1984 when operational considerations required that the Wallops Island station become the primary downlink. Once per day, the data were retrieved from the downlink archives via telephone and stored on the National Park Service Optec computer in Fort Collins, Colorado. All processing and permanent archives are performed on the NPS computer.

3.2 Data Processing

Quality control edits are first performed on the data. Primary edits search for out-of-range data, and check sky/target contrast values (Raleigh contrast checks, target obscured checks and positive sky target contrast checks). Data that pass the quality control edits are used to calculate visibility parameters. Teleradiometer radiance measurements in the green wavelength (550nm) were used to calculate standard visual range (SVR) values. Hourly SVR values from 0800-1600 local time were averaged to compute a daily SVR value. Seasonal statistics were then computed using the daily SVR values. Plots of the daily variations in SVR and plots and statistics of the seasonal frequency distribution of SVR were used to summarize the results.

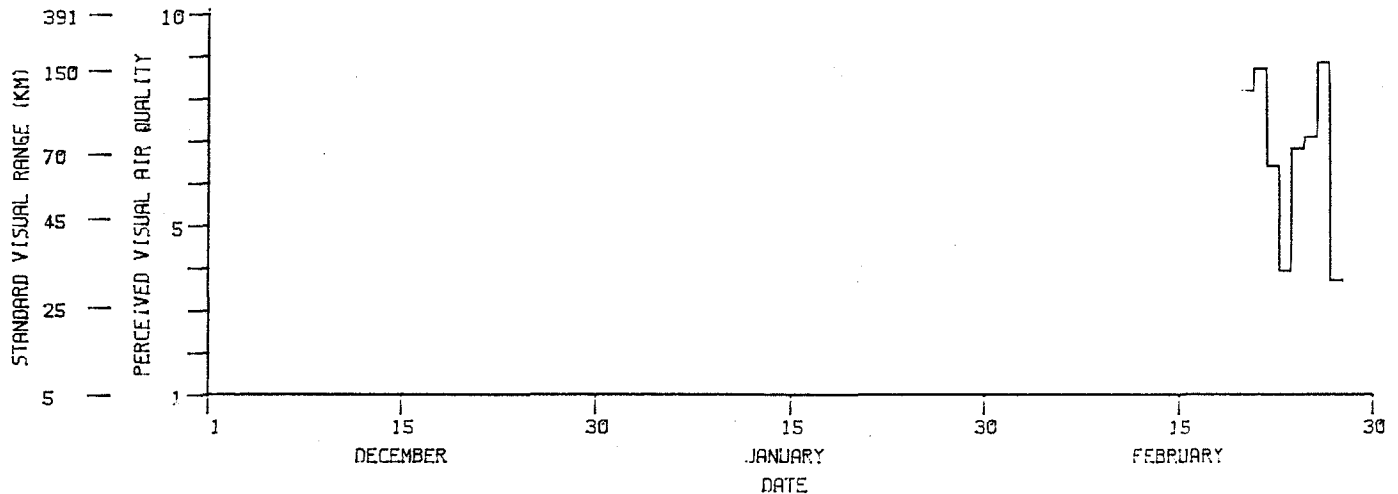
Figures 3-1 through 3-6 are the Seasonal Visibility Summary Reports for Winter 1984, Spring 1984, Summer 1984, Fall 1984, Winter 1985, and Spring 1985 respectively. These reports are comprised of three types of summaries as described below:

- o Daily variation of standard visual range (SVR). This plot includes geometric mean standard visual range values for each day of the reported season. Each bar represents the daily geometric mean of hourly standard visual ranges calculated from 0800-1600 hours. Gaps in the time line indicated that data were missing or did not meet quality control edits.
- o Frequency of occurrence. This plot is a frequency distribution of SVR values for which the 10, 50, and 90 percentiles are tabulated. The Y axis is the standard visual range on a logarithmic scale. The X axis is the cumulative percent frequency of occurrence. The theoretical minimum SVR was defined as the distance to the target; the theoretical maximum SVR is defined as 391 km. The 10% value can be interpreted as: 10% of the time the SVR was less than or equal to the 10% value. The 50% value corresponds to the median value of the cumulative frequency distribution and is an approximation of the seasonal geometric mean SVR. The 90% value can be interpreted as: 90% of the time the SVR was less than or equal to the 90% value.
- o Data Recovered - This is a tabulation by season of the data recovery percentages for telemetry and optical categories. The telemetry data recovery category represents the percent of total possible readings that were transmitted and received successfully. The total possible readings are calculated as the number of daytime hourly averages (9) multiplied by the number of days in a season. Readings could be missed due to instrument error, telemetry system malfunctions, operator errors or processing errors. The optical category represents the percent of telemetry data that resulted in useable data. The percentage indicates how much of this data passed the quality control checks.

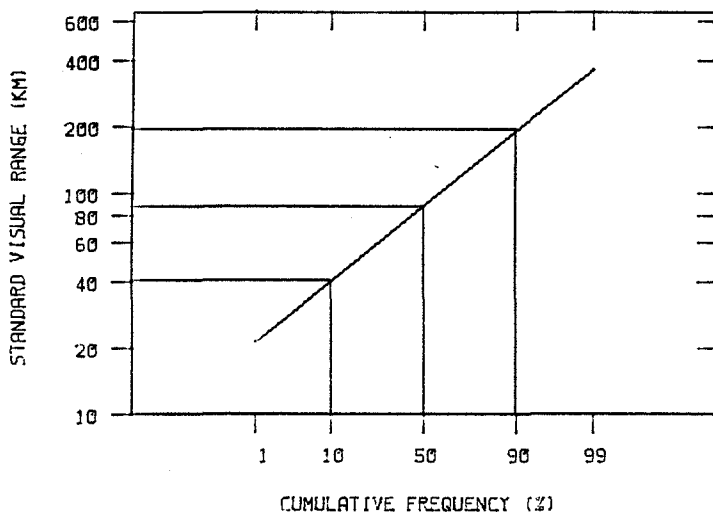
Table 3-1 presents a more detailed summary of data recovery statistics including explanations for missing data throughout the reporting period.

Figure 3-1
WINTER 1984 VISIBILITY REPORT FOR
ACADIA MAINE

DAILY VARIATION OF STANDARD VISUAL AIR QUALITY



FREQUENCY OF OCCURRENCE



EACH BAR IN THE DAILY TIME PLOT ABOVE IS THE DAILY GEOMETRIC MEAN STANDARD VISUAL RANGE (SVR) CALCULATED FROM TELERADIOMETER MEASUREMENTS MADE ON VALID TARGETS DURING THE DAY. ANY GAPS IN THE GRAPH REPRESENT MISSING DATA.

FOR ANY POINT ON THE SLOPING LINE IN THE CUMULATIVE FREQUENCY OF OCCURRENCE PLOT TO THE LEFT, 'X' PERCENT OF THE TIME THE STANDARD VISUAL RANGE (SVR) WAS 'Y' OR LESS. THE SVR VALUES FOR THE 10% 50% AND 90% FREQUENCY OF OCCURRENCE ARE:

PERCENT	SVR (KM)
10.	42
50.	92
90.	206

DATA RECOVERED

SEASON
WINTER 1984

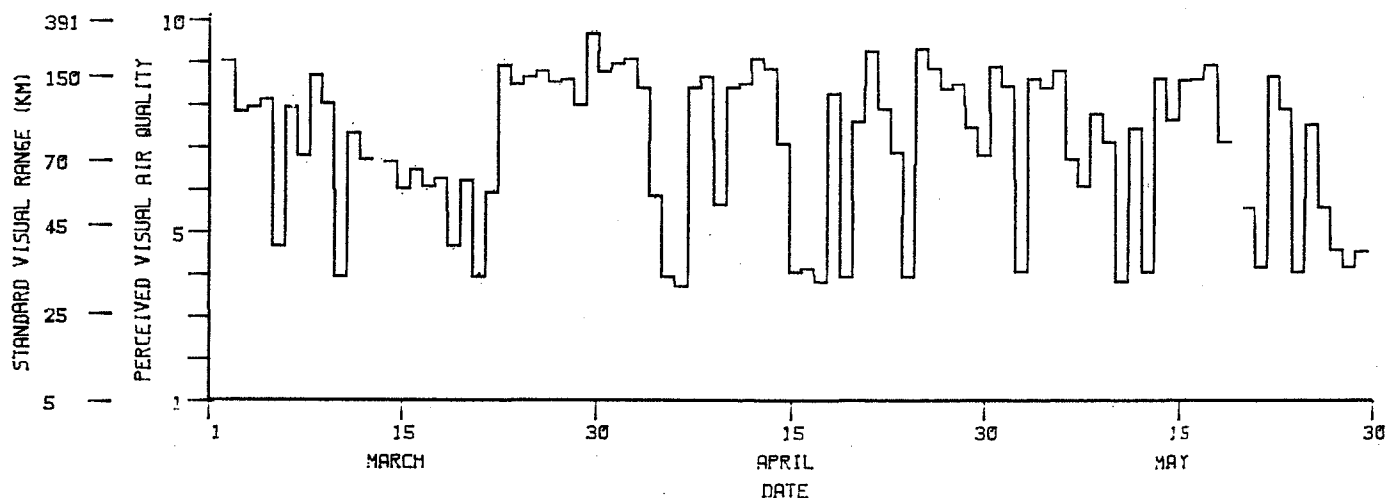
TELEMETRY (%)
8

OPTICAL (%)
90

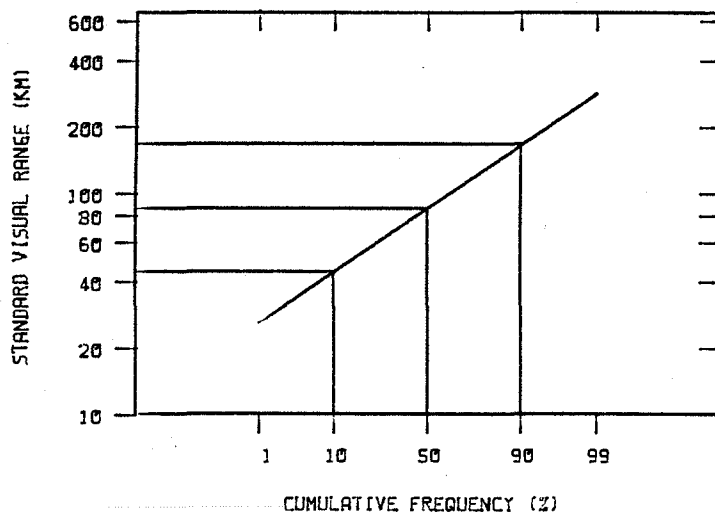
THE TELEMETRY DATA RECOVERY PERCENTAGE IS A MEASURE OF EQUIPMENT STATUS, DISCOUNTING MEASUREMENTS NOT USED FOR REASONS RE-LATED TO ATMOSPHERIC CONDITIONS. THE OPTICAL DATA RECOVERY PERCENTAGE GIVES THE PERCENT OF ALL TELEMETRY DATA RECEIVED WHICH RESULT IN USABLE DATA.

Figure 3-2
 SPRING 1984 VISIBILITY REPORT FOR
 ACADIA MAINE

DAILY VARIATION OF STANDARD VISUAL AIR QUALITY



FREQUENCY OF OCCURRENCE



EACH BAR IN THE DAILY TIME PLOT ABOVE IS THE DAILY GEOMETRIC MEAN STANDARD VISUAL RANGE (SVR) CALCULATED FROM TELERADIOMETER MEASUREMENTS MADE ON VALID TARGETS DURING THE DAY. ANY GAPS IN THE GRAPH REPRESENT MISSING DATA.

FOR ANY POINT ON THE SLOPING LINE IN THE CUMULATIVE FREQUENCY OF OCCURRENCE PLOT TO THE LEFT, 'X' PERCENT OF THE TIME THE STANDARD VISUAL RANGE (SVR) WAS 'Y' OR LESS. THE SVR VALUES FOR THE 10% 50% AND 90% FREQUENCY OF OCCURRENCE ARE:

PERCENT	SVR (KM)
10.	46
50.	90
90.	176

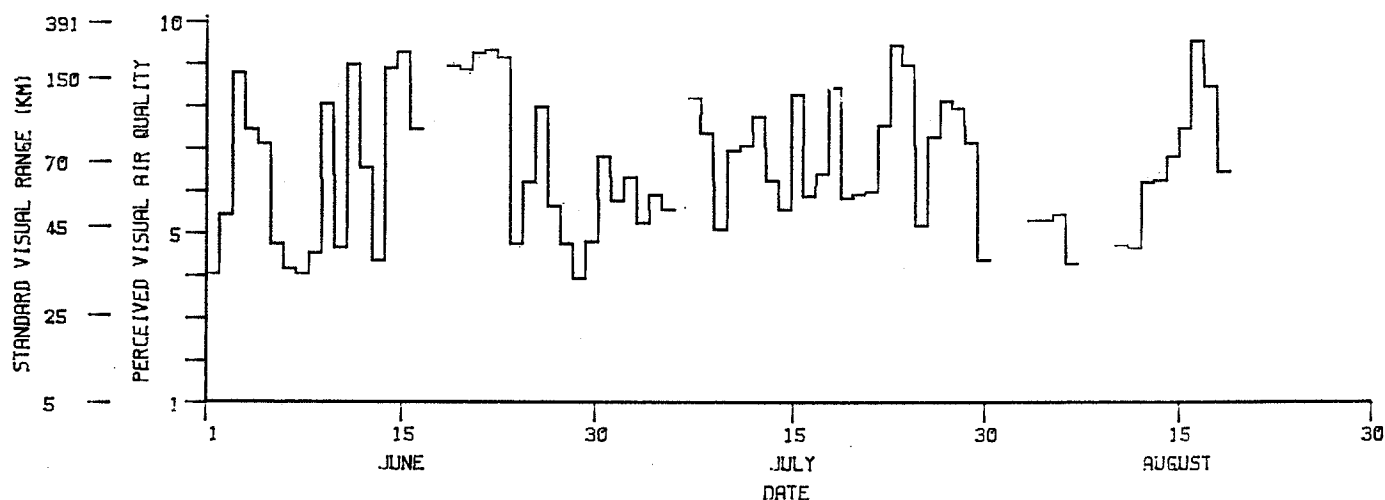
DATA RECOVERED

SEASON	TELEMETRY (%)	OPTICAL (%)
SPRING 1984	90	95
WINTER 1984	8	90

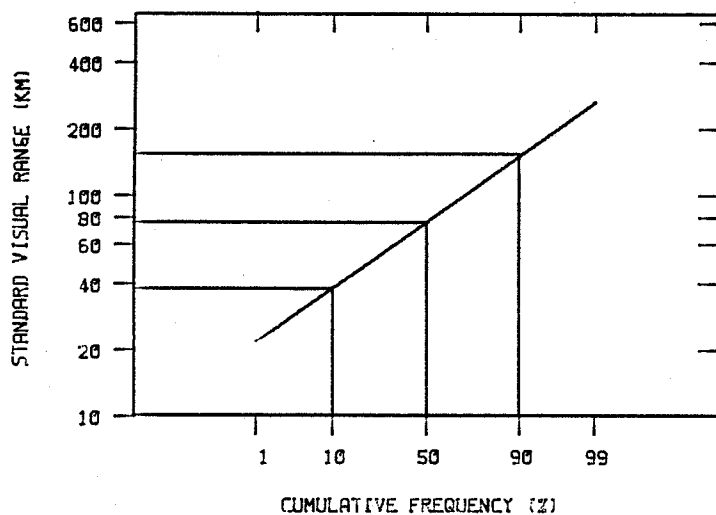
THE TELEMETRY DATA RECOVERY PERCENTAGE IS A MEASURE OF EQUIPMENT STATUS, DISCOUNTING MEASUREMENTS NOT USED FOR REASONS RELATED TO ATMOSPHERIC CONDITIONS. THE OPTICAL DATA RECOVERY PERCENTAGE GIVES THE PERCENT OF ALL TELEMETRY DATA RECEIVED WHICH RESULT IN USABLE DATA.

Figure 3-3
SUMMER 1984 VISIBILITY REPORT FOR
ACADIA MAINE

DAILY VARIATION OF STANDARD VISUAL AIR QUALITY



FREQUENCY OF OCCURRENCE



EACH BAR IN THE DAILY TIME PLOT ABOVE IS THE DAILY GEOMETRIC MEAN STANDARD VISUAL RANGE (SVR) CALCULATED FROM TELERADIOMETER MEASUREMENTS MADE ON VALID TARGETS DURING THE DAY. ANY GAPS IN THE GRAPH REPRESENT MISSING DATA.

FOR ANY POINT ON THE SLOPING LINE IN THE CUMULATIVE FREQUENCY OF OCCURRENCE PLOT TO THE LEFT, 'X' PERCENT OF THE TIME THE STANDARD VISUAL RANGE (SVR) WAS 'Y' OR LESS. THE SVR VALUES FOR THE 10% AND 90% FREQUENCY OF OCCURRENCE ARE:

PERCENT	SVR (KM)
10.	39
50.	79
90.	161

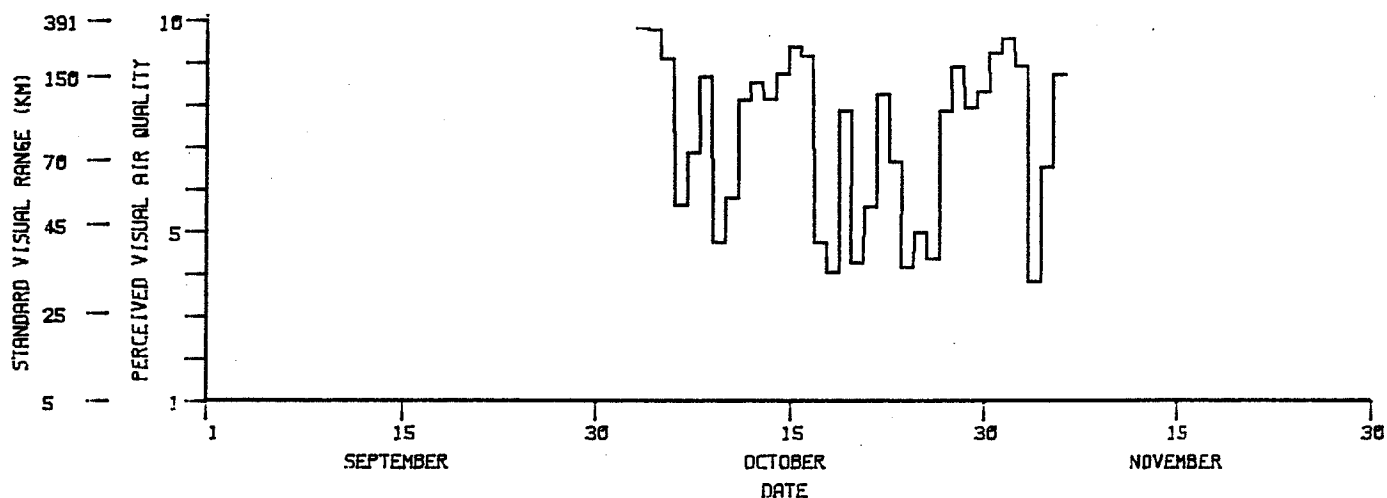
DATA RECOVERED

SEASON	TELEMETRY (%)	OPTICAL (%)
SUMMER 1984	69	100
SPRING 1984	90	95
WINTER 1984	88	90

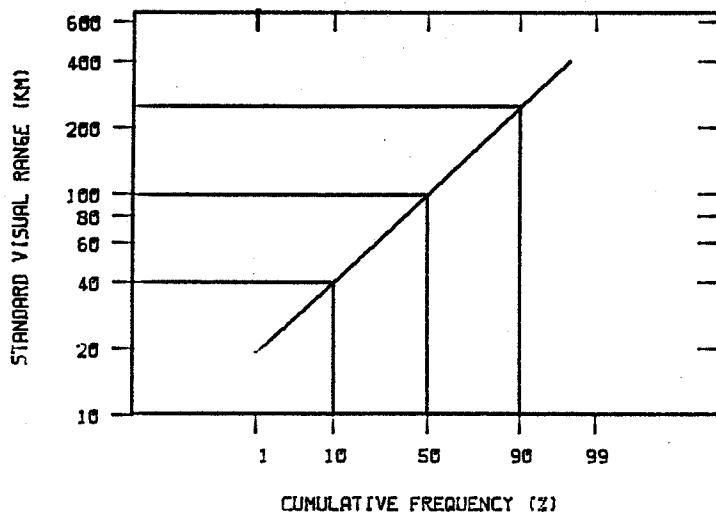
THE TELEMETRY DATA RECOVERY PERCENTAGE IS A MEASURE OF EQUIPMENT STATUS, DISCOUNTING MEASUREMENTS NOT USED FOR REASONS RELATED TO ATMOSPHERIC CONDITIONS. THE OPTICAL DATA RECOVERY PERCENTAGE GIVES THE PERCENT OF ALL TELEMETRY DATA RECEIVED WHICH RESULT IN USABLE DATA.

Figure 3-4
FALL 1984 VISIBILITY REPORT FOR
ACADIA MAINE

DAILY VARIATION OF STANDARD VISUAL AIR QUALITY



FREQUENCY OF OCCURRENCE



EACH BAR IN THE DAILY TIME PLOT ABOVE IS THE DAILY GEOMETRIC MEAN STANDARD VISUAL RANGE (SVR) CALCULATED FROM TELERADIOMETER MEASUREMENTS MADE ON VALID TARGETS DURING THE DAY. ANY GAPS IN THE GRAPH REPRESENT MISSING DATA.

FOR ANY POINT ON THE SLOPING LINE IN THE CUMULATIVE FREQUENCY OF OCCURRENCE PLOT TO THE LEFT, 'X' PERCENT OF THE TIME THE STANDARD VISUAL RANGE (SVR) WAS 'Y' OR LESS. THE SVR VALUES FOR THE 10% 50% AND 90% FREQUENCY OF OCCURRENCE ARE:

PERCENT	SVR (KM)
10.	41
50.	104
90.	262

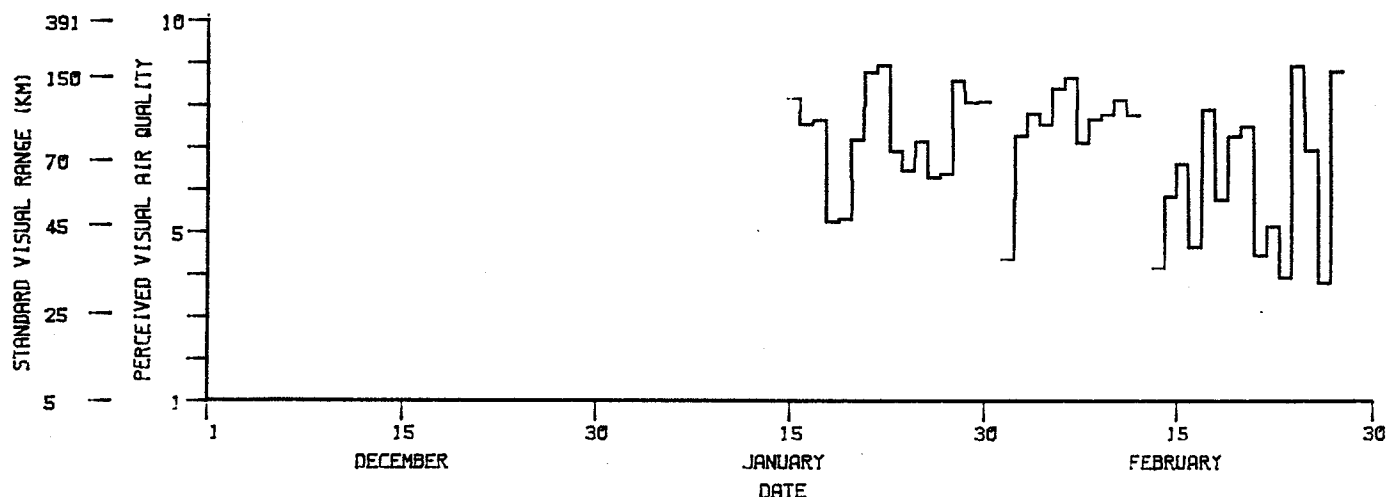
DATA RECOVERED

SEASON	TELEMETRY (%)	OPTICAL (%)
FALL 1984	34	94
SUMMER 1984	69	100
SPRING 1984	90	95
WINTER 1984	8	90

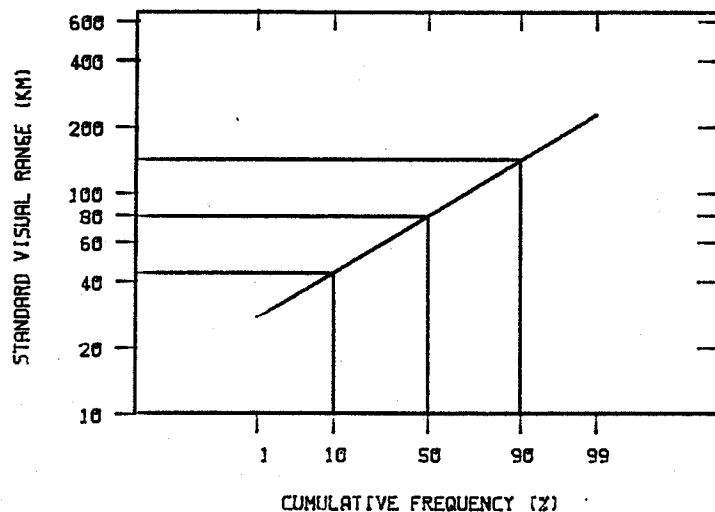
THE TELEMETRY DATA RECOVERY PERCENTAGE IS A MEASURE OF EQUIPMENT STATUS. DISCOUNTING MEASUREMENTS NOT USED FOR REASONS RE-LATED TO ATMOSPHERIC CONDITIONS. THE OPTICAL DATA RECOVERY PERCENTAGE GIVES THE PRECENT OF ALL TELEMETRY DATA RECEIVED WHICH RESULT IN USABLE DATA.

Figure 3-5
WINTER 1985 VISIBILITY REPORT FOR
ACADIA MAINE

DAILY VARIATION OF STANDARD VISUAL AIR QUALITY



FREQUENCY OF OCCURRENCE



EACH BAR IN THE DAILY TIME PLOT ABOVE IS THE DAILY GEOMETRIC MEAN STANDARD VISUAL RANGE (SVR) CALCULATED FROM TELERADIOMETER MEASUREMENTS MADE ON VALID TARGETS DURING THE DAY. ANY GAPS IN THE GRAPH REPRESENT MISSING DATA.

FOR ANY POINT ON THE SLOPING LINE IN THE CUMULATIVE FREQUENCY OF OCCURRENCE PLOT TO THE LEFT, 'X' PERCENT OF THE TIME THE STANDARD VISUAL RANGE (SVR) WAS 'Y' OR LESS. THE SVR VALUES FOR THE 10% 50% AND 90% FREQUENCY OF OCCURRENCE ARE:

PERCENT	SVR (KM)
10.	45
50.	82
90.	149

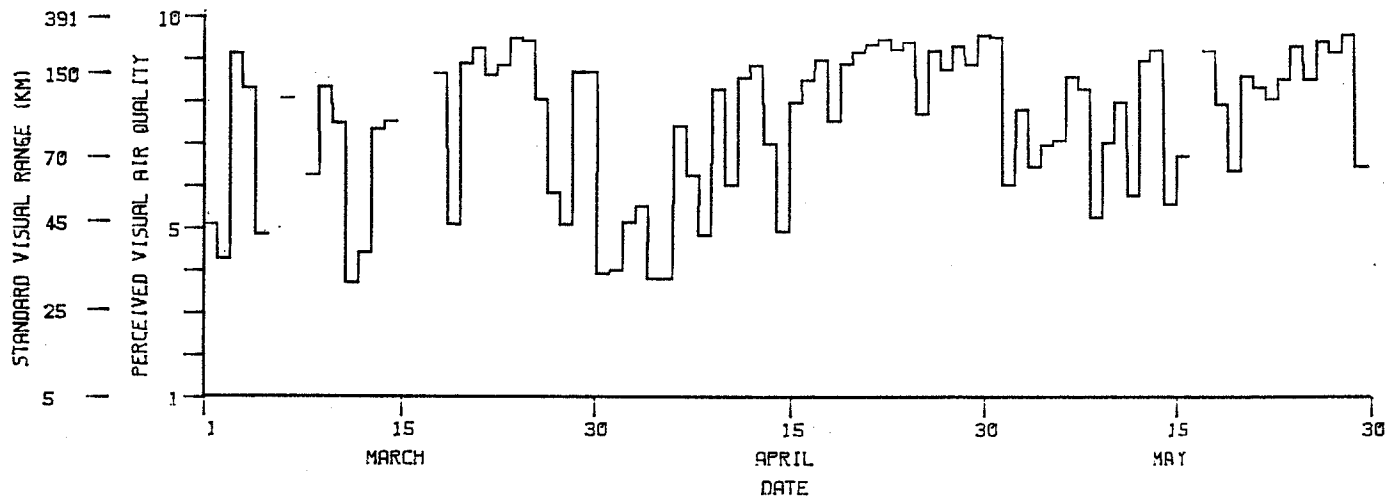
DATA RECOVERED

SEASON	TELEMETRY (%)	OPTICAL (%)
WINTER 1985	48	93
FALL 1984	34	94
SUMMER 1984	69	100
SPRING 1984	90	95

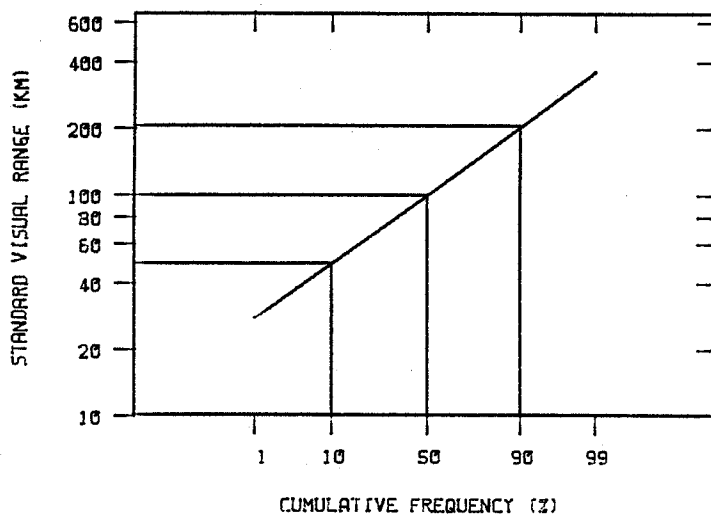
THE TELEMETRY DATA RECOVERY PERCENTAGE IS A MEASURE OF EQUIPMENT STATUS. DISCOUNTING MEASUREMENTS NOT USED FOR REASONS RE-LATED TO ATMOSPHERIC CONDITIONS. THE OPTICAL DATA RECOVERY PERCENTAGE GIVES THE PERCENT OF ALL TELEMETRY DATA RECEIVED WHICH RESULT IN USABLE DATA.

Figure 3-6
SPRING 1985 VISIBILITY REPORT FOR
ACADIA MAINE

DAILY VARIATION OF STANDARD VISUAL AIR QUALITY



FREQUENCY OF OCCURRENCE



EACH BAR IN THE DAILY TIME PLOT ABOVE IS THE DAILY GEOMETRIC MEAN STANDARD VISUAL RANGE (SVR) CALCULATED FROM TELERADIOMETER MEASUREMENTS MADE ON VALID TARGETS DURING THE DAY. ANY GAPS IN THE GRAPH REPRESENT MISSING DATA.

FOR ANY POINT ON THE SLOPING LINE IN THE CUMULATIVE FREQUENCY OF OCCURRENCE PLOT TO THE LEFT, 'X' PERCENT OF THE TIME THE STANDARD VISUAL RANGE (SVR) WAS 'Y' OR LESS. THE SVR VALUES FOR THE 10% 50% AND 90% FREQUENCY OF OCCURRENCE ARE:

PERCENT	SVR (KM)
10.	51
50.	105
90.	216

DATA RECOVERED

SEASON	TELEMETRY (%)	OPTICAL (%)
SPRING 1985	86	97
WINTER 1985	48	93
FALL 1984	34	94
SUMMER 1984	69	100

THE TELEMETRY DATA RECOVERY PERCENTAGE IS A MEASURE OF EQUIPMENT STATUS. DISCOUNTING MEASUREMENTS NOT USED FOR REASONS RE-LATED TO ATMOSPHERIC CONDITIONS. THE OPTICAL DATA RECOVERY PERCENTAGE GIVES THE PRECENT OF ALL TELEMETRY DATA RECEIVED WHICH RESULT IN USABLE DATA.

Table 3-1
Summary of Data Recovery Statistics
Acadia National Park
Automatic Teleradiometer Visibility Monitoring Station
Winter 1984 - Spring 1985

Season	Number of Total Possible Daytime Hourly Averages	Number of Daytime Hourly Averages That Were Received	Percent of Total Possible Daytime Hourly Averages That Were Received	Number of Daytime Hourly Averages Received That Were Usable	Percent of Daytime Hourly Averages Received That Were Usable	Percent of Total Possible Daytime Hourly Averages That Were Usable	Comments
Winter 84	819	67	8%	60	90%	7%	December 1, 1983 - February 20, 1984 - Data collection platform down due to battery malfunctions.
Spring 84	828	744	90%	709	95%	86%	March 1 - CSU data collection down. March 24, hours 8-14 - Data not received. May 19, 20 - CSU data collection down.
Summer 84	828	572	69%	572	100%	69%	June 18-20 - CSU power outage. July 7 - CSU power outage. August 2-7 - GOES west satellite moving - erratic data reception. August 8-10 - ARS modem down. August 20-31 - Platform down.
Fall 84	827	278	34%	260	94%	31%	September 1 - October 5 - Platform down. November 7-30 - Platform down. Fuse blown due to operator error.
Winter 85	810	387	48%	358	93%	44%	December 1 - January 16 - Platform down. February 1 - Data failed contrast edit. February 13 - Data failed contrast edit.
Spring 85	828	712	86%	690	97%	83%	March 6 - 10 hours of data loss due to operator error. March 8 - Data failed contrast edit. March 16-18 - Teleradiometer flip mirror left in the incorrect position. May 17-19 - Data loss due to operator error.

3.3 Quality Assurance

Teleradiometer detector correlation factors are determined to compare the voltage output of the target detector with that of the sky detector when exposed to a controlled amount of light. This quality control operation is performed at various intervals, usually dependant upon the servicing needs of the teleradiometer. Table 3-3 contains teleradiometer servicing dates and corresponding correlation factors.

Table 3-3
Quality Control Teleradiometer Servicing for
Acadia National Park
Automatic Teleradiometer Visibility Monitoring Station
Winter 1984 - Spring 1985

Servicing Date	Determined Correlation Factor	Percent of Change From Previous Reading
2/15/84	Target Voltage X (1.075) = Sky Voltage	---
4/18/85	Target Voltage X (1.070) = Sky Voltage	0.5%

4.0 SUMMARY

This report presents data collected by an automatic teleradiometer visibility monitoring station at Acadia National Park from Winter 1984 through Spring 1985. Table 4-1 presents a summary of the visibility data for this period.

The teleradiometer performed consistently throughout the period Winter 1984 - Spring 1985; however, data losses were experienced primarily due to DCP related problems. Battery problems contributed to the loss of all but the last eight days (7%) of the Winter 1984 data. The failure of the GOES-East satellite and the repositioning of the GOES-West satellite caused intermittent data recovery problems during the Summer 1985. DCP failures also caused substantial data loss during the Fall 1984 and Winter 1985 seasons.

The automatic teleradiometer station continues to operate at Acadia. Summaries of these data will be included in future NPS Regional network seasonal summary reports.

Table 4-1
Summary of Seasonal Visibility Data for
Acadia National Park
Automatic Visibility Monitoring Station
Winter 1984 - Spring 1985

Data Recovery Statistics				Standard Visual Range Statistics (in km)						
Season	Number of Total Possible Daytime Hourly Averages	Percent of Daytime Hourly Averages Received That Were Usable	Percent of Total Possible Daytime Hourly Averages That Were Usable	Frequency of Occurrence			Minimum Value	Maximum Value	Geo- metric Mean	90% Confidence Interval About the Geometric Mean
				10%	50%	90%				
Winter 84	819	90%	7%	42	92	206	30	220	99	88-112
Spring 84	828	95%	86%	46	90	176	29	353	94	90-98
Summer 84	828	100%	69%	39	79	161	28	295	75	71-78
Fall 84	827	94%	31%	41	104	262	29	354	108	100-116
Winter 85	810	93%	44%	45	82	149	30	266	87	83-91
Spring 85	828	97%	83%	51	105	216	29	390	107	102-111