EVALUATION OF NATIONAL PARK SERVICE PARTICIPATION IN THE NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

I. AN OVERVIEW

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I. AN OVERVIEW

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Evaluation of National Park Service Participation in the National Atmospheric Deposition Program

I. An Overview

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The National Atmospheric Deposition Program (NADP) operates a network of over 100 long-term sites monitoring the chemistry of precipitation across the nation. There are 22 National Park Service areas participating in the program; several of them have been functional since early 1980. This report is an early assessment of the quality of information produced at the NPS/NADP sites. The objectives of this overview are to (1) examine and characterize program quality at the site as opposed to quality at the national level, (2) determine whether routine note and error messages generated at the Central Analytical Laboratory (CAL) can be used as a means of quality assessment, and (3) investigate whether recurring problems represent network-wide problems or can be remedied at the site level. Our analyses include the collection of pH and conductivity values and the note and error messages supplied by the Central Analytical Laboratory to each park site. Part II will examine park values for pH, conductivity, and collection efficiency.

Methods

Information from 18 of the 22 parks was compiled from available listings of field and laboratory data which are sent monthly by the Central Analytical Laboratory to each site in the network. The data consisted of the sampling interval, laboratory and field pH, laboratory and field conductivity, precipitation volume in milliliters (ml), and weekly note and error messages generated by the CAL computer (Table 1).

Note and error messages were grouped into five sets, each representing a different aspect of site operation problems (Table 2). Carelessness messages were designed as Error Set I. Lack of protocol messages were placed in Error Set II. Notes about pH were put into Error Set III. Conductivity notes became Error Set IV. Error Set V was a message which compared wet bucket collection efficiency with that of the rain gage collector. Totals of each error set by park were normalized to the amount of time each park had been operating. The data expressed as percent of operating time allowed for comparison between parks.

Error messages generated by CAL for error sets III and IV occur whenever there is a difference of $\geq$1 pH unit between lab and field measurements and $\geq$20 μmhos/cm in conductivity measurements. For our evaluation the more rigorous cut-off points of $\geq$ 0.5 pH units and $\geq$ 10 μmhos/cm were used. Every sample did not have both lab and field measurements; therefore, operating time percentages for each park were instead calculated using the number of weeks that had both lab and field values instead of the number of weeks the site had been operating.

Frequency plots of error sets by park were made with the joint aim of establishing the general level of park performance and identifying which parks were having a particular set of problems. The parks were ranked in terms of their performance in each error category. Other rankings of the sites were made to determine whether interfering factors correlated to error sets. These include the length of time a site had been operating, the size of the park, the size or participation of the research program at the park, and the distance from operator's workplace to sample site. Data were plotted over time to determine seasonal trends.

Results and Discussion

Frequency plots of the error sets by park revealed a large fluctuation in the number and types of problems at any given park (Table 3 and Figs. 1-5). No particular trends or commonality of errors were noted. The majority of parks were functioning satisfactorily, meeting protocol and keeping the regular weekly schedule. Ranking of the parks by error set (Table 4), however, revealed some areas for improved performance. Carelessness errors (Error Set I, Fig. 1) occurred for 15-20% of the samples. The four parks with the highest occurrence were Channel Islands, 61%; Craters of the Moon, 54%; Theodore Roosevelt, 48%; and Shenandoah, 53%. Big Bend, Glacier, Rocky Mountain, and Indiana Dunes had the lowest occurrence of carelessness errors. Those note and error messages involving departure from protocol (Error Set II, Fig. 2) occurred 6% of the time for the average park. Only Channel Islands, 46%; Glacier, 22%; Yellowstone, 16%; and Craters of the Moon, 16%, were significantly different from the average.

With the 0.5 pH unit cutoff (Error Set III, Fig. 3) the frequency of pH discrepancies at a park averaged 37%. Six parks had greater values: Craters of the Moon, 86%; Mt. McKinley, 79%; Rocky Mountain, 76%; Indiana Dunes, 56%; Everglades, 55%; and Big Bend, 52%. Acadia, Shenandoah, and Sequoia were consistently in agreement with CAL on pH. The average park had a discrepancy of more than 10 μmhos/cm in conductivity measurements only 13% of the time (Error Set IV, Fig. 4). Channel Islands and Craters of the Moon at 100%, Great Smoky Mountains at 50%, and Everglades at 37% were above this average. It should be noted, however, that over the period of our analysis Channel Islands' sample size was only one sample and Craters of the Moon had no samples with both lab and field measurements.

Error Set V (large variance between sample depth and rain gauge measurement) occurs about 7% of the time for the average park (Fig. 5). Isle Royale, Glacier and Yellowstone showed above average percent errors (39%, 17%, and 16%, respectively).

The rankings in Table 4 were used not only as an indication of overall site performance but also as identification of the areas of the NADP program needing more attention. The average park receives some type of note or error message for half of the samples collected. While carelessness is an area where field operator improvement would make a difference, problems with the measurement of pH are more common and often cannot be solved at the field level. Changes in the methodology or sampling strategy to rectify general problems of pH measurement will require guidance at the network level.

Sites that consistently rank high in all error sets are unproductive ones with serious problems. These furnish NADP with very little information and either must correct their methods or be dropped from the program. While Craters of the Moon was a consistent offender early in its operating history, it has taken steps to correct this and now functions on an acceptable level. One other park site, Channel Islands, had such logistic problems with operating on a regular schedule that it has been taken out of the network.

Sites ranking near the top in only one category, such as Isle Royale in collection efficiency or Theodore Roosevelt in carelessness, usually have only one specific recurring problem. Isle Royale has poor collection efficiency during the winter months when the station resides at Houghton, MI. Theodore Roosevelt continuously failed to bag the bucket prior to shipment to CAL during the sampling interval.

Conclusions

Overall, we feel the quality of data coming out of the parks is good. In those areas where the median values of an error set are below 10% the operation is considered excellent, although there is still room for improvement. This conclusion is supported at the network level where less than 0.5% of the submitted samples are excluded from the NADP data base. By ranking the parks within the various error sets we have established a standard by which each park can measure its performance. Further, this report has identified areas for improvement of field operations and areas within the NADP program that need more attention.

We feel the preliminary note and error messages can be employed in a similar manner by individual site personnel to identify areas of performance for improvement. These data summaries benefit individual site operators and supervisors and provide a rapid assessment of program status.

Table 1. Explanations of notes and error messages generated by CAL computer

Error or note	Key
Error #1	Time on for sample ________ precedes the time off for sample ________. Please notify CAL of correct times by sending a note with your next bucket mailing.
Note #2	Time between sample _______ off and sample ________ on is greater than 3 hours (# of hours given). Possible missing samples.
Note #3	The sampling interval for ________ was nonstandard. The interval was ________ days.
Note #4	_________ did not have a standard Tue-Tue sampling period. Actual sampling period was Mon-Mon (or the like; for general).
Note #5	The field pH for sample _______ (pH) was outside the expected range for precipitation samples. (Expected range is _______ to ______.)
Note #6	The lab pH differed by more than 1. pH unit from the field pH for sample ________.
Note #7	Conductance <1 or >300.
Note #8	The lab conductivity differed by more than 20 µmho/cm from the field conductivity for sample ______.
Note #9	The liquid depth of sample _______ does not compare well with the precipitation depth recorded for that period. Please re-check your rain gage chart and event record to confirm the precipitation depth and the proper operation of the collector. Notify CAL of any changes.
Note #10	Sample _______ had major leakage during shipment to CAL.
Note #11	A required date or time for sample ________ is missing. Please notify CAL of missing info by sending a note with your next bucket.
Note #12	Sample _________ was not bagged. Please bag all buckets before shipment to CAL.
Note #13	A required time zone code for sample ________ is missing. Please notify CAL of missing info.

Table 2. Definitions of Error Sets

Error Set I	A combination of notes/errors 1, 2, 10, 11, 12, 13, which are all considered carelessness.
Error Set II	A combination of notes 3 and 4, both having to do with nonstandard sampling periods or not following protocol.
Error Set III	A combination of notes 5 and 6, both having to do with pH, either not in expected pH range or a difference of one unit or more.
Error Set IV	Is note 8, lab conductivity differed by more than 20 μmhos/cm from field conductivity.
Error Set V	Is note 9, liquid depth of sample does not compare well with precipitation depth recorded.

Table 3. Names, NPS codes, NADP codes, and length of operating time for National Park Service/National Atmospheric Deposition sites

NPS code	Site name	State	NADP code	Sampling interval
DENA	Denali National Park	Alaska	AK03	12/2/80-9/29/81
ORPI	Organ Pipe Cactus National Monument	Arizona	AZ06	11/4/80-9/29/81
GRCA	Grand Canyon National Park	Arizona	AZ03	Not operating at time of survey
BUFF	Buffalo National River	Arkansas	AR16	Not operating at time of survey
SEKI	Sequoia-Kings Canyon National Park	California	CA75	9/30/80-9/29/81
CHIS	Channel Islands National Park	California	CA85	12/2/80-9/29/81
YOSE	Yosemite National Park	California	CA99	Not operating at time of survey
MEVE	Mesa Verde National Park	Colorado	CO99	4/28/81-9/29/81
ROMO	Rocky Mountain National Park	Colorado	CO19	11/25/80-9/29/81
EVER	Everglades National Park	Florida	FL11	11/25/80-9/29/81
CRMO	Craters of the Moon National Monument	Idaho	ID03	11/17/80-9/29/81
INDU	Indiana Dunes National Lakeshore	Indiana	IN34	11/25/80-9/29/81
ACAD	Acadia National Park	Maine	ME99	11/18/80-9/29/81
CACO	Cape Cod National Seashore	Massachusetts	MA01	Not operating at time of survey
ISRO	Isle Royale National Park	Michigan	MI25	11/25/80-9/22/81*
GLAC	Glacier National Park	Montana	MT05	11/18/80-9/29/81
THRO	Theordore Roosevelt National Park	North Dakota	ND07	5/5/81-9/29/81
GRSM	Great Smoky Mountains National Park	Tennessee	TN11	11/18/80-9/29/81
BIBE	Big Bend National Park	Texas	TX04	11/25/80-9/29/81
SHEN	Shenandoah National Park	Virginia	VA28	5/12/81-10/6/81
OLYM	Olympic National Park	Washington	WA14	11/25/80-9/22/81
YELL	Yellowstone National Park	Wyoming	WY08	11/25/80-9/29/81

*18 weeks missing from 2/3/81-6/16/81.

Table 4. Rankings of National Park Service NADP sites by performance

Error Set rank					
Carelessness (I)	Protocol (II)	pH (III)	Conductance (IV)	Efficiency (V)	% of Error Free Weeks
Channel Islands (61%)	Channel Islands (46%)	Channel Islands (*)	Channel Islands (*)	Isle Royale (39%)	Channel Island (21%)
Craters of the Moon (54%)	Glacier (22%)	Craters of the Moon (*)	Craters of the Moon (*)	Glacier (17%)	Isle Royale (22%)
Shenandoah (53%)	Yellowstone (16%)	Mt. McKinley (79%)	Great Smoky Mountain (50%)	Yellowstone (16%)	Theordore Roosevelt (24%)
Theodore Roosevelt (48%)	Craters of the Moon (16%)	Rocky Mountain (76%)	Everglades (37%)		Craters of the Moon (27%)
Median 18%	Median 6%	Median 37%	Median 13%	Median 7%	Median 51%
Indiana Dunes (9%)	Sequoia (3%)		Shenandoah (7%)		Mt. McKinley (66%)
Rocky Mountain (9%)	Olympic (2%)	Sequoia (17%)	Yellowstone (4%)	Rocky Mountain (2%)	Big Bend (73%)
Glacier (8%)	Acadia (2%)	Shenandoah (12%)	Mt. McKinley (4%)	Theodore Roosevelt (0%)	Organ Pipe (75%)
Big Bend (2%)	Organ Pipe (0%)	Acadia (10%)	Glacier (0%)	Organ Pipe (0%)	Acadia (81%)