RESULTS OF 1986 SNOW ACIDITY SAMPLING IN CALIFORNIA

by
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Because of widespread concern over acid rain, a field survey of snow acidity was conducted during the 1985-86 season by teams participating in the California Cooperative Snow Surveys Program. The purpose of the special sampling was to provide broad coverage of the snow zone in California to determine the existence of either a widespread problem of snow acidity or whether specific "hot spots" or zones of acidity existed. Acid snow would be the frozen version of the acid rain problem.

The survey teams carried small plastic tubes and litmus paper indicator sticks. The surveyor filled the tube with surface snow and placed the capped tube in a pocket until the snow melted. He then inserted the litmus paper stick and checked the color after five to ten minutes. The color was matched against a reference chart and the pH (acidity) level was recorded on the snow notes. The Department of Water Resources furnished the materials for the special survey.

PROCEDURES

The use of field pH kits was pioneered by Phillip Farnes of the Soil Conservation Service in Montana. He started measuring the pH of snow in western Montana in 1981, after the Mt. St. Helens eruption.

The procedure is relatively simple. Each snow survey team in the acidity survey was provided a kit of colored pH indicator strips or sticks, and small polystyrene plastic test tubes (12mm x 75mm) with snap caps. The ColorpHast[2] nonbleeding sticks of litmus paper came in a plastic box about half the size of a cigarette package, 100 to a package, with at pH range of 4.0 to 7.0. The boxes have a color code from yellow (pH of 4.0) through greenish brown to grayish blue at a pH of 7.0. The color reference bars are 0.2 pH apart in the middle of the range, but increments are larger toward the ends of the range. Since the anticipated range for most samples was 5.0 to 5.5, this provided enough sensitivity if observers could distinguish the shades of color. In the field, two observers would read the color match and agree (or compromise) on the best reading. Most observers could agree on a color match quite readily.

Snow acidity was tested during the regular field snow surveys about the first of each month from January through April. Many snow courses are measured about May 1 as well; by then, however, melting impurities could be likely to contaminate the surface snow. Therefore, no acidity testing was done then.

Usually, two tests were made at each course. These were averaged to yield a single course value. A complete tabulation of all acidity measurements is contained in a December 1986 Department report on the acidity sampling survey.

1/ Presented at the Western Snow Conference, April 19-21, at Kalispell, Montana. Chief, Flood Hydrology and Water Supply Branch, Division of Flood Management, California Department of Water Resources, Sacramento, CA.

2/ ColorpHast is a registered trademark. It is mentioned here for information and does not imply endorsement by the Department of Water Resources.

RESULTS

A total of 522 separate snow course determinations of snow acidity were made during the season. By month, these reports were:

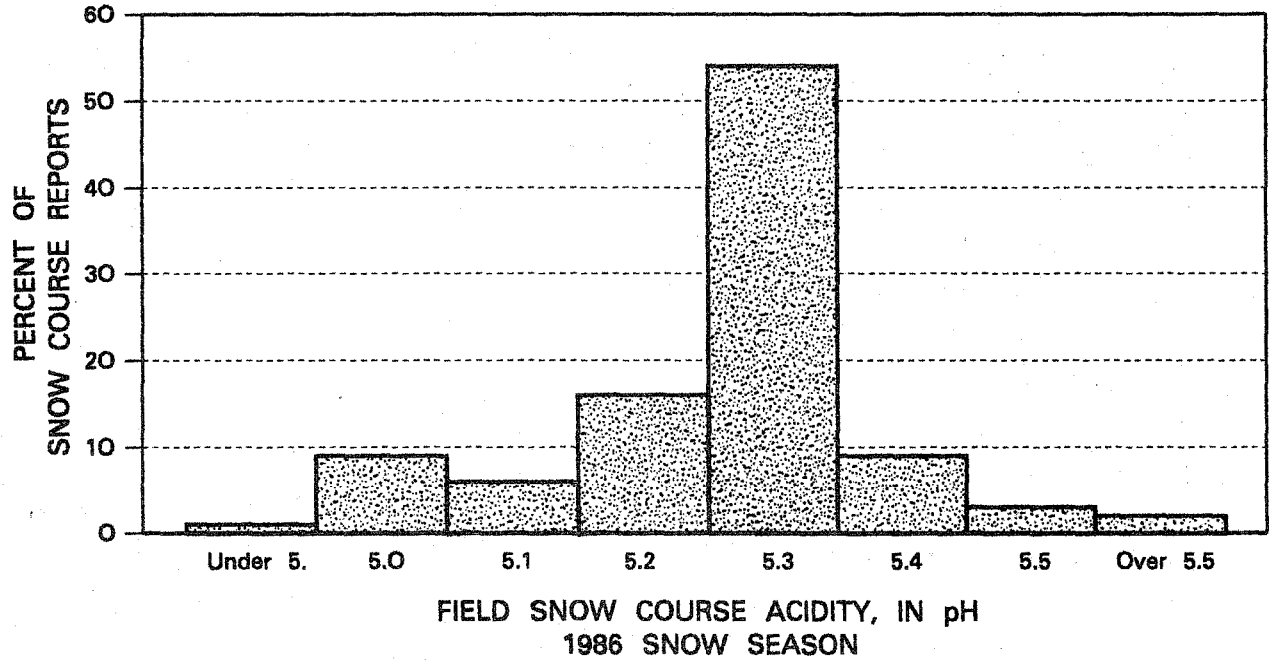
January 1 survey	56
February 1 survey	142
March 1 survey	139
April 1 survey	185
Total	522

These numbers represent about 60 percent of the total number of snow courses measured. Areal coverage was very good, extending from near Mt. Shasta in the north to the southern Sierra Nevada. Only five tests were reported from the south State, but there are few measured snow courses in southern California.

The pH values were clustered around 5.3 with some scattering of samples with lower readings and a few values over 5.5. The distribution of the 522 course reports are listed as follows and also plotted on Figure 1.

pH	Number	Percent
Under 5.0	6	1
5.0	45	9
5.1	30	6
5.2	84	16
5.3	285	54
5.4	47	9
5.5	17	3
Over 5.5	8	2
Total	522	100

Figure 1



The color bars on the test kit are at pH values of 4.7, 5.0, 5.3, 5.5 and 5.7 (and other values at greater range), so this may have influenced the larger number of 5.0 than 5.1 pH readings. Some readings may have been measurement errors. Soaking the litmus paper too long causes a shift toward the acidic side on many samples.

A regional summary follows:

Region	January		February		March		April	
	No.	Avg.pH	No.	Avg.pH	No.	Avg.pH	No.	Avg.pH
Shasta-Trinity	0	--	11	5.2	16	5.3	23	5.3
Stony Creek	0	--	1	5.3	1	5.3	1	5.2
Northern Sierra: Feather-Yuba	13	5.3	11	5.3	24	5.3	20	5.3
Central Sierra: American-Mokelumne	20	5.3	22	5.2	15	5.3	24	5.3
San Joaquin: Stanislaus-San Joaquin	10	5.3	17	5.2	13	5.2	28	5.3
Tulare: Kings-Kern	10	5.4	27	5.3	24	5.4	40	5.2
North Lahontan	3	5.1	28	5.2	29	5.1	28	5.3
South Lahontan	0	--	24	5.2	15	5.3	19	5.3
Santa Ana	0	--	1	5.1	2	5.3	2	5.3

No strong regional trend is apparent, but the North Lahontan average was slightly lower in the March 1 survey. The average represents samples in the Tahoe-Truckee, Carson, and Walker River basins. The average was lowered by a number of 5.0 and 5.1 pH readings from sampling near the end of February. Comparable pH readings of 5.1 were also reported from two Mono Lake basin courses that month. The differences from other regions is small and may not be significant given the accuracy of the method. However, there is a suggestion of a slight acidity shift in the Central Sierra east slope on March 1.

A pH of 7.0 is neutral, neither acid nor alkaline. A pH of 5.0 is ten times more acidic than 6.0. Clean precipitation, rain or snow, theoretically has a pH of about 5.6 because of the carbon dioxide in the air. Precipitation pH below 5.0 is generally regarded to be acidic.

Most snow samples tested about 5.3. That is not significantly different from the range of 5.4 to 5.6 expected from clean natural precipitation. The results match quite well with the mean snowfall of 5.34 during 1983-84 at the Central Sierra Snow Laboratory near Donner Pass reported by Berg and Woo and with the work of other researchers in the Sierra.

SUMMARY

The results of field acidity sampling at about 520 snow course measurements during the 1986 snow season show no evidence of widespread acidity problems in the California mountain snowpack. Results appear to be reasonably reliable, although not as accurate as more precise laboratory meter methods. The tests can be carried out by the regular snow gaging teams with only minor amounts of additional costs, effort, and inconvenience.

Because results in the 1986 season did not indicate acidity problems in the Sierra Nevada snowpack and compare reasonably well with work done at specific sites by other researchers, continuation of the field testing program into 1987 did not seem warranted. Field sampling with the kits can be reinstituted in the future if signs of acidity begin to show. Since the routine monitoring network is sparse in the snow zone, there would be merit in some periodic field sampling from time to time by individual cooperators willing to make such measurements.

ACKNOWLEDGEMENTS

We wish to thank the many snow survey teams who were willing to assume the additional chore of acidity sampling during their regular snow-course measurement work. This made it possible for all of us to learn something more about the current chemical condition of the California snowpack. Special thanks is also extended to Dr. Neil Berg and associates at the Central Sierra Snow Laboratory, who encouraged us with this project.

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