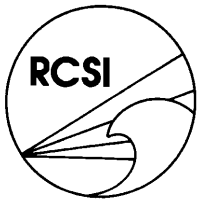

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Changes in Water Quality of Streams
Since the Phosphate Content of Laundry Detergents was Lowered

By: Kenneth Harbison
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Water Pollution May 1974

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SUMMARY

Phosphorus in detergents was limited by law in New York State after December 31, 1971. Tests done in 1972 showed that phosphorus content had decreased in the waters of Allen's Creek, Irondequoit Creek and Thomas Creek. It has been suggested in other areas that such decreases and improvements in water quality can be explained in part by the heavy rainfall of Hurricane Agnes in 1972 which increased streamflows. However, a comparison of rainfall in 1971 and 1972 shows that in this area total rainfall was heavier in June and July 1971 than in 1972, lending support to the theory that the decrease of phosphorus in detergents actually worked to decrease stream pollution in Monroe County.

Another claim made is that removing phosphate from detergents will not lower the phosphorus coming into the lakes and streams enough to make any difference to the waters. Studies done in Erie County where a total ban on phosphorus in detergents was in effect a year earlier than in Monroe County indicate an average 20-25% improvement in stream waters using a number of variables as criteria.

It will take a long time for lakes and streams to be restored to their original clarity, but the data permit cautious optimism.

BACKGROUND

The latest report on over-fertilization of lakes appeared in the May 24, 1974 issue of Science magazine. The authors fertilized two basins of one lake with nitrates and sugar (a source of carbon). Phosphorus was added to only one, and that one became "a teeming green soup" while the other did not (1). From this and other data they concluded that "rapid abatement of eutrophication may be expected to follow phosphorus control measures".

This theory receives support from the successful outcome of the diversion of sewage in Lake Washington (2), but it is known that it does not work under all circumstances - an example is the lack of improvement in Lake Sammamish after partial diversion of sewage (3). New York State is, or soon will be, in a position to test whether the theory applies to our waters, and the preliminary data reported here indicate that we may be hopeful.

* Note: The publication of this Bulletin was unavoidably delayed from its intended publication date in 1973. It is being published now with the original data to maintain the sequence of bulletins.

Action by Canada. After studies of its own and recommendation by the Joint International Commission on the Great Lakes (4), on June 4, 1970 Canada's Environmental Protection Service issued regulations under the Canada Water Act which specified that after August 1, 1970 laundry detergents could not contain more that 8.7% phosphorus. This regulation was subsequently amended to limit phosphorus content of detergents to 2.2%. The Canadians also have a program of upgrading sewage treatment plants to include the removal of phosphate.

Action by the United States Federal Government. Congressional hearings were held in this country over several years (5) that led to committee recommendations of "immediate reduction and eventual elimination of phosphate in detergents". The history of the controversy over phosphates in detergents was summarized in the 1972 report by the Committee on Government Operations, accurately titled: "Phosphates and Phosphate Substitutes in Detergents: Government Action and Public Confusion" (6). The report recommended immediate reduction of phosphorus content of detergents to 8.7%, and further reduction to 2.2% by December 31, 1972, except in areas that the Environmental Protection Agency said were not subject to problems of eutrophication. No federal action to lower the content of phosphorus in detergents followed this recommendation. The Federal Water Pollution Control Act of 1972 was passed which supplied funds for the building of sewage treatment plants.

Action by New York State. The New York State Department of Health initiated studies in 1965 which led to recommendations that phosphorus inputs to the State's water be limited by control of detergent phosphate content and tertiary treatment of municipal wastes. New York State enacted legislation limiting the phosphorus content of detergents to 8.7% after Dec. 31, 1971; after June 1, 1973 no added phosphorus was permitted. There are specific exemptions for products used in automatic dishwashers and cleaning of dairy equipment.

Action on the County level. Some localities have passed local regulations limiting phosphorus in detergents. Erie County set January 1, 1972 as the date after which no phosphorus could be added to the detergents sold in the County. The County of Monroe considered the suggestion of the League of Women Voters that a ban on added phosphate be enacted earlier than the statewide ban but local options were preempted by state regulations before the legislature had a chance to act on the proposal.

WATER QUALITY IN ERIE COUNTY STREAMS

The effectiveness of a ban on the sale of phosphorus containing detergents in reducing phosphate in municipal waste depends on the extent to which the ban is circumvented by purchase of phosphorus-containing detergents elsewhere. In a poll conducted in March, 1973 of randomly selected residents in Erie County (7) 14% of those responding reported that they used phosphorus-containing detergents once a week or more often. Since the ban on the sale of phosphate-based detergents in Erie County had been in effect for 15 months at the time of the poll, it can be reasonably assumed that these users were bringing into the county detergents purchased elsewhere. In the same poll, 77% of the respondents reported that they had used phosphate-containing detergents never, or only once or twice, since the ban came into effect, and 9% reported usage up to a few times a month. The Council on Environmental Quality has estimated that 60-70% of the phosphorus in municipal sewage comes from detergents, therefore on the basis of this poll it can be predicted that the phosphate ban should cut the input of phosphorus into municipal waste treatment plants in half.

An unusually well documented field experiment on a grand scale has been conducted in Erie County (8). The Buffalo Sewer Authority Plant treats almost 90% of the total waste water in the County; the Lackawana and Blasdell plants treat an additional 5%.

Buffalo does not have tertiary treatment of its sewage for phosphorus removal. Table 1 shows the reduction in phosphorus coming into the sewage treatment plants after the partial and total bans were enacted. The decrease in phosphorus after the total ban is close to 50% and is in satisfactory accord with the prediction.

Table 1. Decrease in phosphorus coming into Erie County Sewage Treatment Plants after May 1971. In-plant studies from 1970 were used as a base line.

	No. gal/day	% Decrease after Partial Ban	% Decrease After Total Ban
Buffalo Sewer Authority	166 (million)	18.7%	44.1%
Lackawana	8.0	18.3%	53.6%
Blasdell	0.88	30.0%	43.5%

(from a study by Hobson, SUNY at Buffalo, N.Y.)

In addition, a series of Stream Surveys have been published by the Erie County Department of Health that compare values for seven variables: BOD (organic matter), DO (oxygen), % saturated DO, PO_4 (phosphate), NO_3 (nitrate), Cl (chloride) and Fe Coli (fecal coliform bacteria) before and after the phosphorus content of detergents was lowered.

Overall, there was a 20-25% improvement in stream quality after the phosphorus content of detergents was lowered to 8.7%. Some sections of streams showed a much greater improvement (9).

Due caution is required in interpreting these results. Difference in rainfall in 1970 and 1971 can account for some drop in BOD. All streams are not alike; urban and rural watersheds furnish different sources of organic matter and minerals, therefore all streams would not respond equally to the lowering of detergent phosphates. Furthermore, the condition of the stream at the time of the phosphorus reduction can strongly affect the degree of change, and the length of time required for a change. Dr. Robert W. Sweeney, Director of the Great Lakes Laboratory of SUNY College at Buffalo, has explained in a letter that the dramatic effect in some Erie County streams may have been produced because these have a rich "bank" of phosphorus on the bottom which is released when the bottom water is depleted of oxygen. Curtailing the incoming phosphorus cuts down on the initial growth, over-crowding, death, and decay of algae enough to increase the oxygen and effectively close the "bank". A parallel situation has been described in detail for Lake Erie in a study known as "Operation Hypo" (hypolimnion is the bottom section of a stratified lake) which was supported by the Federal EPA (10)

WATER QUALITY IN MONROE COUNTY STREAMS

Studies conducted locally in 1971 and 1972 (11) on three creeks in the Irondequoit Watershed showed substantial decreases in phosphorus after limitations on phosphate in detergents took effect in Jan. 1972. The data summarized in Table 2 reveal that the reduction in phosphorus level in the streams of Monroe County parallel the reduction reported in Erie County. Official measurements of rainfall (data collected at the Monroe County Airport) are reported in Table 3. Measurements made in the Allen Creek Basin in 1972 confirm the official monthly averages to within 0.1 inches. Table 3 compares rainfall at the airport from June through August in 1971 and 1972. Detergent manufacturers had argued that the great decrease in phosphorus measured in the streams was only partially caused by the ban. It was, they said, in large part caused by the increase in rainfall and resultant dilution of the stream water in 1972. In some areas total precipitation was, of course, much higher in 1972 after Hurricane Agnes. However, in the Rochester area rainfall was very heavy during July 1971 and very light in July 1972, which equalized the effect of Hurricane Agnes. Unnoticed by most of us, there

was more rainfall in June and July in 1971 than in 1972. These data make it more likely that the phosphorus reduction in our streams is directly related to the ban.

Table 2. Average phosphorus concentration in Monroe County creeks in mg P/liter.

Year	June-September 1971			June-September 1972			% Decrease in P
	Ave. P	Std. Dev.(c)	No. of observations	Ave. P	Std. Dev.(c)	No. of observations	
Allen's Creek at Nalge(b)	1.102	0.210	(36)	0.960	0.086	(8)	13%(d)
Irondequoit Creek, Linden Ave.(a)	.634	0.099	(9)	0.354	0.54	(10)	44%(e)
Irondequoit Creek, Browncroft(b)	1.208	0.177	(37)	0.589	0.082	(8)	51%(e)
Thomas Creek at Baird Rd. (b)	1.361	0.200	(6)	0.858	0.104	(8)	37%(e)

Keys (a) Soluble orthophosphate as phosphorus
(b) Total hydrolysable phosphate as phosphorus
(c) Standard deviation of average
(d) Not a statistically significant decrease
(e) A statistically significant decrease

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Table 3. Total precipitation at the Rochester Weather Station (inches of rainfall per month).

Month / Year	June	July	August	September	Average, June & July	Average, June thru September
1971	3.52	5.59	3.18	1.79	9.11	14.08
1972	6.56	2.43	3.14	3.84	8.99	15.97

The improvements in water quality described here have occurred within a short time and are encouraging. A cautious optimism is suggested. It is not possible to know how much of the improvement has resulted directly from the lowering of the phosphorus content of detergents, but the evidence appears strong that there was a marked beneficial effect on streams. Caution is suggested because dramatic biological effects are unlikely to be detected as rapidly as the chemical ones. Some lakes appear to recover slowly or perhaps not at all after large efforts of diversion of wastewater (3), while other lakes recover more promptly (2, 12). We can at least hope to have started the process of reclamation of local streams and lakes.

REFERENCES

(1) Schindler, D.W., Eutrophication and Recovery in Experimental Lakes: Implications for Lake Management. 1974. Science. 184: 897-899

(2) Edmondson, W.T., Phosphorus, Nitrogen and Algae in Lake Washington after Diversion of Sewage. 1970. Science 169: 690

(3) Emery, Richard M., Clifford E. Moon and Eugene B. Welch, Delayed Recovery of a Mesotrophic Lake after Nutrient Diversion. J. Water Pollution Control Federation 45: 913-925, 1973

(4) International Joint Commission, Canada and United States. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Published by Information Canada, Ottawa, 1970

(5) Phosphates in Detergents and the Eutrophication of America's Waters. Twenty-third Report by the Committee on Government Operations;April 14,1970 U.S.Gov't Printing Office, Washington D.C.

(6) Phosphates and Phosphate Substitutes in Detergents: Government Action and Public Confusion. Ninth report by the Committee on Government Operations, 1972. For sale, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. $.55

(7) Hammerman, Howard et al, The Erie County Phosphate Ban, Final Report. Dept. Urban Planning and Development, Cornell University, Ithaca. 1973

(8) Hopson, N.E.,Letter summarizing work done at SUNY, Buffalo Faculty of Engineering and Applied Sciences by Civil Engineering students, 1972.

(9) Leyking, W., M. C. Lanighan and J. Puleo, BOD and Phosphate Levels of 28 Erie County Streams. Erie County Laboratory, Public Health Division, Buffalo N.Y. 14202, 1971

(10) Burns, N.M. and C. Ross, "Project Hypo", Discussion of Findings;Report previous to clearance for publication by EPA

(11) The Irondequoit Creek System: A Drainage Basin Before Sewage Diversion. Summer 1972. Grant report, NSF GY9605. Available in collection of Dept. of Geology Library, U. of R.

(12) Murphy, C. B. Jr., Effect of Restricted Use of Phosphate-based Detergents on Onondaga Lake. Science 182: 379-381, 1973