

SUPERIOR ADVISORY NOTES

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Beaches protect coastal bluffs. When beaches are washed away or submerged, bluff erosion increases.

Slip Sliding Away: Erosion on Lake Superior's North Shore

Dale Baker and Peder Otterson

Background

Lake Superior water levels have been monitored regularly since 1860. They fluctuate from month to month and year to year. The lake normally fluctuates about a foot annually, being lowest just before the snow melts in the spring and highest in September.

The lowest levels recorded occurred in 1925-1926. The other extreme occurred in 1985 and 1986, when new monthly record highs were set for 12 consecutive months. Between these two extremes, the lake's fluctuation approaches four feet. Long-term fluctuations appear to have an irregular cycle: high water levels were experienced in 1951-1952, 1972-1974, and 1985-1986.

High lake levels are due mainly to precipitation. The Great Lakes basin has had above-average precipitation for 13 of the last 15 years. Since 1900, Lake Superior basin precipitation and water levels have gradually increased, as shown in Figure 1. Some climatologists believe this trend may reflect a long-term climatic shift toward wetter weather and higher lake levels.

Since mid-1985, Lake Superior's high water levels have caused extensive damage along Minnesota's North Shore. Although in many places the shore is composed of volcanic rock that resists erosion, much of the shoreland development is in erodable areas where the soils are predominately clay and gravel. Consequently, planners in coastal counties question where they can safely encourage coastal development, and where they should discourage it. Property owners ask how much erosion to expect in the future. Unfortunately, no one has answers for them. Current erosion rates have not been measured, and it is impossible to predict where and at what rates future erosion will occur.

The Survey

To deal with some of these questions, coastal property owners on Minnesota's North Shore were surveyed in 1986. This was a joint project of the Minnesota Department of Natural Resources, the Minnesota Sea Grant Extension Program, and the Lake Superior Conservation Corps. The survey had five objectives: (1)

LAKE SUPERIOR WATER LEVEL AND PRECIPITATION 1900 - 1986

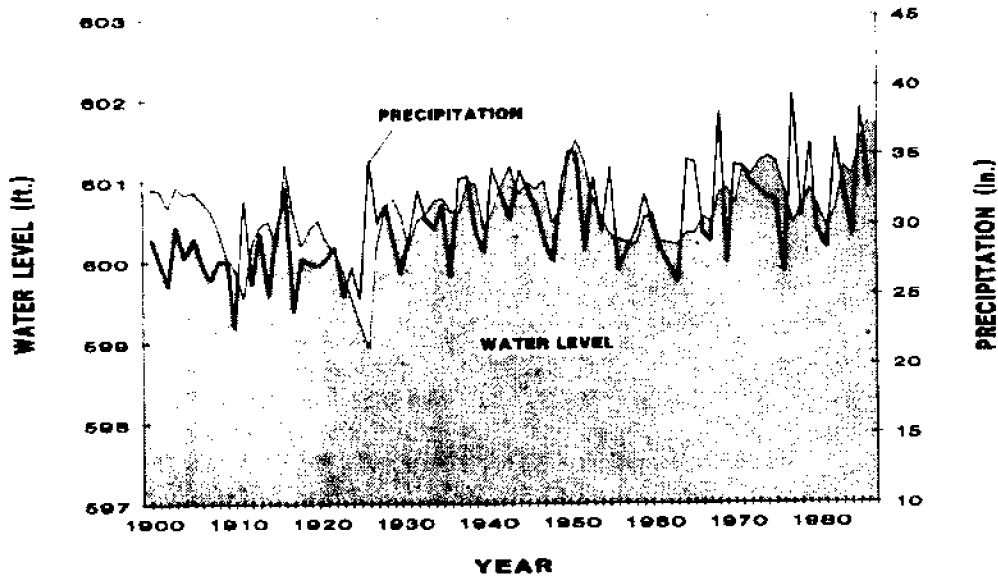


Figure 1 Lake Superior basin precipitation (solid line) and water levels (shaded area) have increased since the turn of the century.

determine if coastal erosion is a major concern among coastal property owners, (2) identify areas where erosion is a problem, (3) estimate long-term and 1986 erosion rates for each county, (4) determine whether the loss of buildings is a major concern, and (5) assess the educational needs of the property owners regarding erosion and its control.

The survey was conducted at North Shore homes and businesses from the Duluth city limits to the Canadian border; property within the city of Duluth was not included (see Figure 2). The survey form was filled out at the site if possible. If not, the form was left with a request that it be filled out and returned.

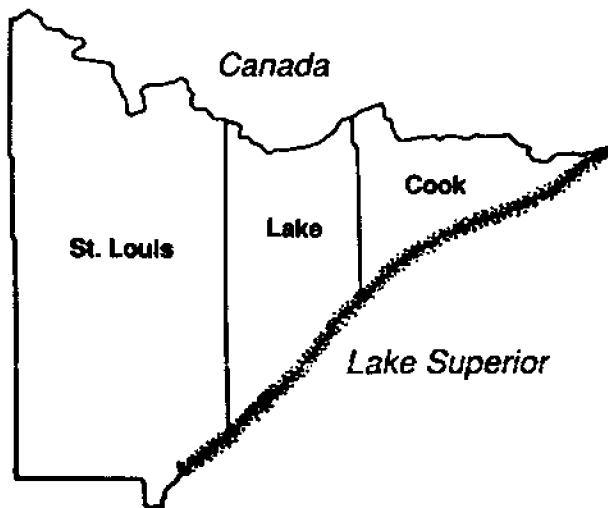


Figure 2. The coastal erosion survey was conducted in the shaded portions of St. Louis, Lake, and Cook Counties in 1986.

Survey Results

Three hundred forty-one sites were visited, and 199 property owners responded. The response rate was 58 percent. The results are summarized in Table 1.

As expected, the greatest concern about erosion occurred where erosion rates are highest, especially where clay banks or bluffs are directly exposed to wave action. In general, the clay bluffs are located in St. Louis County and in southwestern Lake County. Scattered pockets of clay are also found farther north. Wherever they occur, erosion is a problem.

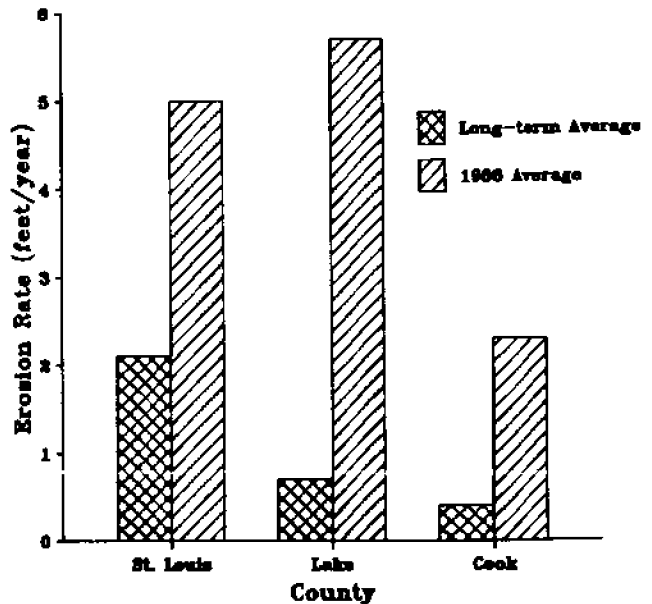


Figure 3. A comparison of long-term and 1986 estimated coastal erosion rates shows the impact of recent high water levels. Note that St. Louis County rates are based on a small sample (14 properties) and do not include the city of Duluth.

Table 1. Responses, by county, from 199 erosion surveys.¹

	County		
	St. Louis	Lake	Cook
Number of completed surveys	14	91	94
Land use (%):			
Residential	72	69	46
Seasonal	14	17	36
Commercial	14	14	18
Very concerned ² about erosion (%)	82	73	56
Average length of property ownership (years)	15	22	22
Estimated long-term shore erosion rate (feet/year) ³	2.1	0.7	0.4
Estimated 1986 erosion rate (feet/year) ³	5.0	5.7	2.3
Structure setback from bluff (feet)	56	55	55
Height of base of structure above water (feet)	39	19	15
Height of edge of bluff above water (feet)	36	17	11
Bluff composition ⁴	C	C,B	B,S,G
Sites with shore protection (%)	36	30	37
Average cost of shore protection (\$)	2,530	2,000	1,059
Average property value (\$)	163,700	135,266	140,443
Number of property owners with flood insurance	0	5	17

¹Many of the figures listed in Table 1 are averages. Conditions at specific sites may vary considerably from these averages.

²Respondents were considered very concerned if they rated their concern at 8-10 on a scale of 0-10.

³These averages are based on all responses, including those that reported no erosion.

⁴C=clay, B=bedrock, S=sand, G=gravel.

Erosion is not limited to clay soils. Storm waves and high water levels have eroded other types of shore as well. Cobble beaches and banks have been cut back, sea caves have collapsed, and even bedrock has been washed away.

Proceeding northeast from Duluth, into Lake County and then into Cook County, property use gradually shifts from year-round to seasonal, and from residential to commercial.

The longest period of property ownership is 39 years in St. Louis County, 75 years in Lake County, and 70 years in Cook County. There are 14 parcels where ownership has been continuous for more than 50 years; many more properties have been owned for at least 25 years. These long periods of ownership are important because they represent continuous observation through cycles of high and low water.

Landowners were asked to estimate the depth of shoreland lost during 1986, as well as the total depth lost since their purchase of the property. Long-term annual erosion rates were calculated by dividing the total estimated loss in feet by the number of years of property ownership. The long-term estimates are considerably lower than those for 1986, as shown in Figure 3. The explanation for this is two-fold. First, people can more easily recall recent losses than where the shoreline was ten years ago. Second, erosion rates during 1986 were much higher than the long-term averages due to the high water levels. In addition, heavy rainfall in early

1986 oversaturated many clay banks, both on and off Lake Superior, causing them to slump.

The long-term and 1986 erosion rates include reports of zero erosion by respondents with property located on bedrock or in protected areas. This was the case at three sites in St. Louis County, 14 in Lake County, and 27 in Cook County. Had these reports been excluded, the average erosion rates reported in Table 1 would have been higher.

Although the average setback of structures from the bluff is about 55 feet in all three counties, the average height of the bluffs decreases heading away from Duluth. Erosion decreases to the northeast, but lower elevations may make structures on this portion of the shore more susceptible to wave damage and flooding.

About one-third of those surveyed have some type of shore protection, such as rock riprap, retaining walls, or vegetation. Many reported that their shore protection was damaged by high water during 1986. Within each county, the cost of protective measures averages one to two percent of the total reported property value. This average includes many properties without shore protection.

Discussion

Coastal erosion is a major concern among coastal property owners. The most severe problems occur in St. Louis and Lake Counties, where wave action erodes clay slopes.

Our estimated 1986 erosion rate of 5 feet per year for St. Louis County is within the range of 5 to 11.9 feet per year reported for the clay bluffs of St. Louis County for 1973-74. That study was conducted during a previous high water cycle.⁵

North Shore structures have been lost because of erosion. Losses to date have not been substantial, but if erosion continues at current rates, this will change. Structures have an average setback of 55 feet from the bluff; if erosion continues at 5.7 feet per year, as estimated for Lake County in 1986, it won't be long before the threat to structures increases dramatically.

The educational needs of the property owners were assessed in the survey, and information about water levels and erosion control was provided. Informational meetings are being planned to discuss the results of the survey and address concerns raised by survey respondents. A more detailed analysis of the data will be done and follow-up visits will be made to reference sites identified as possible benchmarks for further study.

Conclusion

Rates of shore erosion are greatest during periods of high water. Past experience has shown that concern about erosion tends to fluctuate with lake levels. As water levels fall, concern vanishes, but erosion never stops; it only slows down. It is hoped that the counties and state will develop long-range strategies for dealing with erosion while interest remains high.

Erosion rates vary according to rock and soil type, and degree of exposure to waves. Where erosion or storm damage is prevalent, shore protection should be considered if long-term property values are to be maintained. Unfortunately, effective shore protection is expensive. In some cases, it may be more cost-effective to relocate structures than to try to protect them.

The estimated long-term and 1986 erosion rates presented here are based on figures reported by property owners. Additional studies based on data are needed to substantiate these estimates.

Minnesota Sea Grant and the Department of Natural Resources offer assistance to property owners through on-site inspections and consultations. For more information on these services or on erosion control contact:

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⁵Great Lakes Shoreline Damage Survey, St. Louis County, Minnesota, U.S. Army Corps of Engineers, Minnesota Dept. of Natural Resources and Arrowhead Regional Development Commission, 1986.

References

Publications are available without charge from Minnesota Sea Grant Extension unless otherwise indicated.

"Smooth Sailing through Coastal Permits." Minnesota Sea Grant Extension, 1982. 4 pages. Explains the permits required for Great Lakes shore protection projects.

"Sources of information about Great Lakes Water Levels and Erosion." Minnesota Sea Grant Extension, 1987. 2 pages. Includes an annotated publication list and a list of engineering firms that deal with erosion control.

Low Cost Shore Protection. U.S. Army Corps of Engineers, 1981. 36 pages. Explains natural coastal processes and tells how shore property can be protected with relatively low-cost techniques.

Help Yourself: A Discussion of Erosion Problems on the Great Lakes and Alternative Methods of Shore Protection. U.S. Army Corps of Engineers, 1978. 24 pages. Similar to above, but more detailed and technical. It also lists the advantages and disadvantages of various protective devices.

"Controlling Bluff Groundwater along the Great Lakes." Cornell Cooperative Extension, 1979. 6 pages. Explains how seeps and springs can cause erosion on coastal bluffs, and suggests ways to improve drainage.

A Guide to Coastal Erosion Processes. Cornell Cooperative Extension, 1985. Describes coastal processes and erosion, and provides a checklist for pinpointing the cause of erosion at a particular site. Purchase for \$2.25 from New York Sea Grant Extension Program, SUNY College, Brockport, NY 14420.

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