U. S. DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PROCEEDINGS

4TH ANNUAL

LAKE ERIE COASTAL EROSION STUDY WORKSHOP

APRIL16-18, 1996

USGS Center for Coastal Geology

St. Petersburg, FL

Edited by

David W. Folger

Open-File Report 96-507

AUGUST 1996

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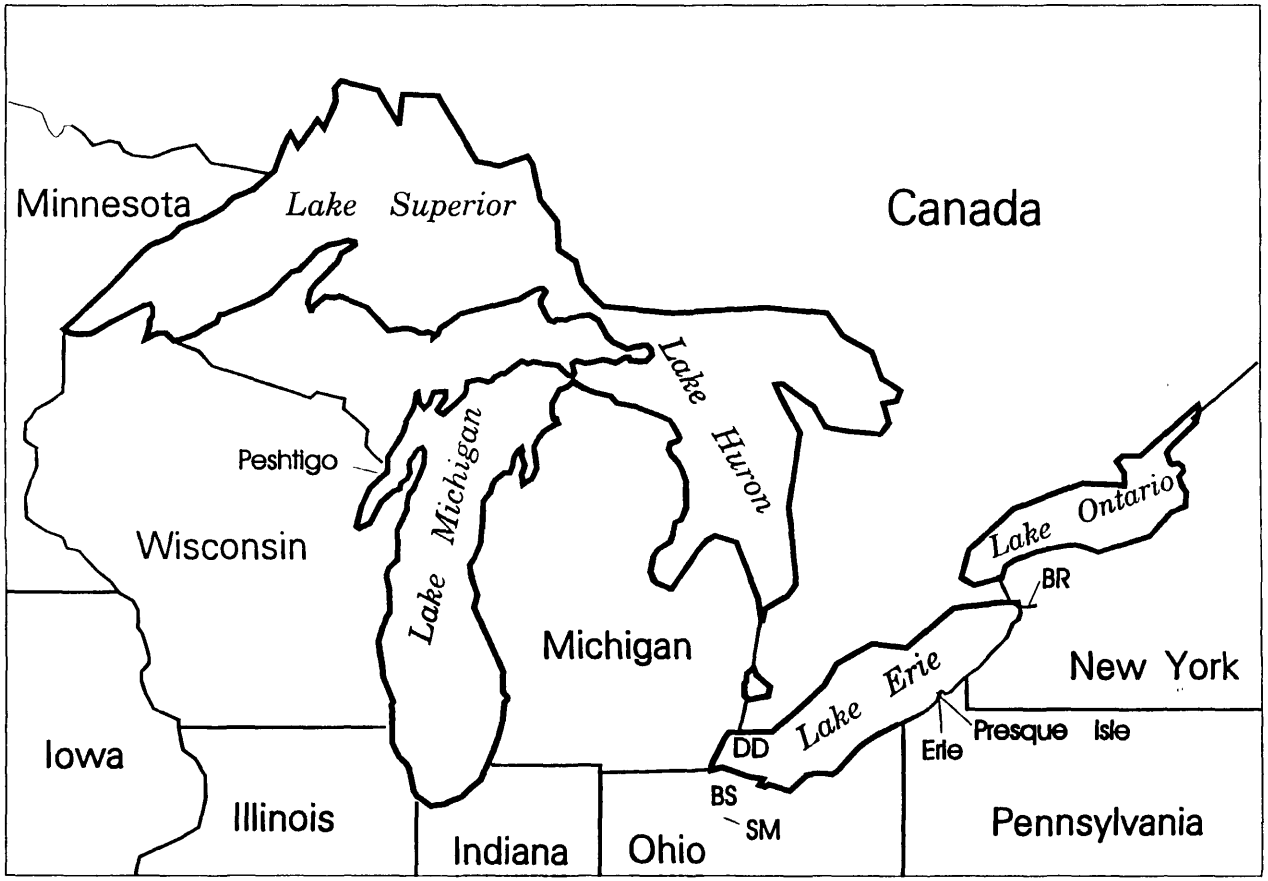
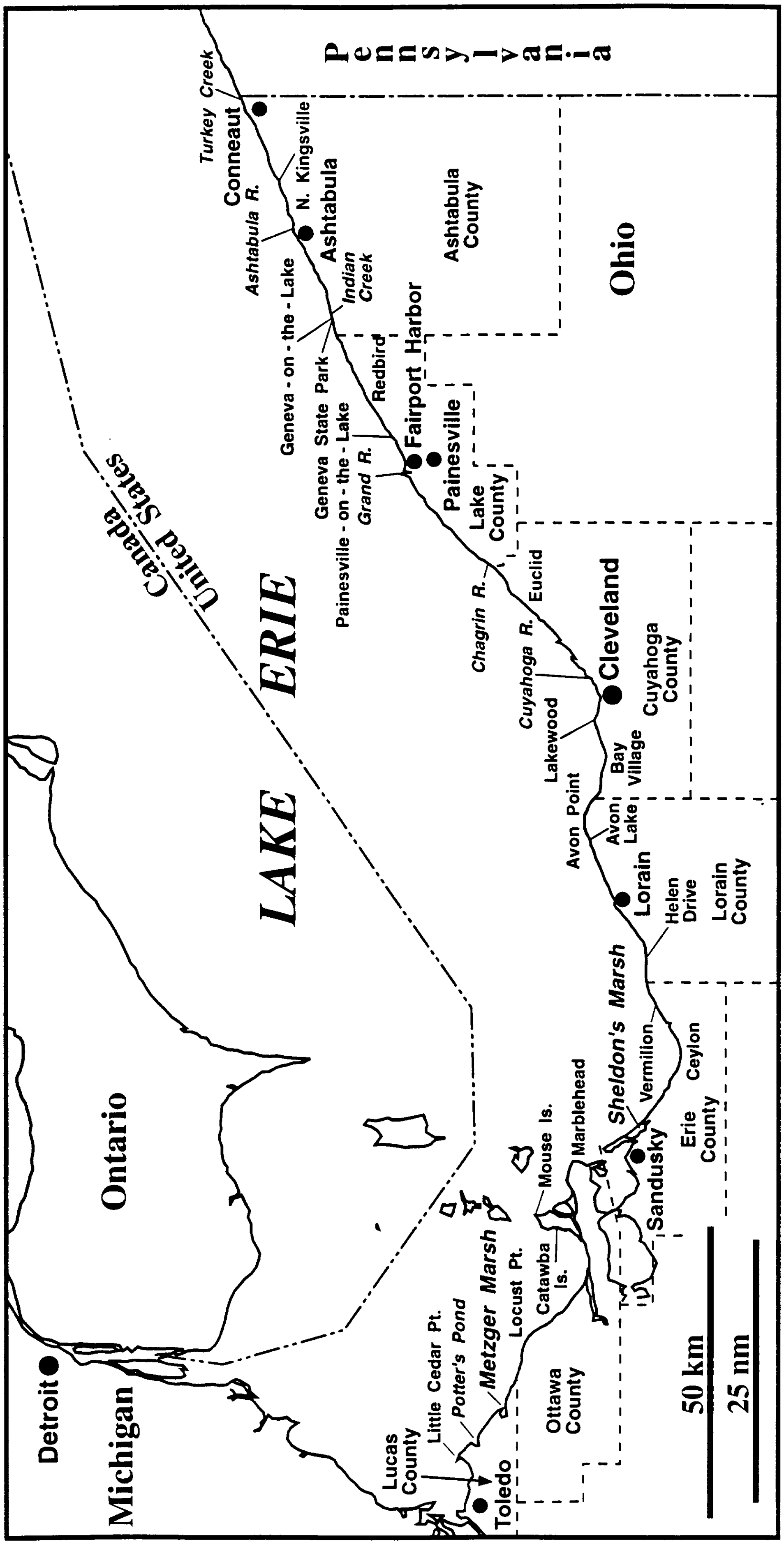
APPENDIX



BS - Black Swamp; SM - Springville Marsh; DD - Detroit Delta; BR - Buffalo River



Pennsylvania
Turkey Creek
Conneaut
N. Kingsville
Ashtabula R.
Ashtabula
Indian Creek
Ashtabula County
Ohio
Geneva - on - the - Lake
Geneva State Park
Redbird
Fairport Harbor
Geneva - on - the - Lake
Grand R.
Painesville - on - the - Lake
Painesville
Lake County
Chagrin R.
Euclid
Cuyahoga R.
Cleveland
Cuyahoga County
Lakewood
Bay Village
Avon Point
Avon Lake
Lorain
Helen Drive
Lorain County
LAKE ERIE
United States
Canada
Ontario
Sheldon's Marsh
Vermillion
Ceylon
Erie County
Sandusky
Marblehead
Mouse Is.
Catawba Is.
Locust Pt.
Metzger Marsh
Potter's Pond
Little Cedar Pt.
Ottawa County
Lucas County
Toledo
Detroit
Michigan
50 km
25 nm

INTRODUCTION

The Lake Erie Coastal Erosion Study, a cooperative effort between the Ohio Geological Survey and the U.S. Geological Survey, was initiated in FY 1991 to document the rates of retreat along the Ohio shoreline, map the nearshore geology, and assess some of the processes responsible for the retreat.

Participants over the duration of the cooperative have included Scudder Mackey, Jonathan Fuller, Donald Guy, Dale Liebenthal, and Richard Pavey of the Ohio Geological Survey and John Haines, Peter Barnes, Ronald Circe, Steven Colman, David Folger, David Foster, Robert Oldale, Eleanora Robbins, Gerald Shideler, Byron Stone, and S. Jeffress Williams of the USGS. Michael Chrzastowski of the Illinois State Geological Survey and Curtis Larsen of the USGS attended one workshop as consultants.

Field work for the study is complete. Evaluation, compilation, and publication of data will be completed during 1996.

The results from six of the seventeen studies are presently available to the public as U.S. Geological Survey Open-File Reports. These include:

1) The geologic framework of the Ohio part of Lake Erie (U.S. Geological Survey Ope-File Report 95-220)-Fuller and others;

2) Maps and sidescan sonar images showing interpretation of acoustic backscatter overlain on historically mapped bottom sediments of the Ohio part of Lake Erie (U.S. Geological Survey Open-File Report 95-252)-Foster and others;

3) Shore and lakebed erosion; response to changing levels of Lake Erie at Maumee Bay State Park, Ohio (U.S. Geological Survey Open-File Report 95-662)-Fuller;

4) Sediments of the southwestern corner of the central basin of Lake Erie (U.S. Geological Survey Open- File Report 96-21)-Fuller;

5) Remote video monitoring systems (U.S. Geological Survey Open-File Report 96-56)-Haines and Townsley;

6) Influence of lake ice on coastal erosion-Ohio shore of Lake Erie-winter

1993/1994 (U.S. Geological Survey Open-File Report 96-57)-Barnes and others.

Abstracts that provide summaries of work completed in 1993 and 1994, are available in U.S. Geological Survey Open-File Reports 94-200 and 95-224 edited by David W. Folger.

AGENDA

4th ANNUAL WORKSHOP

LAKE ERIE COASTAL EROSION STUDY

USGS CENTER FOR COASTAL GEOLOGY

St. Petersburg, FL

April 16-18, 1996

Purpose: To integrate all aspects of the study and to implement plans for publication

Day 1

April 16, 1996

Introduction

0830	Status of USGS Coastal Studies	Abby Sallenger
0845	Agenda for the Workshop	Dave Folger
0900	Methods for Compiling and Publishing Lake Erie data	Dave Foster

Geologic Framework--Products and Accomplishments

0930	Expanded Nearshore Mapping and Profiling-Central Basin	Jonathan Fuller Don Guy
1000	Coffee Break/Discussion	

1015	Lewis Dataset-Cleveland State University	Jonathan Fuller
1030	Offshore Sidescan Analysis-Central Basin	Jonathan Fuller
1100	Regional Mapping/Cross-Sections	Byron Stone Rick Pavey
1130	Synthesis-Geologic History and Stratigraphy	Byron Stone Rick Pavey Jonathan Fuller
1200	Lunch	
1300	Products-Geologic Framework	Jonathan Fuller Don Guy Rick Pavey Byron Stone

Rates, Processes, and Budget--Products and Accomplishments

1330	Recession-Line Mapping	Scudder Mackey Don Guy
1400	Sediment Budget	Scudder Mackey
1500	Coffee Break/Discussion	
1515	Seasonal entrainment of sediment by ice	Peter Barnes
1545	Recession Analysis and Factors	Scudder Mackey Don Guy John Haines
1645	Products: Rates, Processes, and Budget	Scudder Mackey John Haines

		Don Guy Peter Barnes
1700	Adjourn	

Day 2

April 17, 1996

Process/Predictive Models--Products and Accomplishments

0830	Process/Predictive Models- Central Basin	Don Guy Scudder Mackey John Haines
1000	Coffee Break/Discussion	
1015	Process/Predictive Models- Western Basin	Scudder Mackey Don Guy John Haines
1130	Products: Process/Predictive Models	John Haines Scudder Mackey Don Guy
1200	Lunch	

Case Studies--Products and Accomplishments

1300	Video Monitoring-Painesville	

	on-the-Lake	John Haines
1330	Recession Analysis-Painesville on-the-Lake	Don Guy
1400	Recession Analysis/Sediment Budget-Geneva State Park	Don Guy Scudder Mackey
1430	Coffee Break/Discussion	
1445	Recession Analysis-Helen Drive et al.	Don Guy
1515	Recession Analysis/Sediment Budget-Little Cedar Point, Potter's Pond, Metzger Marsh	Scudder Mackey
1600	Products: Process/Predictive Models	Scudder Mackey John Haines Don Guy
1700	Adjourn	

Day 3

April 18, 1996

Methods and Techniques--Products and Accomplishments

0830	Shallow Draft Vessel and Equipment for Nearshore Sidescan Operations	Dale Liebenthal Jonathan Fuller

Product Coordination and Schedule-Final Products

0900	Production and Material Needs Planning and Scheduling-Final Products	USGS & OGS Staff
1000	Coffee Break/Discussion	
1015	Production and Material Needs Planning and Scheduling-Final Products (con't)	OGS & USGS Staff
1200	Adjourn	

ABSTRACTS

SEASONAL ENTRAINMENT OF SEDIMENT IN LAKE ERIE COASTAL ICE: IMPLICATIONS FOR COASTAL EROSION

Barnes, Peter W.[1], Dunhill, Gita[1], Schoonmaker, Kelly[1], and Guy, Donald E., Jr.[2]

[1]U.S. Geological Survey, MS 999 345 Middlefield Rd. Menlo Park, CA 94025,
[2] Lake Erie Geology Group, Division of Geological Survey, 1634 Sycamore Line, Sandusky, OH 44870-4132

A study of coastal processes on the Ohio coastline of Lake Erie assessed the role of lake ice in coastal erosion during the winters of 1993 and 1994. Ice was present at the coast for 3-4 months, initially forming in late December then dispersing and melting by mid-April. The coastal ice canopy was essentially unchanged from mid-January to late March. Thus, the influence of ice on coastal erosion and sediment transport was focused at the beginning and end of the ice season.

Observations indicate that anchor ice formation (Tsang, 1982; Kempema and Reimnitz, 1991; Barnes and others, 1994) on the lakebed, its release with entrained sediment, and subsequent surface accumulation, is a widespread process during the freeze-up in the Great Lakes. We believe that anchor ice processes are the major mechanism for sediment entrainment along the shoreface. Anchor ice forms at night under calm conditions and is dislodged during the morning, rising to the surface during periods with offshore winds. In 1994, onshore winds prevailed during the period of ice formation while offshore winds prevailed during break-up. The former would enhance anchor ice accumulation and the latter would cause coastal ice to move offshore. In addition, the post-freeze-up ice regime in 1994 had fewer and smaller ice ridges than were measured in 1993 (Barnes et others., 1993); this suggests less vigorous wave activity during ice formation and a greater opportunity for anchor ice development. As a result, sediment concentration in coastal ice was an order of magnitude higher in 1994 than in 1993 (705 vs. 55 kg/m of coast). If it is assumed that this quantity of sediment is removed from the coast at the time of break-up, then about 10% of the observed erosion

(Carter, 1977; Carter and Guy, 1983) can be attributed to ice processes. Because demise of the ice canopy occurs primarily by advection (Barnes et al, 1994), the amount of sediment sampled in the stable ice canopy is a reasonable approximation of the sediment transported alongshore and offshore.

Comparison of 1993/1994 shoreface profiles obtained just before freeze-up (late December), mid winter (February), and shortly after break-up (mid April) indicate a similar pattern at 3 survey sites. The winter profiles indicate erosion inshore of water <1.5 m deep when compared to the pre-freeze up profiles. Post-break-up profiles show recovery toward the pre-freeze up shoreface. One explanation for this sequence is repetitive nearshore anchor ice events removing sediment during freeze up followed by rebuilding of the shoreface during and following break up in the spring.

We conclude that the amount of coastal erosion due to ice entrainment and transport is, in large part, controlled by the opportunity, frequency, and intensity of poorly understood anchor-ice events during freeze up and drift trajectories of sediment-laden nearshore ice at break-up. The intensity of these processes is strongly controlled by wind and resultant ice drift.

References:

Barnes, P.W., Kempema, E.W., Reimnitz, Erk, and McCormick, Michael, 1994, The influence of ice on Lake Michigan Coastal Erosion: Journal of Great Lakes Research, v. 20, p. 179-195.

Barnes, P.W., McCormick, Michael, and Guy, D.E., Jr., 1993, Winter coastal observations, Lake Erie, Ohio shore: U.S. Geological Survey Open-File Report 93-539, 27p.

Carter, C.H., 1977, Sediment-Load measurements along the United States shore of Lake Erie: State of Ohio, Division of Geological Survey, Report of Investigations No. 102, 24p.

Carter, C.H., and Guy, D.E., Jr., 1983, Lake Erie shore Erosion, Ashtabula County, Ohio: Setting, processes, and recession rates from 1876 to 1973: Ohio Division of Geological Survey Report of Investigations, No. 122, 107p.

Kempema, E.W., and Reimnitz, Erk, 1991, Nearshore sediment transport by slush/brash ice in southern Lake Michigan, in N.C. Kraus, K.J. Gingerich, and

D.L. Kriebel (eds.), Coastal Sediments '91: American Society of Civil Engineers, NY, p. 212-219.

Tsang, G. 1982, Frazil and Anchor Ice: a Monograph. National Resource Council Subcommittee on Hydraulics of Ice-Covered Rivers, Ottawa, Ontario, Canada, 90p.

METHODS FOR COMPILING AND PUBLISHING LAKE ERIE DATA

Foster, David S. and Polloni, Christopher F.

U.S. Geological Survey, Woods Hole, MA 02543

The U.S. Geological Survey archives data on CD-ROM for publication and distribution. It also provides on-line access to its data holdings via the World Wide Web (www) at the public access page *http://www.usgs.gov.* The objective is provide researchers and the public easy access to information.

Two CD-ROMS related to the coastal environment that we have made available are: 1) the Southern Lake Michigan Coastal Erosion Study (USGS Open File Report 94-255, 1994) and, 2) a geologic map of the seafloor in western Massachusetts Bay (USGS DDS-3,1992) constructed from digital sidescan sonar images, photography, geologic maps, and sediment samples. These products were designed to replace paper atlases and provide an all-digital product that can be distributed on-line or replicated for distribution.

Data integration tools and concepts utilizing graphic editors such as CorelDraw allow the user to prepare final copies of maps using computer programs such as ISM, ARC/INFO, ARCVIEW, GMT, and MAPGEN. We present a novel technique for assembling, integrating, and displaying spatially referenced information in the form of a Lake Erie atlas with tools and standard files that allow the user not only to browse the HTML-compatible data files with network software such as MOSAIC or NETSCAPE, but also to build one's own products with the included tools. Figure 1 summarizes the methods of integrating information into digital products.

A near-shore surficial sediment map (described by Fuller, this volume) is included as an example of an Arc/Info coverage that can be used to generate user-defined overlays for analysis and display using ArcView software.

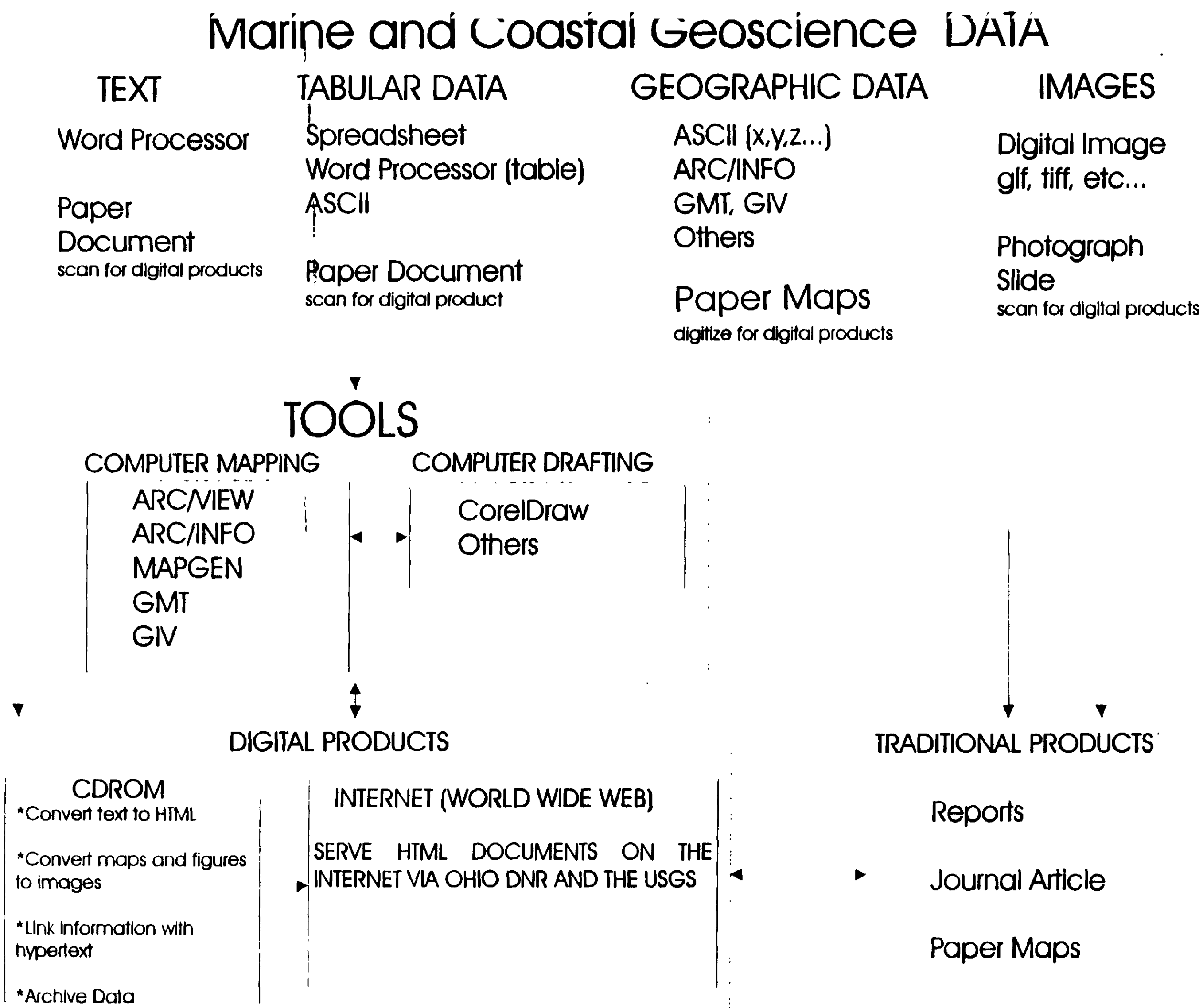

Marine and Coastal Geoscience DATA
TEXT
Word Processor
Paper Document
scan for digital products
TABULAR DATA
Spreadsheet
Word Processor (table)
ASCII
Paper Document
scan for digital product
GEOGRAPHIC DATA
ASCII (x,y,z...)
ARC/INFO
GMT, GIV
Others
Paper Maps
digitize for digital products
IMAGES
Digital Image
gif, tiff, etc...
Photograph
Slide
scan for digital products
TOOLS
COMPUTER MAPPING
ARC/VIEW
ARC/INFO
MAPGEN
GMT
GIV
COMPUTER DRAFTING
CorelDraw
Others
DIGITAL PRODUCTS
CDROM
*Convert text to HTML
*Convert maps and figures to images
*Link information with hypertext
*Archive Data
INTERNET (WORLD WIDE WEB)
SERVE HTML DOCUMENTS ON THE INTERNET VIA OHIO DNR AND THE USGS
TRADITIONAL PRODUCTS
Reports
Journal Article
Paper Maps

Figure 1

SEDIMENT TEXTURAL ANALYSES OF SHORE AND NEARSHORE SAMPLES FROM LAKE ERIE FROM THE COLLECTION OF DR. THOMAS LEWIS

Fuller, J. A.[1] and Lewis, T. L.[2]

[1]Ohio Geological Survey, Sandusky, Ohio 44870-4132
[2]Deceased, formerly at Cleveland State University, Cleveland, Ohio

The Dr. Thomas L. Lewis collection of shore and lak-bottom sediment samples, collected from both surface and subsurface, and the data resulting from their analyses, were transferred to the Ohio Geological Survey, Lake Erie Geology Group, following the death of this prominent researcher from Cleveland State University. The existence of this significant sample and data collection is herewith brought to the attention of Lake Erie researchers.

Over 200 beach and dune samples from around Lake Erie are included in the collection. Sieve analyses for each sample are available. For many of the samples, heavy minerals and/or coarse grain components have been identified. Approximately 46 beach ridge samples are also available.

Dr. Lewis carried out analyses of many samples acquired by the Ohio Geological Survey. These include about 150 sand samples from the Ohio waters between Mouse Island and Locust Point, 64 samples off Fairport Harbor, and 100 splits from vibratory cores collected throughout Ohio waters of Lake Erie and off Erie, Pennsylvania.

Much of Dr. Lewis's data is already in digital form. These data will be released on a CD-ROM once cataloguing has been completed. Location maps and nondigital data sheets will be scanned and included.

SURFICIAL SEDIMENT OF OHIO'S NEARSHORE AREA OF LAKE ERIE INTERPRETED FROM SIDESCAN-SONAR DATA

Fuller, J. A. and Liebenthal, D. L.

Lake Erie Geology Group, Division of Geological Survey, 1634 Sycamore Line, Sandusky, OH 44870-4132

During 1995, two shore-parallel transects were run 2.6 and 3.2 km from shore to supplement data collected previously as part of this study. Another line at 300 m from shore was run between Conneaut and Cleveland. The first two lines were run to help delineate the outer edges of some of the sand deposits. The line at 300 m from shore was designed to refine maps of the changes in sediment distribution since earlier data were collected. The new 730 km of trackline augmented the 840 km previously acquired.

Data were collected from the OGS Research Vessels GS-l and GS-3. A 100 kHz Klein Sidescan-Sonar System was used to collect the data and Loran-C was used for navigation.

Backscatter from the sidescan sonar records was classified into five categories that were related to sediment type (see Table 1). Based on this classification, the distribution of sediment in the Ohio nearshore is as follows: From the Pennsylvania-Ohio state border to about Fairport Harbor, and from West Cleveland to Ceylon, rock dominates the inshore area and mud or sandy mud dominates the offshore area, except near harbor mouths where typically a fillet of sand and muddy sand are associated with harbor structures. Additional video coverage of the bottom is needed to check and revise our sediment distribution map which is based mostly on sidescan data.

From Fairport Harbor to Euclid, the area is dominated by glacial deposits inshore and sand offshore. Many of the sand and sandy mud areas are probably thin veneers over till. From Euclid to West Cleveland, the bottom is mostly sand and sandy mud exposed in about equal areas. The nearshore from Ceylon to Marblehead also is dominated by recent sediments, with only small areas of glacial till or rock exposed. Muds dominate in the offshore areas whereas sandy mud and sand are most common in the higher energy areas nearshore. The short section of coast from Marblehead to Catawba is a complex of all the bottom types with none dominant. The reach from Catawba to Little Cedar Point (near Toledo) is dominated by thin, sandy mud, and mud overlying glacial till that is sparsely exposed. Nearshore profiles show that narrow sand deposits exist along much of the shore and in some areas are associated with beaches.

The depth and composition of the lake bottom offshore are important as controls of the amount of wave energy available for coastal erosion. Where rock is exposed, downcutting is slow and wave energy related to increasing water depth changes little; where glacial deposits are present downcutting is more rapid and the rate of wave energy increase nearshore is greater. Where unconsolidated sediments are accumulating, shoreline accretion is taking place. This can be transitory especially in the event of a large storm which may remove not only the recently accumulated material but underlying cohesive strata as well.

REFLECTION CHARACTERISTICS

Sediment	Sidescan Sonar	3.5 kHz Echo Sounder
Mud	Low backscatter with little reflection.	Internal reflectors with no multiples.
	With gas-high backscatter.	Strong reflection and strong multiples.
Sandy Mud	Intermediate to strong backscatter with few surface features.	Intermediate reflectors with some internal reflectors.
Sand/Silt	Intermediate backscatter with complex surface and fairly consistent reflectors.	Smooth surface with few to no internal reflectors.
Glacial Units	Intermediate to high backscatter with strong reflections and complex surface.	Many internal reflectors with rough surface, no internal reflectors, and smooth surface.
Rock	High backscatter with dark, complex reflections.	Sharp hard reflector with multiples.

Table 1. Relation of Sidescan Sonar Backscatter and Echo Sounder Reflection to Sediment Type.

CHANGES IN BEACH WIDTHS AND RECESSION RATES ALONG THE LAKE ERIE SHORELINE AT GENEVA STATE PARK

Guy, Donald E., Jr. and Goodrich, Barbara J.

Lake Erie Geology Group, Ohio Division of Geological Survey, 1634 Sycamore Line, Sandusky, OH 44870-4132

Construction in 1987 of marina breakwaters extending 185 m from shore at Geneva State Park, provided an opportunity to monitor the impact of large structures on coastal processes. To document impacts of the breakwaters, beach widths, and recession rates along 2,896 m of shore were measured using charts and aerial photographs from 1876 to 1993. Beach widths were measured in nine different years and recession rates were determined for four time periods. These data provide a basis for comparing post-construction changes with the normal range in beach width, beach distribution, and recession rates. Data collected from this imagery complement changes in nearshore bathymetry, beach width, beach elevation, and bluff recession previously documented with repetitive shore-normal profiling (Guy, Fuller, and Mackey, 1994).

A nearly continuous beach bordered Geneva State Park in all the years prior to construction of the breakwaters. Mean beach width ranged from 6.7 m in 1986 to 23.4 m in 1958 (Table 1). Maximum beach widths ranged from 20 m in 1986 to 52 m in 1954. After construction of the breakwaters, beach widths increased dramatically west (updrift) of the breakwaters and decreased east (downdrift) of the breakwaters . By 1993, the beach along 244 m of shoreline west (updrift) of the breakwaters ranged from 25- to 80-m wide, with a mean width of 41 m. In contrast, along 1341 m of shore east of the breakwater, the maximum beach width was 7.6 m and mean width was 2.8 m. In addition, four segments of shore, 30- to 305-m long, lacked a beach. In 1993, mean beach width along the entire park was 7.4 m; at comparable lake levels in 1876 and 1980, mean beach widths were 9.6 and 11.1 m, respectively.

Mean beach widths were compared for 3 segments of the park shoreline: a 1,036-m-long segment along the western shoreline, a 244-m-long segment west of the breakwaters, and a 1,341-m-long segment east of the breakwaters (Table 2). Comparison of mean beach widths for years with similar lake levels shows that beaches have decreased in width along two segments of the park, with the greatest decrease along the segment east of the breakwaters. Along the westernmost segment, post-construction mean beach width was about half pre-construction widths. Along the eastern segment, post-construction mean beach width was only 30 percent of pre-construction mean beach width.

Historically, bluff recession rates have been low (<0.6m/yr). Even during the high-water period of 1973-1986, recession rates were <1.5 m/yr. Comparison of mean and maximum recession rates for four time periods shows that for two segments of shore west of the breakwaters, recession rates increased during the first three time periods and decreased in the last (Table 3). However, along the shoreline east of the breakwaters, recession rates have increased in each successive time period, and, in the last period, rates were 33 percent higher than in any preceding period. During the 1986-1990 time period, recession rates increased dramatically downdrift of the park where maximum rates were 6.8 m/yr. During the 1990-1993 period, recession rates declined along the two western segments of the park, but increased to a maximum of 8.1 m/yr along the eastern segment.

Since construction of the breakwaters, beach width west of the breakwaters has increased, whereas beach width east of the breakwaters has decreased in response to the dramatic increase in recession rates. Thus, it is clear that these structures have affected coastal processes along this stretch of the Ohio lakeshore.

References:

Carter, C. H., Monroe, C.B., and Guy, D. E., Jr., 1986, Lake Erie shore erosion: the effect of beach width and shore protection structures: Journal of Coastal Research, v. 2, no. 1, p. 17-23.

Guy, D. E., Jr., Fuller, J. A., and Mackey, S. D., 1994, Coastal response to breakwater construction at Geneva State park, northeast Ohio [abs.]: Geological Society of America, North Central Section, Abstracts with Programs, v. 26, no. 5, p.18.

TABLE 1.- SUMMARY OF BEACH WIDTHS ALONG GENEVA STATE PARK

YEAR	1876	1938	1954	1958	1968	1973	1980	1986	1990	1993
LAKE LEVEL, m above LWD	1.13	0.49	0.90	0.33	0.73	1.43	1.16	1.45	0.88	1.21
MEAN BEACH WIDTHS, m										
Entire park	9.6	21.3	16.4	23.4	14.5	8.6	11.1	6.7	10.5	7.4
Western shoreline of park	8.3	23.6	14.8	20.0	12.3	8.9	7.9	4.4	7.0	4.7
Shoreline just west of breakwaters	15.2	6.1	12.9	23.2	9.1	3.6	13.4	11.5	42.2	41.3
Shoreline east of breakwaters	9.4	22.9	18.4	26.1	17.3	9.3	13.1	7.4	6.8	2.8
MAXIMUM BEACH WIDTHS, m										
Entire park	18.3	36.6	51.8	42.7	36.6	33.5	33.5	19.8	61.0	64.0
Western shoreline of park	12.2	36.6	25.9	32.0	35.1	18.3	19.8	15.2	24.4	13.7
Shoreline just west of breakwaters	18.3	6.1	30.5	35.1	24.4	6.1	15.2	15.2	61.0	64.0
Shoreline east of breakwaters	18.3	36.6	51.8	42.7	36.6	33.5	33.5	19.8	21.3	7.6

Western shoreline: 91-m transects 445-455 and 30-m transects 1376-1410
Shoreline just west of breakwater: 91-m transects 442-444 and 30-m transects 1367-1375
Shoreline east of breakwater: 91-m transects 426 439 and 30-m transects 1315-1359
Beach widths for 1876 and 1938 were measured at 91-m intervals and are from Carter, Monroe, and Guy, 1986.

TABLE 2.-COMPARISON OF MEAN BEACH WIDTHS ALONG GENEVA STATE PARK

MEAN BEACH WIDTH, m							
Year	1876	1980	1993	1973	1986	1954	1990
Lake level, m above LWD	1.13	1.16	1.21	1.43	1.45	0.90	0.88
Entire park shoreline	9.6	11.1	7.4	8.6	6.7	16.4	10.5
Western shoreline of park	8.3	7.9	4.7	8.9	4.4	14.8	7.0
Shoreline just west of breakwaters	15.2	13.4	41.3	3.6	11.5	12.9	42.2
Shoreline east of breakwaters	9.4	13.1	2.8	9.3	7.4	18.4	6.8

TABLE 3.- COMPARISON OF RECESSION RATES ALONG GENEVA STATE PARK

		Western shoreline of park	Shoreline just west of breakwaters	Shoreline east of breakwaters
MEAN	1876-1973	0.04	0.33	0.05
RECESSION	1973-1986	0.28	0.25	0.47
RATE	1986-1990	0.48	0.72	0.92
m/yr	1990-1993	0.23	0.00	1.23
MAXIMUM	1876-1973	0.14	0.41	0.23
RECESSION	1973-1986	1.47	0.33	1.24
RATE	1986-1990	2.21	2.73	6.79
m/yr	1990-1993	2.06	0.00	8.08

Western shoreline of park: transects 1376-1408
Shoreline just west of breakwaters: transects 1367-1375
Shoreline east of breakwaters: transects 1324-1359

CORRELATION OF RECESSION RATES AND RECESSION-RATE VARIABLES AT TWO SITES ON LAKE ERIE

Guy, Donald E., Jr.

Lake Erie Geology Group, Ohio Division of Geological Survey, 1634 Sycamore Line, Sandusky, Ohio 44870-4132

Measurements of coastal recession at Helen Drive in Lorain County and at Painesville-on-the-Lake in Lake County are being correlated against a number of natural and anthropogenic variables. The former include lake level, storm surge, wave energy, wave direction, beach width, bedrock elevation, ice, freeze, thaw, and precipitation; the latter include shore protection and alteration of the ground-water system.

Recession measurements at Helen Drive were made at the toe of a 10-m-high bluff composed of till and glaciolacustrine sediment. These measurements were made at approximately biweekly intervals in 1976 by Carter and Guy (1988). Their study correlated erosion with maximum water level, storm surge, storm duration, and beach width, and identified a threshold water level and threshold storm surge necessary for erosion. This study attempts to correlate these data with wave data hindcast by Hubertz and others (1991).

Recession of the 15-m-high till bluff at Painesville-on-the-Lake can be documented for 117 years using historical charts and aerial photographs. From 1968 to the present, aerial photography was taken at least every five years; this imagery has been used to document recession for relatively short time intervals. Analysis is currently underway to determine how recession during these short time intervals was affected by natural and anthropogenic variables.

References:

Carter, C. H., and Guy, D. E., Jr., 1988, Coastal erosion: processes, timing, and magnitudes at the bluff toe: Marine Geology, v. 84, p. 1-17.

Hubertz, J. M., Driver, D. B., and Reinhard, R. D., 1991, Wind waves on the Great Lakes: a 32 year hindcast: Journal of Coastal Research, v. 7, no. 4, p. 945-1219.

DISTRIBUTION OF NEARSHORE SEDIMENT AND NEARSHORE BARS, ASHTABULA COUNTY, OHIO

Guy, Donald E. Jr.

Lake Erie Geology Group, Division of Geological Survey, 1634 Sycamore Line, Sandusky, Ohio 44870-4132

Distribution of nearshore sediment and nearshore bars along 43 km of the Ohio lakeshore was mapped using data from 20 shore-normal bathymetric profiles run in August and September 1995. The profiles are 1-2 km apart along the shore of most of Ashtabula County, and they extend 1 km offshore to a water depth of 7-9 m. All of the profiles are tied to benchmarks established and used by the U. S. Lake Survey for profiling in the late 1940's. Horizontal and vertical control for the surveys was maintained with a geodimeter, and bathymetric data were collected with a recording echosounder operated from a small boat. Temporal changes in distribution of sediment and nearshore bars were mapped by comparing 1995 data with data collected along the same profiles in 1974 (Carter and Guy, 1983).

Two principal map units-sand/gravel and shale-were identified on the bathymetric records based upon differences in acoustic reflectance. Observations made during the profiling in 1995 and divers' observations in 1974 aided in the interpretation of the records.

Deposits of sand or gravel are typically thin and extend <200 m offshore before pinching out on shale bedrock. Exceptions occur updrift (west) of the harbor structures at Ashtabula and Conneaut where sand extends nearly 1000 m offshore. Nearshore bars occur along two of the profiles. One profile had one nearshore bar and one profile had two nearshore bars (Table 1).

Data collected in 1995 show that nearshore deposits of sand are thin and that sand extends only about half as far offshore as it did in 1974. In addition, the number of sand bars has decreased. These data suggest that the total volume of sand along the Ashtabula County shoreline has decreased over the past 21 years.

References:

Carter, C. H., and Guy, D. E., Jr, 1983, Lake Erie shore erosion, Ashtabula County, Ohio: setting, processes, and recession rates from 1876 to 1973: Ohio Division of Geological Survey Report of Investigations122, 107 p.

TABLE 1. NEARSHORE BARS--ASHTABULA COUNTY

	1974		1995	
PROFILE	DISTANCE FROM SHORELINE TO BAR CREST (M)	BAR DEFINITION*	DISTANCE FROM SHORELINE TO BAR CREST(M)	BAR DEFINITION*
VII-6	46	moderate		
VII-9	91	moderate	128	poor
VII-16	152	poor		
VII-22	46	poor		
VII-25	122	moderate		
VII-28	46	good	37	poor
	137	moderate	98	moderate
V-22	152	poor		

* poor, 0.3-0.6 m relief; moderate, 0.9-1.2 m relief; good, >1.5 m relief

SHALLOW DRAFT VESSEL AND EQUIPMENT FOR COLLECTION OF NEARSHORE SIDESCAN SONAR DATA

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As part of the Ohio Geological Survey and U.S. Geological Survey Cooperative study of Lake Erie, we designed and constructed an 8-m vessel to survey critical shallow-water areas. Principal considerations that went into the design included: shallow draft for nearshore and riverine operations, a protected cabin with adequate space for sidescan sonar, single-channel seismic, echo sounding, and navigation equipment, and a 110-volt generator. The boat also had to be easily trailerable. Especially important was a cantilevered boom on the bow from which to deploy the sidescan sonar fish. Over 110 km of high quality sidescan sonar data have now been acquired successfully from this vehicle in waters as shallow as 0.5 m.

LAKE ERIE RECESSION DATABASE DEVELOPMENT-AN UPDATE

Mackey, Scudder

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Recession rates have been calculated along digital shore-normal transects spaced at 30-m (100-ft) intervals for the entire Ohio Lake Erie coastline for the following time periods: Long-term: 1877-1973; short-term: 1973 to 1990; and total: 1877 to 1990. Additional geologic data have been acquired for each of these transects including: beach width, bluff height, shoreline orientation (azimuth), bluff slope angle, bedrock elevation, extent of offshore sand cover, nearshore slope (to the 2-m or 6-ft isobath), and offshore slope (to the 4-m or 12-ft isobath), and type of shore protection. Beach widths, bluff slope angles, and type of shore protection were determined from 1990 aerial photography. Bedrock elevation and stratigraphic data were acquired from revised coastal cross-sections (Pavey and Stone, this volume). The extent of offshore sand was determined from offshore profile data collected in 1973. Bluff height and nearshore and offshore slopes were determined from USGS 7.5-minute quadrangle map sheets, measured sections, and Ohio Geological Survey coastal cross-sections. These data have been integrated into a comprehensive database tied to each of our shore-normal digital transects. However, portions of this data set are temporally incompatible. For example, shore protection present only in 1990 photography does not affect recession rates calculated for the time period between 1877 to 1973. Where available, additional data on beach width, nearshore and offshore slope, extent of offshore sand, and type of shore protection are being collected for appropriate time intervals to eliminate temporal incompatibilities, Moreover, the shore-normal transects are not referenced geographically. Control points and reference transects for each aerial photograph are being digitized and geographically referenced. These data will be incorporated into a comprehensive database and merged with existing ARC-INFO coverage for the south shore of Lake Erie.

RELATIONSHIP BETWEEN SEDIMENT SUPPLY, BARRIER SYSTEMS, AND WETLAND LOSS IN THE WESTERN BASIN OF LAKE ERIE-A CONCEPTUAL MODEL

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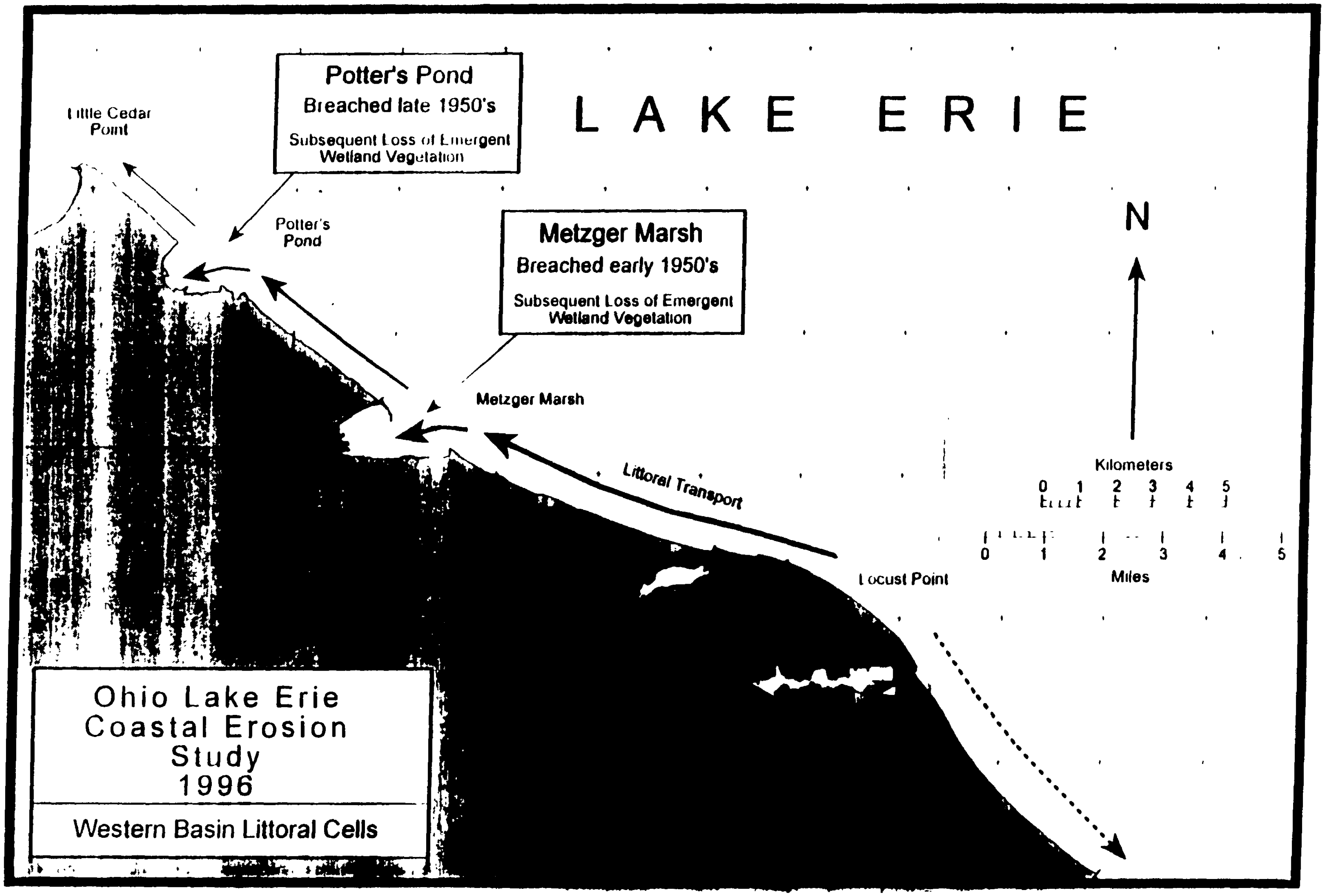
A conceptual model has been constructed to explain the loss of barrier beaches and adjacent wetlands in the Western Basin of Lake Erie. The dominant direction of littoral transport is to the west from the area of Locust Point to Little Cedar Point (Figure 1). Reduction in available sediment supply, rising lake level, and severe storm activity in the late 1940's and early 1950's caused a reduction in barrier width and breaching of the barrier at Metzger Marsh. Loss of the Metzger Marsh barrier resulted in rapid erosion of wetland deposits within the marsh and created a "sand sink" due to deposition of littoral sand diverted into the embayment. The littoral cell from Locust Point to Little Cedar Point was then segmented into two littoral cells (Figure 1). The dramatic reduction in available sediment supply to the western cell resulted in a reduction of barrier width and eventual breaching of the barrier at Potter's Pond in the late 1950's (Figure 2). During this time, lake levels were falling from the record high in 1956. Loss of the barrier at Potter's Pond resulted in rapid erosion of wetland deposits, subsequent deposition of littoral sand diverted into the embayment, and further segmentation of the Locust Point to Little Cedar Point littoral cell into three separate cells (Figure 1). The progressive loss of barrier beaches and adjacent coastal wetlands in the western basin of Lake Erie can be attributed to the progressive segmentation of the Locust Point to Little Cedar Point littoral cell. Littoral cell segmentation has had an unforeseen long-term impact on these barrier systems and adjacent coastal wetlands.



Little Cedar Point
Potter's Pond
Breached late 1950's
Subsequent Loss of Emergent Wetland Vegetation
LAKE ERIE
Potter's Pond
Metzger Marsh
Breached early 1950's
Subsequent Loss of Emergent Wetland Vegetation
N
Metzger Marsh
Littoral Transport
Kilometers
0 1 2 3 4 5
0 1 2 3 4 5
Miles
Locust Point
Ohio Lake Erie Coastal Erosion Study 1996
Western Basin Littoral Cells

Figure 1

Potter's Pond

Loss of Protective Barrier and Subsequent Destruction of Emergent Wetland Habitat

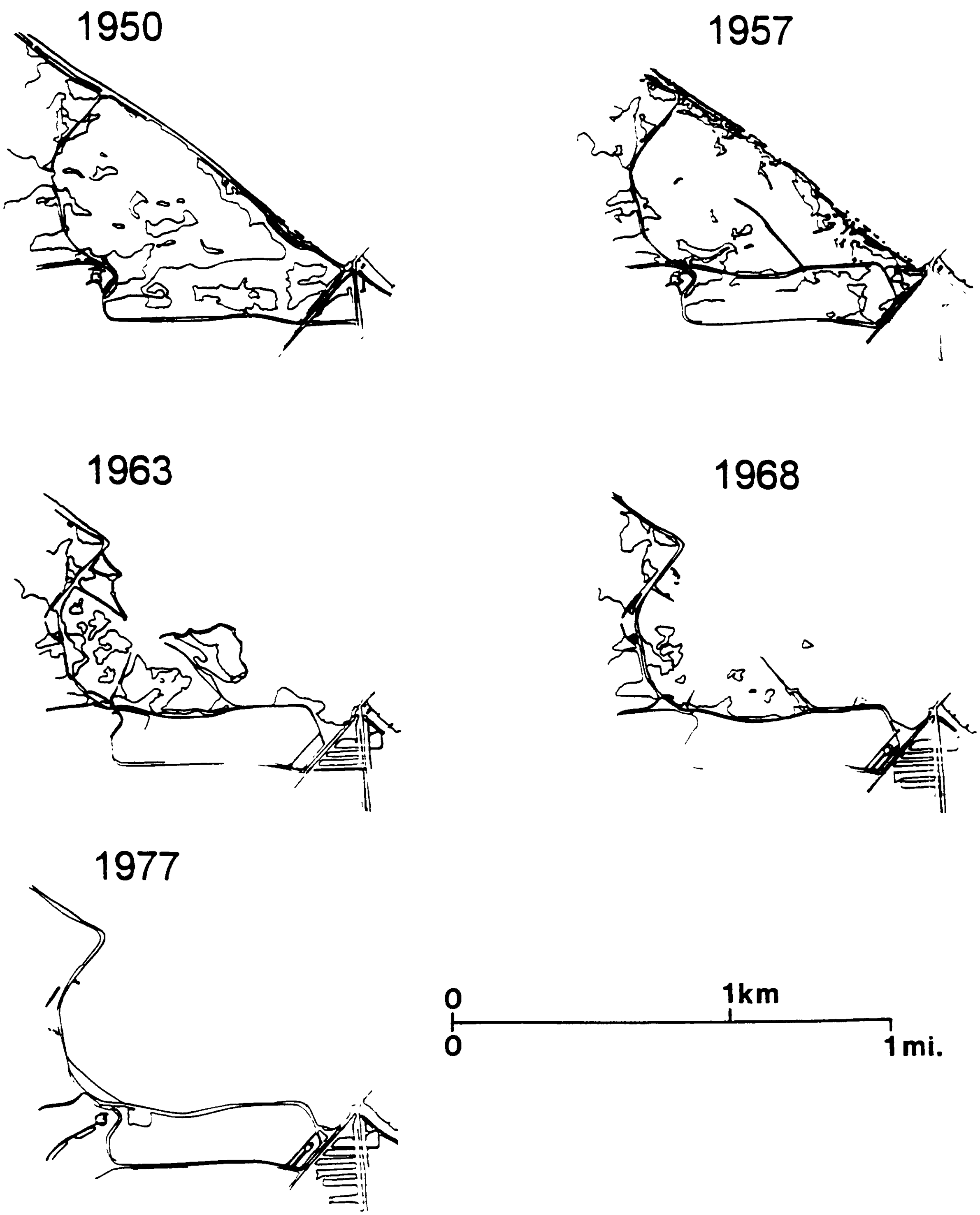


Figure 2

Ohio Lake Erie Coastal Erosion Study
1996

MULTIVARIATE RECESSION FACTOR ANALYSIS--
ASHTABULA AND LAKE COUNTIES, OHIO

Mackey, Scudder D., and Breay, Carlton, J.

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Multivariate analyses have been used to determine the relative contribution and statistical importance of geological factors to long- and short-term recession rates in both protected and unprotected areas (Table 1). For the entire reach of the coastline (both protected and unprotected combined), long-term recession rates can be most accurately predicted using an expression that combines bluff height, shoreline orientation, bedrock elevation, extent of offshore sand cover, and the nearshore slope (Regression factor [R] value of 0.55; see Table 1). Short-term recession rates are most accurately predicted by an expression that incorporates beach width, bluff height, and nearshore slope (R value of 0.27). For unprotected reaches of the coastline, long-term recession rates can be most accurately predicted using an expression that combines shoreline orientation, bluff slope angle, bedrock elevation, and extent of offshore sand cover (R value of 0.37). Short-term recession rates are most accurately predicted by an expression that incorporates beach width, bluff slope angle, and bedrock elevation (R value of 0.42). In general, long-term rates are influenced primarily by shoreline orientation and bedrock elevation; short-term rates are influenced primarily by beach width along both protected and unprotected reaches of the coastline. These analysis are *preliminary* as the data sets may not be temporally compatible. However, we hypothesize that long-term recession is related to the fundamental, stable, physical parameters of the Ohio coastline, such as shoreline orientation, bluff composition, and bedrock elevation (relative to lake level), while short-term recession is related to more ephemeral factors, such as changing beach width, storm severity and direction, and lake levels. Additional data on beach width, nearshore and offshore slope, extent of offshore sand and type of shore protection are being collected for equivalent time intervals for which we have recession data to test this hypothesis.

TABLE 1

Recession Factors – Ashtabula and Lake Counties, Ohio
Mulitvariate Statistical Analyses

Regression Coefficients and Statistical Significance*

	Protected & Unprotected		Unprotected Only	
	Long Term	Short Term	Long Term	Short Term
Beach Width	**+0.002**	**-0.007**	**-0.001**	**-0.006**
Bluff Height	**+0.021**	**+0.025**	**-0.001**	**+0.003**
Shoreline Orientation	**-0.002**	**-0.007**	**-0.002**	**+0.001**
Bluff Slope Angle	**+0.002**	**+0.002**	**-0.001**	**-0.002**
Bedrock Elevation	**-0.039**	**-0.022**	**+0.001**	**+0.002**
Offshore Sand Extent	**+0.001**	**0.000**	**+0.001**	**0.000**
Nearshore Slope	**-0.170**	**-0.295**	**-0.028**	**-0.091**
Offshore Slope	**-0.198**	**-0.207**	**+0.144**	**+0.040**
R	0.55	0.27	0.37	0.42

	Protected & Unprotected		Unprotected Only	
	Long Term	Short Term	Long Term	Short Term
Beach Width		X		X
Bluff Height	X	X		
Shoreline Orientation	X		X	
Bluff Slope Angle			X	X
Bedrock Elevation	X		X	X
Offshore Sand Extent	X		X	
Nearshore Slope	X	X		
Offshore Slope				

* X denotes statistical significance -- P-values less than 0.05, typically less than 0.0001.

Note: Beach widths and bluff slope angles determined from 1990 aerial photography. Offshore sand extent determined from offshore profile data collected in 1973. Bluff height and nearshore and offshore slopes determined from USGS 7.5' Quad sheets, measured sections, and Ohio Geological Survey coastal cross-sections.

GEOLOGICAL FACTORS AND RECESSION RATE-ASHTABULA AND LAKE COUNTIES, OHIO

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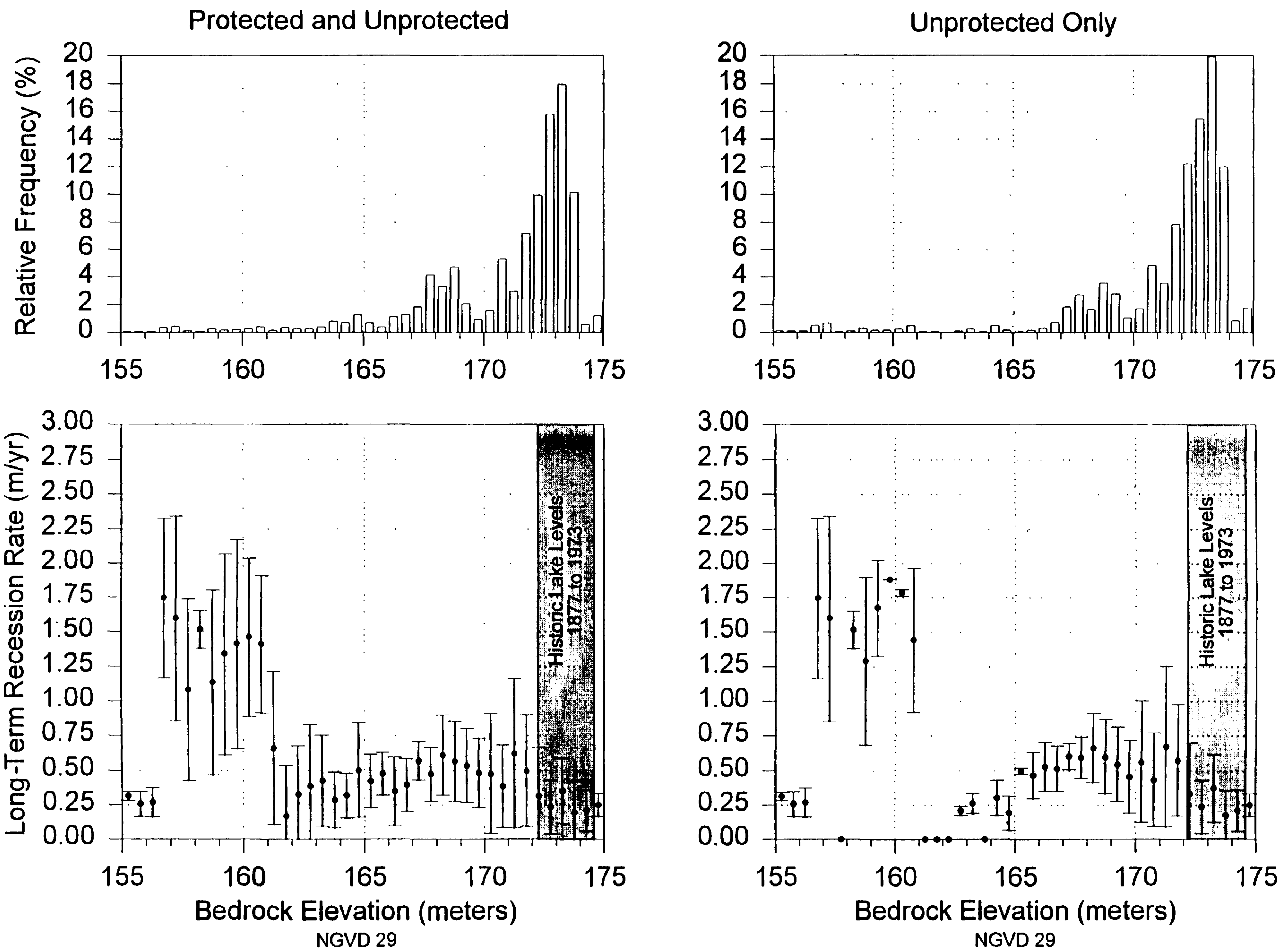
Using multivariate analyses as a guide (Mackey and Breay, this volume), relationships between selected geological factors and recession rate were examined in more detail by creating bivariate statistical plots of selected geological factors and recession rates. The following procedure was used: data from transects with independent and dependent data pairs for the appropriate independent variable were selected from the combined data set. Histogram plots were then generated showing the overall frequency distribution for each independent variable. Equivalent long- and short-term recession data were also isolated for each class interval during this process. Recession statistics were then calculated for each class interval and the mean and standard deviation (as an error bar) were plotted against the independent variable to assess general trends for protected and unprotected areas (combined) and unprotected areas of the coastline (see examples, Figure 1-3). The minimum number of data points used for these calculations is 1118.

Long-term recession rates have been reduced by at least 50% in areas where bedrock elevation is within the range of historic lake levels (Figure 1) for both protected and unprotected areas of the coastline. In areas where bedrock is about 2 m below historic lake levels, and long-term recession rates are lower, the number of data points are few, and other factors, such as shoreline orientation, impact long-term recession rates. Long-term recession rates decrease dramatically as shoreline orientation changes from a western exposure to an eastern exposure (Figure 2). This is not surprising given the southwest-to-northeast prevailing wind direction and Lake Erie's long fetch. The impact of shore protection can also be seen in these plots-a reduction in recession rate of 0.2 and 0.3 m/yr is evident between the combined and unprotected plots. Short-term recession rates decrease dramatically with increasing beach width (Figure 3). Wide beaches absorb wave energy and protect the toe of the bluff from erosion. A significant drop in recession rate occurs where beaches are >6 m wide and again where beaches are between 26 and 32 m wide. Short-term recession rates are reduced by 75% in areas where beaches are >30 m wide.

Bedrock Elevation vs Long-Term Recession Rate



Shoreline Orientation vs Long-Term Recession Rate

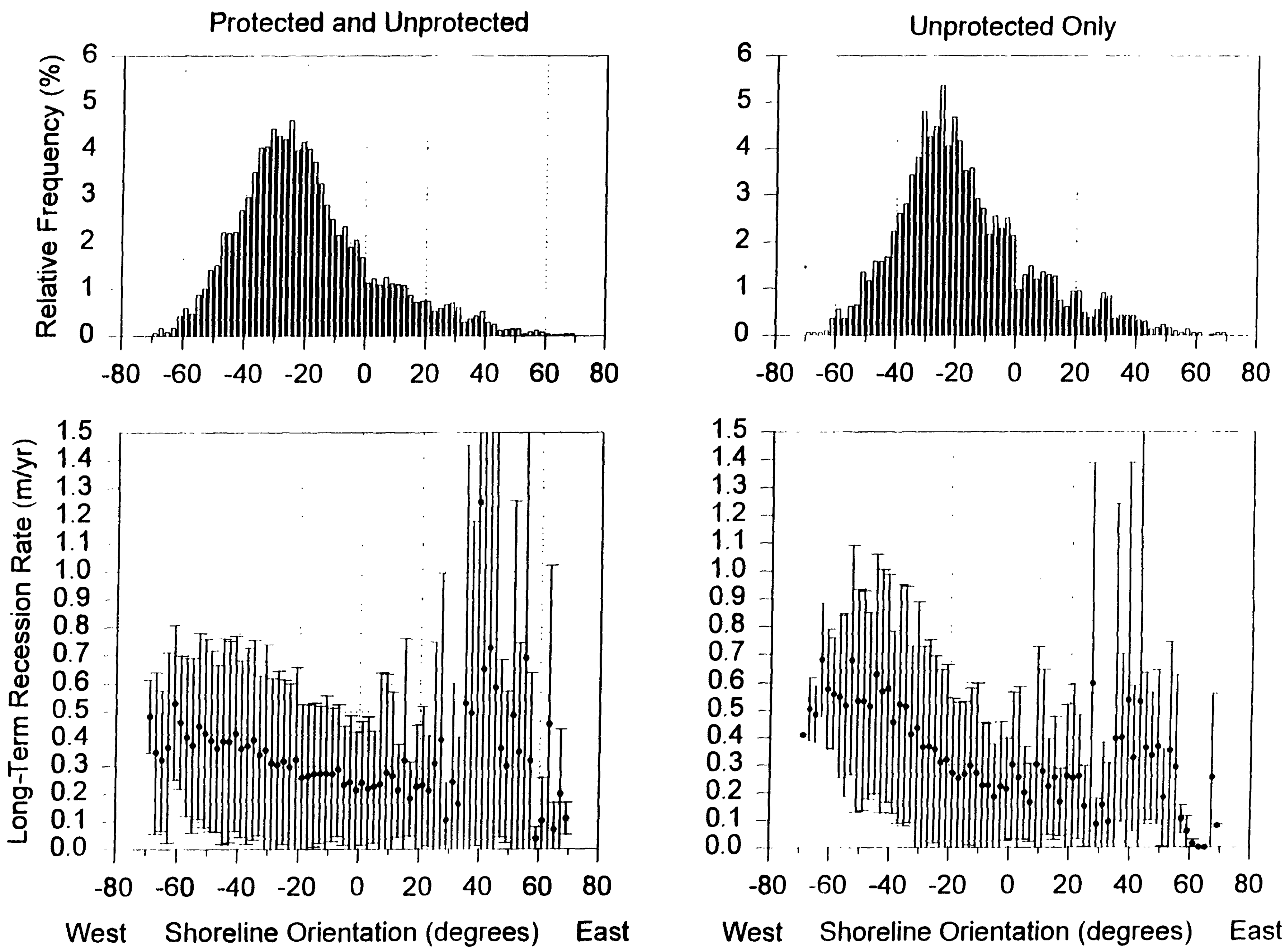


Figure 2

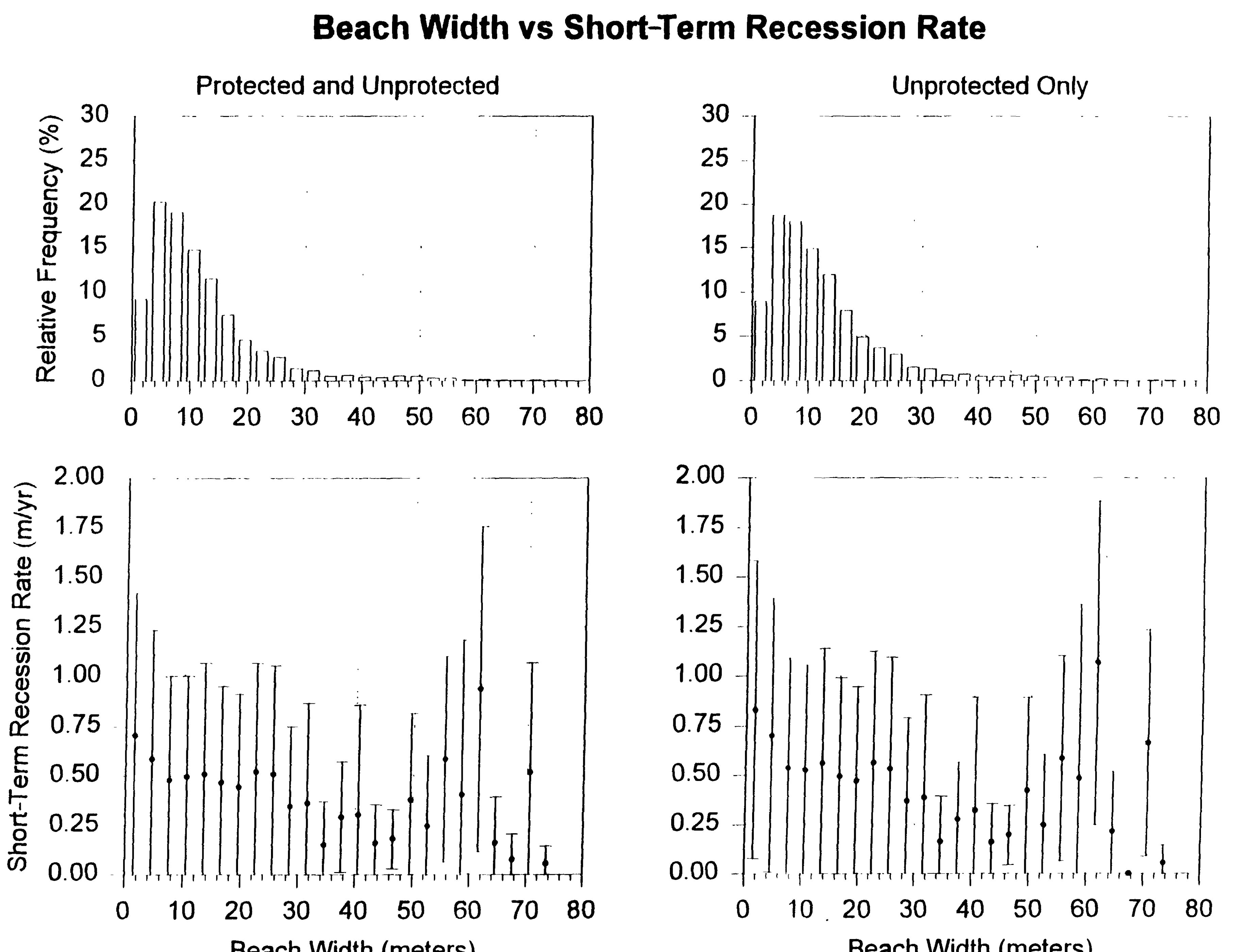

Beach Width vs Short-Term Recession Rate
Protected and Unprotected
Unprotected Only
Relative Frequency (%)
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
Short-Term Recession Rate (m/yr)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Beach Width (meters)
Beach Width (meters)

Figure 3

LAKE ERIE RECESSION-LINE MAPPING-AN UPDATE

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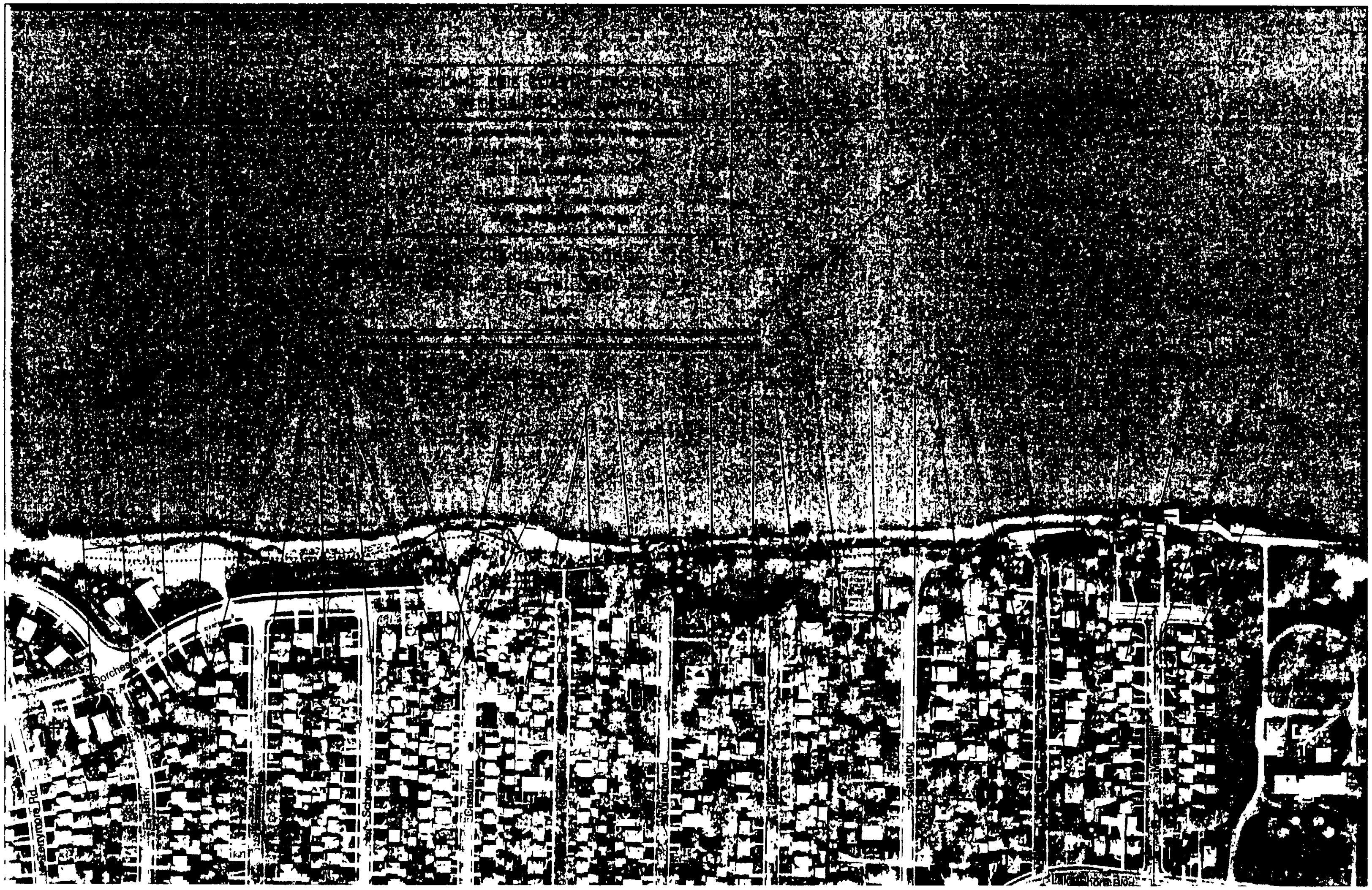
Recession-line mapping has been completed for the entire Ohio Lake Erie coastline for the years 1876-77, 1973, and 1990. Recession lines have been plotted on 1:2,400 scale base maps enlarged from 1:12,000 aerial photography acquired in 1990. Recession rates have been calculated along digital shore-normal transects spaced at 30-m (100-ft) intervals for the entire Ohio Lake Erie coastline (Mackey and Guy, 1994).

Each of 460 aerial-photographic map frames will be produced illustrating digital transect locations and the location of the 1876-77, 1973, and 1990 bluff recession lines (Figure 1). Recession-rate data for each frame will also be printed on the back of each frame (Table 1). These maps will be produced at a nominal scale of 1:4,800 and bound together in geographic order from east to west for each Ohio coastal county. A statistical summary of long-term, short-term, and total recession rates will be included for the entire Ohio Lake Erie coastline, for the Central and Western Basins, and for each Ohio county. These maps and data form the core of our recession data set for the Ohio Lake Erie coastline.

References:

Mackey, S. D. and Guy, D. E., Jr., 1994, A different approach to mapping coastal recession-combining the old with the new [abs.]: Abstracts with Programs Geological Society of America, North Central Meeting, Kalamazoo, MI, v.26, no. 5, p. 52.

Prepared in cooperation with the
OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY
and the
DEPARTMENT OF THE INTERIOR, U.S. GEOLOGICAL SURVEY



Base photo 1990
Page XXX

OHIO LAKE ERIE COASTAL EROSION STUDY
RECESSION - LINE MAPPING OF CUYAHOGA CO.

Open-File Report 96-XXX
CUY 380

Figure 1

OHIO LAKE ERIE COASTAL EROSION STUDY
RECESSION - LINE MAPPING

Map Key - 1996 Mapping

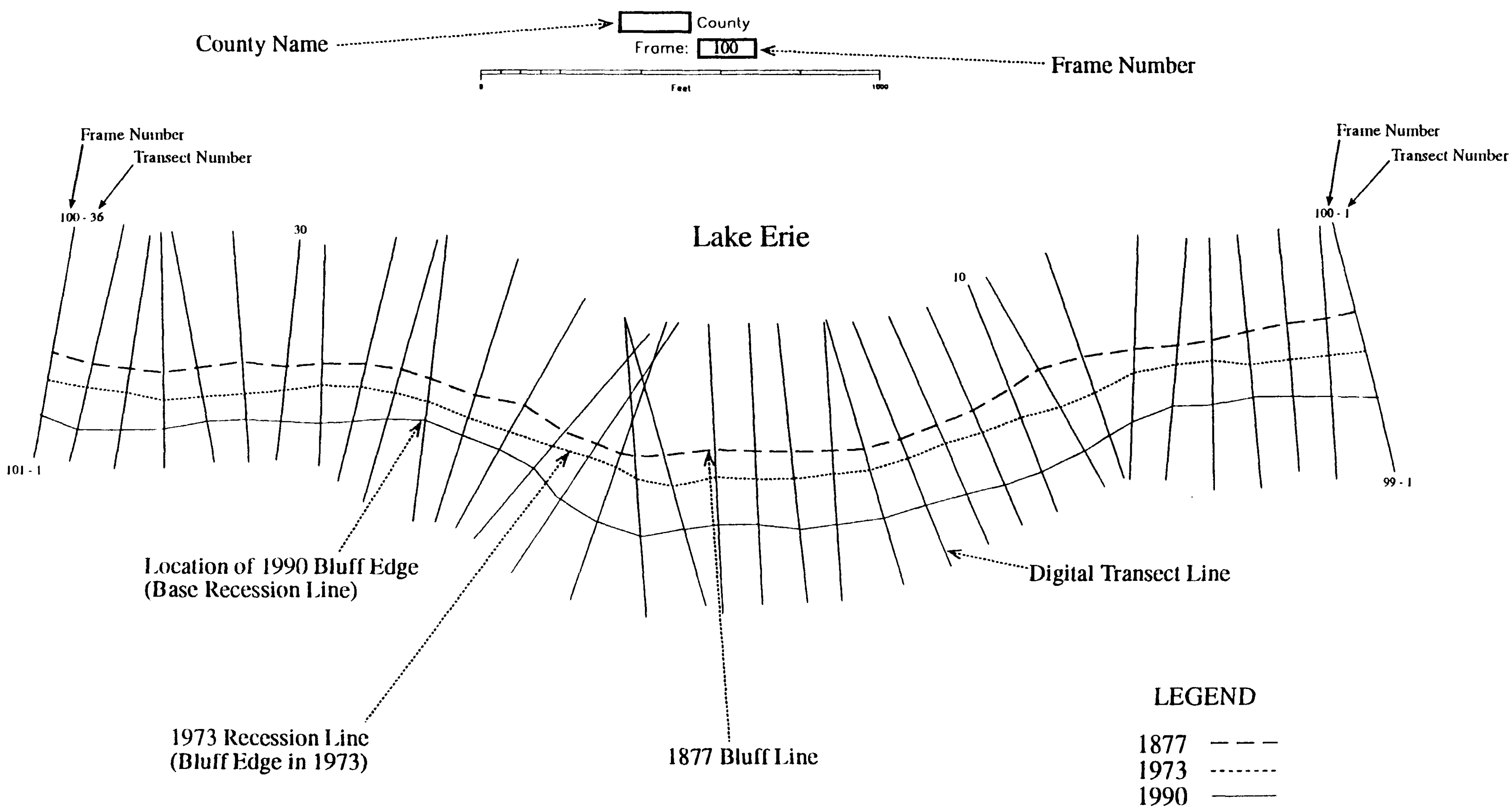


TABLE 1

SURFICIAL MATERIALS, BEDROCK SURFACE TOPOGRAPHY, AND COASTAL EROSION IN THE EASTERN HALF OF THE LAKE ERIE COASTAL AREA, LORAIN, CUYAHOGA, LAKE, AND ASHTABULA COUNTIES, OHIO

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A preliminary map (1:100,000 scale) of surficial earth materials in the coastal area, from 82 degrees W longitude eastward to the Pennsylvania line, modifies previous work (White and Totten, 1979; Reeder and others, 1973; Ford, 1975) by showing the distribution of surface deposits based on detailed soils maps, new aerial photography, and new field reconnaissance.

Bedrock-surface contours are revised with new water-well, oil-and-gas well, and highway test-boring data. Mapping of areas of bedrock in shallow, nearshore areas by Fuller (1995) further expands the coverage of rock-surface topography. The accompanying coast-parallel geologic section, 1:50,000 scale with 40x vertical exaggeration, shows materials in the shoreline bluff extending below lake level to the bedrock surface. The line of section is referenced to the 1990 top-of-bluff recession line with 30-m transect spacing (Guy and others, 1995), and the topography shown on 7.5-minute maps. Stratigraphic relations of materials in the bluffs are based on more than 200 (95 in Ashtabula County) measured sections, borings, or wells from previous and new field studies, all of which are adjusted to the present bluff.

Bedrock in the coastal area is Ohio Shale and is above lake level along the coast in the western part of the area where the rock forms high shoreline headlands at Avon Lake (189 m altitude), Bay Village (191 m), and Lakewood (195 m). From the

western boundary to the Cuyahoga River, the wave-planed rock surface forms a platform, up to 1.6 km wide, in the nearshore area. In the Cuyahoga River valley, rock lies about 55 m below lake level at an altitude just below 122 m, as shown by a high-amplitude, fairly continuous nearshore seismic reflector that extends to offshore rock outcrops in the east.

East of Cleveland, the glacially eroded rock surface, which is overlain by the Ashtabula Till, forms broad lows at the shoreline near the present Chagrin River (155 m), Grand River (161 m), Mentor Headlands (157 m), and Geneva-on-the-Lake (169 m). Subsurface data indicate that streams have incised the bedrock surface at Indian Creek (173 m - 0.76 m incision), Ashtabula River (163 m inferred, 9.7 m incision), and Conneaut Creek (167 m, 5.5 m incision). Rock exposure at Geneva-on-the-Lake has been widened by shoreline erosion since previous geologic studies in the 1960's. To the east, the rock surface is inferred to be at 172-174 m altitude, just below lake level, except at West Conneaut and Turkey Creek where it is above lake level. East of Cleveland, the onshore rock surface rises gently (1.8-3.6 m/km) to the south as a planar feature 1.6 to 5 km wide. This planar bedrock surface predates deposition of the Ashtabula Till and may record lake-erosion bevelling during the Erie Interstade or older shoreline transgressions.

Compact, calcareous, clayey till (equivalent to the Hiram and Hayesville Tills of adjacent areas), overlies the shale in the bluffs along the shoreline in eastern Lorain and western Cuyahoga Counties. The clayey till is generally homogeneous, containing 9-18% sand in the matrix, has subhorizontal fissility, and has moderate to high dry strength. The till is commonly < 5 m thick and is inferred to be mostly a basal lodgement facies.

The Ashtabula Till underlies the 15-m- to 21-m-high, near-vertical and slump-faced shoreline bluffs in the eastern part of the area. Two subtly contrasting facies of the Ashtabula Till are superposed along the bluff. The basal facies is a compact, homogeneous deposit with a clayey silt matrix and scattered pebbles, cobbles, and very few small boulders. The basal till facies has a matrix sand content that varies from 18.8 percent in the eastern part of the area to 13.7 percent in the western part. Silt content of the till matrix ranges from 53.9 percent to 46.7 percent from east to west. Similarly, clay content ranges from 29.8 to 35.9 percent. The deposit contains 4-10 percent small pebbles by volume, mostly composed of soft gray shale and siltstone.

The overlying facies is compact and has a clayey silt matrix but characteristically contains elongate lenses of microlaminated to thin-bedded clay, silt, fine sand, and some gravel. The upper till facies has an mean matrix sand content of 12.9 percent (0.7-49.7 percent range), mean silt content of 63.1 percent (34.7-94.6 percent range), and mean clay content of 24.0 percent (3.8-51.2 percent range). Most sections comprise <10% discontinuous lenses or blocks of sheared, stratified fine sand, silt, and clay. Grain-size analysis indicates mixing of silt-rich materials in the matrix (95.6 percent silt) of some zones within the till.

Extensive surface deposits of sand and gravel cover the coastal till deposits in areas east of major stream valleys. These deposits include thin eolian sand dunes at the land surface and shoreline beach and foreshore deposits. The gravelly sand deposits east of North Kingsville, at Redbird, and in east Cleveland appear to be late Wisconsinan-age deltaic and contemporaneous shoreline deposits related to sediment sources of the ancestral streams in the nearby river valleys. Typically, these deposits consist of upward-coarsening sequences of sand, silt, and clay, ranging in total thickness from 4 m to <1 m. Ripples in the fine sand indicate eastward paleocurrents, presumably related to longshore transport from the mouths of the ancestral streams. Lower and younger shoreline deposits and associated erosional features truncate some of these deltaic deposits.

The glacial erosional history of the area is related chiefly to Illinoian and late Wisconsinan glaciations which deepened the Erie basin, removed earlier surficial deposits in the coastal area, and produced a smoothed bedrock surface. Shoreline erosion processes produced planed-rock surfaces in the coastal area, possibly after the Illinoian ice recession, during late-Wisconsinan ice-margin recession, and during the Erie Interstade. Within the last 2000 years, wave erosion has produced the wide planed-rock surface that lies immediately offshore of the present lake bluffs. The depositional history of surficial sediments in the area is related to persistence of late Pleistocene glacial lakes in the Erie basin. The Ashtabula Till facies record a continuous depositional sequence from advance of ice into the basin to meltout sedimentation in the deep glacial lake. Final ice recession from the area was followed closely by progradational sedimentation of coastal deposits in a series of lowering lakes in the basin that persisted during deglaciation of the Erie-Ontario region.

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Fuller, J. A., Circe, R. C., and Oldale, R. N., 1995, The geologic framework of the Ohio area of Lake Erie: U.S. Geological Survey Open File Report 95-220, 17 p.

Guy, D. E. Jr., 1995, Distribution of nearshore sediment and nearshore bars, Lake County, Ohio, *in* Folger, David W., ed., 3rd Annual Lake Erie Coastal Erosion Workshop: U.S. Geological Survey Open-File Report 95-224, p. 20-23.

Reeder, Neil E., Riemenschneider, Victor L., Reese, Paul W., 1973, Soil Survey of Ashtabula County, Ohio: U.S. Department of Agriculture Soil Conservation Service and Ohio Division of Lands and Soils, 114 p.

White, George W., and Totten, Stanley M., 1979, Glacial geology of Ashtabula County, Ohio: Ohio Division of Geological Survey Report of Investigations 112, 52 p.

MULTIPLE ORIGINS FOR DARK BANDS ON OFFSHORE SIDESCAN SONAR RECORDS, CENTRAL BASIN OF LAKE ERIE

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A cooperative project between the Perkins High School Science Department of Sandusky, Ohio, the Ohio Geological Survey (Lake Erie Geology Group), and the U.S. Geological Survey (Coastal Research Program) studied the orientation, width, depth, and distribution of dark linear features on the lake bottom that were recorded on sidescan sonar records collected along 925 km of trackline in Ohio's part of Lake Erie.

Three possible origins for the bands are: (1) disruption of bottom sediments by propeller wash from the heavy ship traffic in the area; (2) natural gas seepage along linear joints from the rocks underlying the modern, lacustrine bottom sediments; and (3) furrows cut into the bottom sediments by grounded keels of ice flows.

No relation is apparent between water depth and the distribution of the bands. Because some extend into shallow water and others are not concentrated specifically in the shipping lanes, we eliminated the ship hypothesis as their principal cause. However, we cannot eliminate it as a possible cause for those in appropriate water depths and orientations.

The orientation of the bands fall into two groups. One lies at 71^{o} and one at 106^{o}. Regional joint patterns in the Ohio Shale bedrock lie at 51^{o} and 141^{o}, and in the Columbus Limestone at 60^{o} and 85^{o}. Thus the orientation of the dark bands does not match well with the orientation of the bedrock joints. However, joint orientation of the tills that lie between the bedrock and the modern lacustrine sediments has not been adequately documented to rule out a correlation with the dark bands.

The 71^{o} orientation nearly parallels the major axis of the lake and also the prevailing SW wind direction. This supports the suggestion that the band orientation may be associated with wind-driven ice flows dragging their keels through the bottom sediments. In a few locations, features that resemble furrows can be seen on the sidescan sonar records. Similar features on nearshore sidescan sonar records show bends in the furrows and discontinuous marks that can be related to ice grounding.

Bands first noted on sidescan records in September 1991 were found in August and September 1992 at the same locations. Their similarity suggests that some of the bands are stable at least over a year or can be regenerated at the same location.

This temporal stability of some of the bands suggests that a problem exists for an ice-scour origin for all the bands. Storms should destroy evidence of the ice scour and it is unlikely that ice would scour the same area in exactly the same orientation year after year. Because the distribution of dark bands seems to be unrelated to water depth and they have this temporal stability, ice as their only cause seems unlikely.

SCUBA dives on two of the wide bands verified that the occurrence of the acoustically hard returns were from areas of a soft mud bottom with no hard physical surfaces and no visible furrowing. Two possible explanations are that the mud is being suspended by an upwelling of ground water with significantly different temperature (not noted during SCUBA dives) or that microscopic gas bubbles are entrained in the mud. If the latter is the case the question remains as to the source of the gas, from the underlying Paleozoic rocks or from the modern sediments themselves.

Evidence of "bright spots" on subbottom records below many of the bands suggests that gas accumulations occur in the shallow sediments. This could explain the apparent stability of the dark bands in muds where such features should be destroyed by each major storm event and are simply regenerated by gas seeping from the rocks below. The 71^{o} orientation could be related to an extension of the Saint Lawrence Fault Zone.

Thus, of the three hypotheses, we believe that the two most likely causes for these features are ice scour of mud and sandy mud bottom and deep gas seeping up through the sediments. Which is more important is still open to question.

REFERENCES FOR MOST OF THE PUBLICATIONS GENERATED AS PART OF THE LAKE ERIE COASTAL EROSION STUDY

1992

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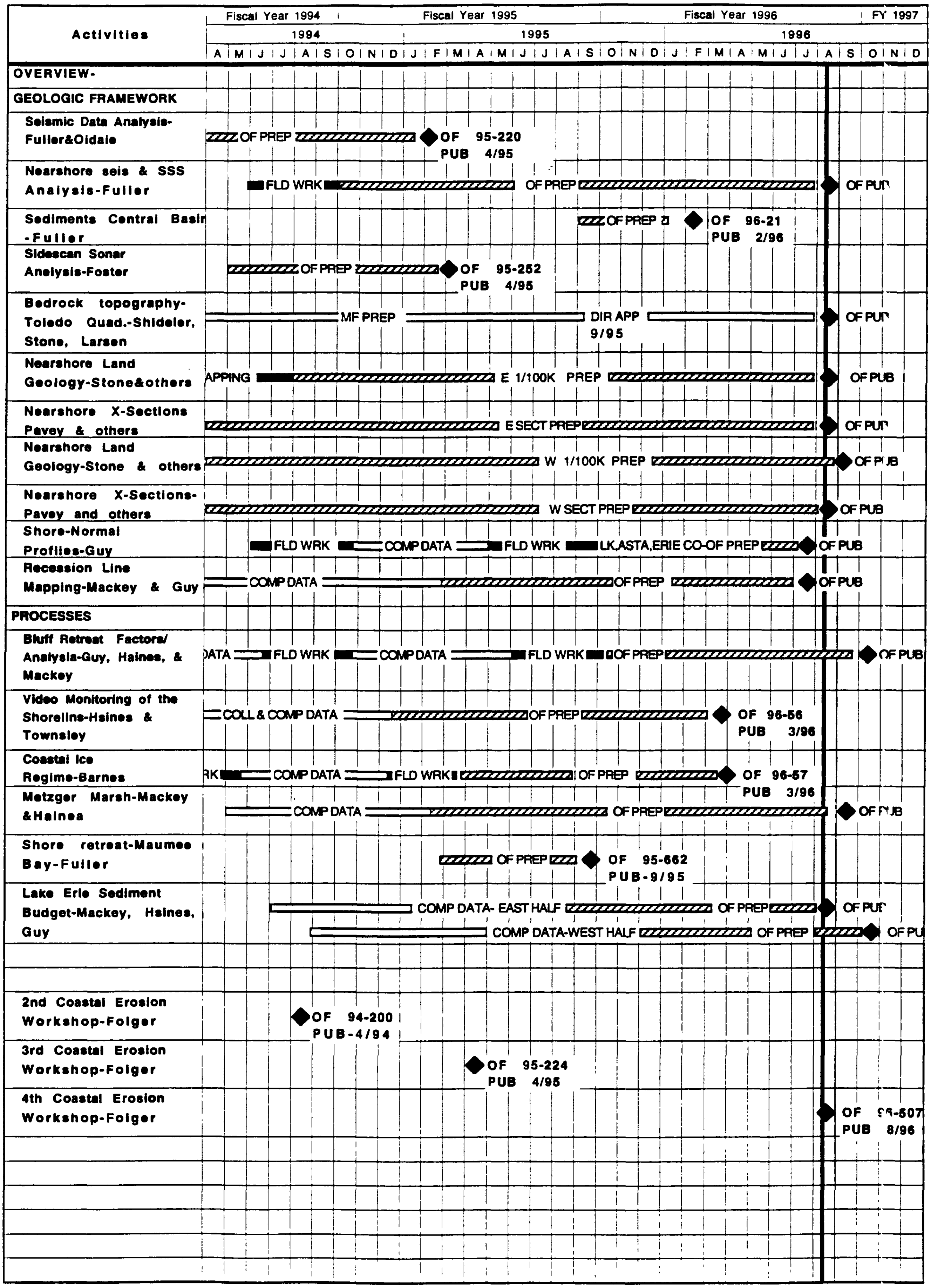
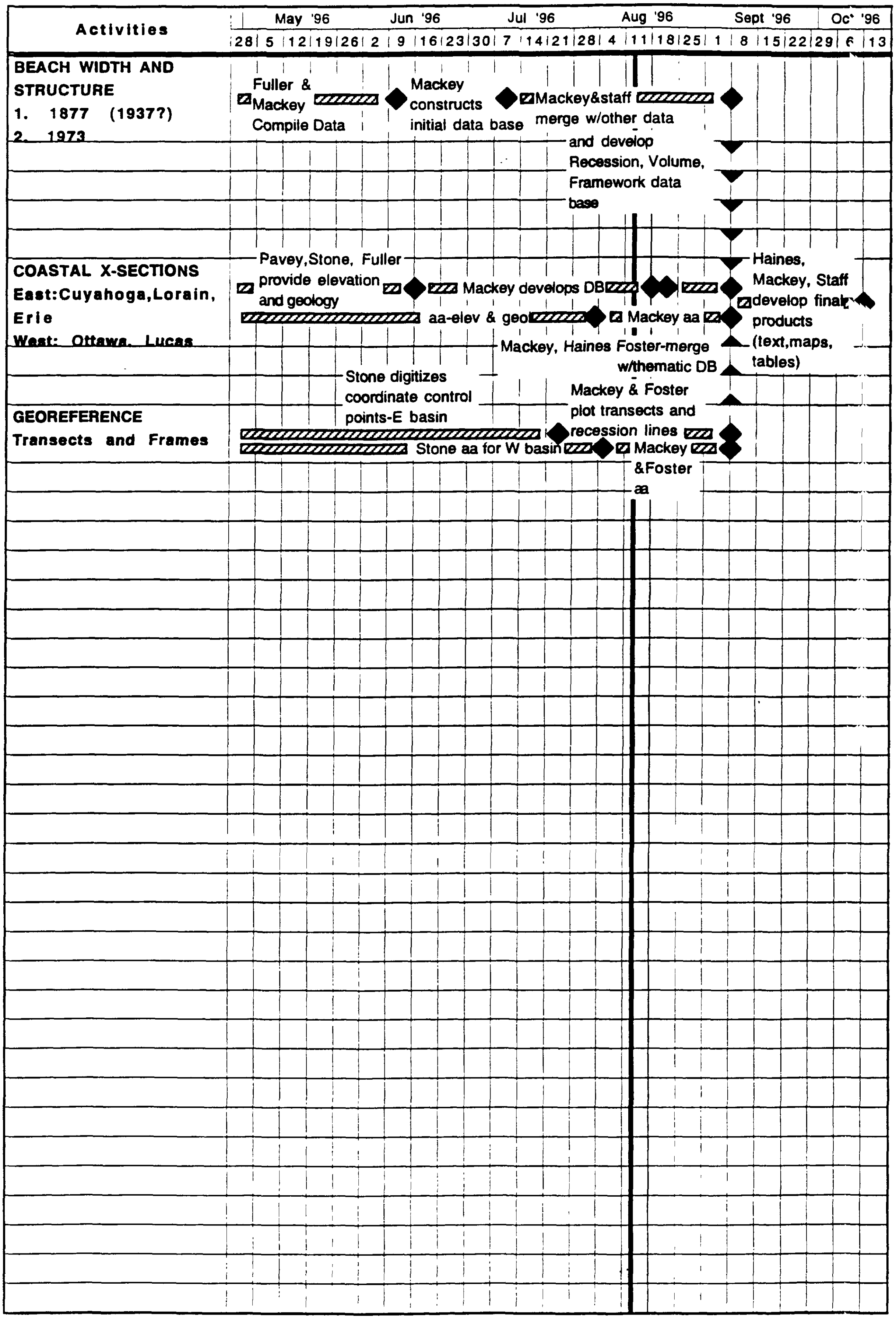
APPENDIX A

LAKE ERIE SCHEDULE



APPENDIX B

RECESSION FACTORS/ANALYSIS



APPENDIX C

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