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TRIBUTARY INPUT OF SEDIMENTS INTO THE GREAT LAKES

Lake Michigan, Lake Huron, and Lake Erie

by

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ABSTRACT

Water quality monitoring of Lake Michigan, Lake Huron, and Lake Erie was performed using visual interpretation of Landsat multispectral scanner (MSS) band data. Transparencies were acquired on the basis of proximity to 1984 Great Lakes ship survey dates. A total of thirty-five scenes were found which corresponded to spring, summer, and winter survey dates.

The images were visually interpreted to detect sediment input from tributarie into the lakes. This was performed to help monitor changes in water quality and t provide ancillary information to be used in the design of lake sample locations. The results of this analysis are shown on overlays which attach to each print. Several tributaries were identified as sediment sources and were annotated by name whenever possible.

The U.S. Environmental Protection Agency's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, prepared this report for the Agency's Environment Services Division in Region 5 and Great Lakes Program Office.

CONTENTS

FIGURES

re 1. Great Lakes study area location. Approximate scale 1:5,000,000.

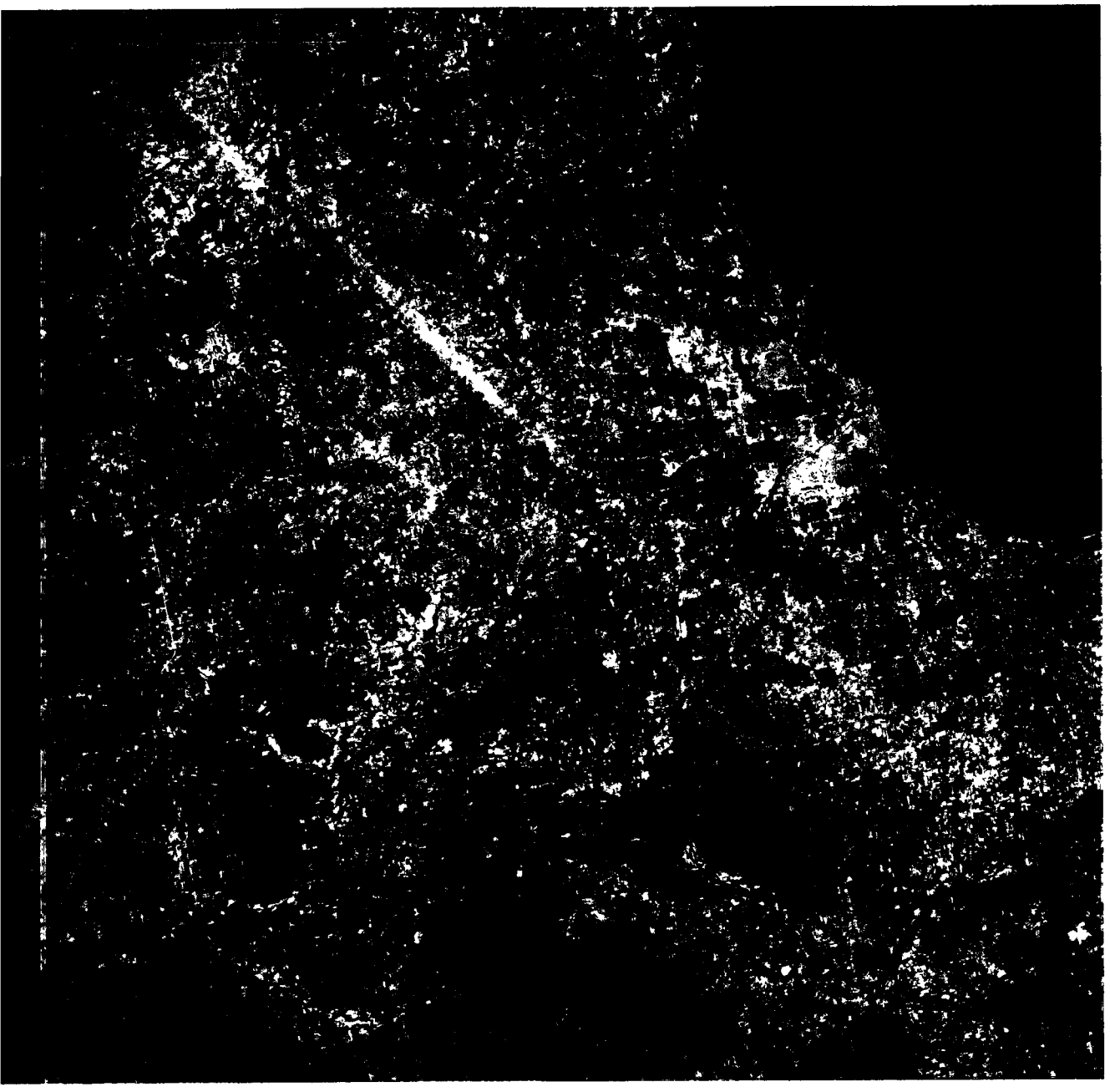
INTRODUCTION

The Great Lakes National Program Office conducted ship surveys on Lake Michig Lake Huron, and Lake Erie (Figure 1) between April 1984 and January 1985. These w performed to help monitor the progress towards the objectives of the 1978 Canada-United States Great Lakes Water Quality Agreement. Water sample data were collect for use in lake eutrophication models and to monitor changes in water quality. In support of these objectives, this study was performed to identify sources of sediment input from tributaries into the lakes.

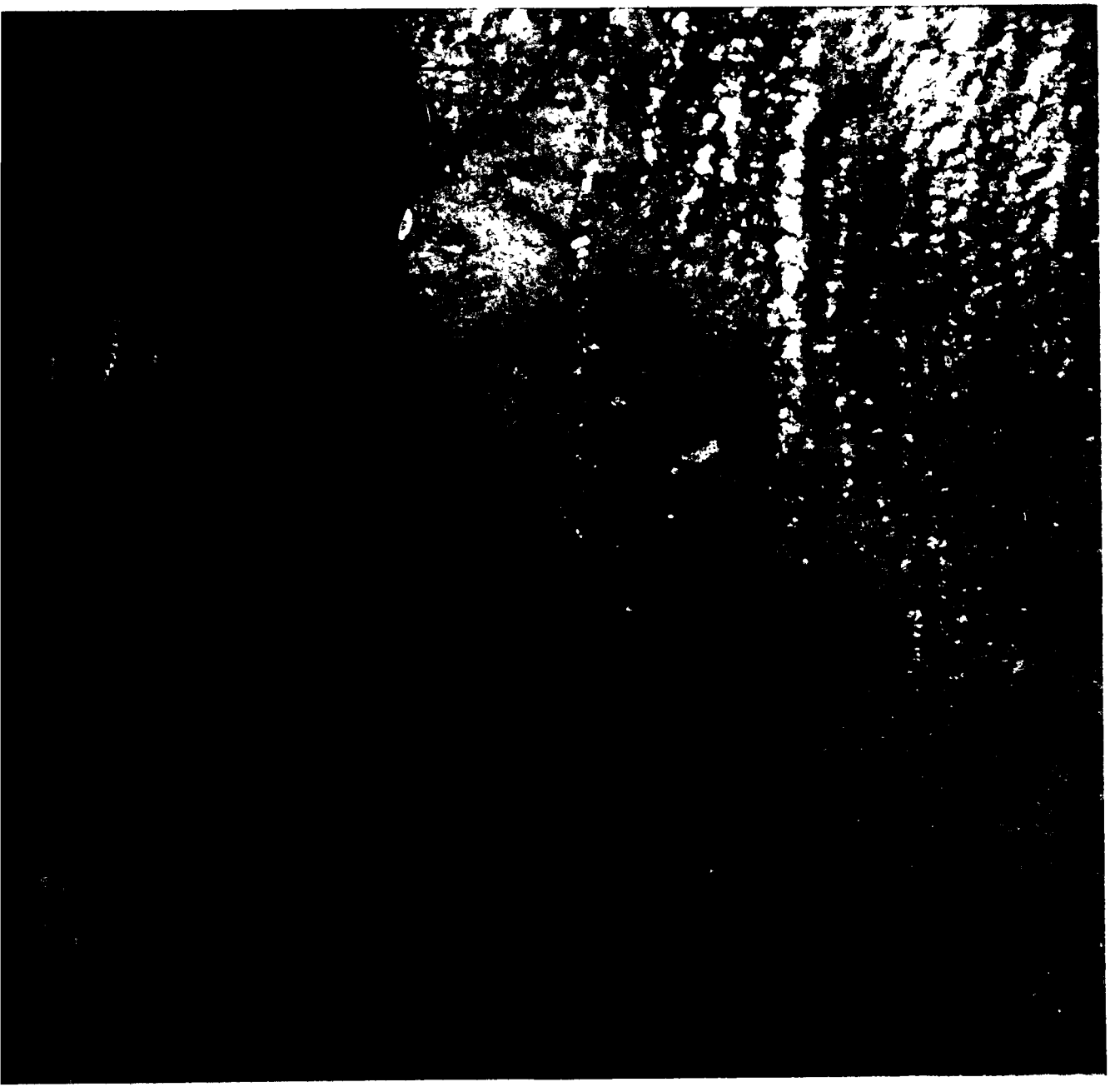
Landsat multispectral scanner (MSS) band 2 transparencies covering Lake Michigan, Lake Huron, and Lake Erie were used for the analysis. Multiple image dates, which corresponded to the spring, summer, and winter surveys, were acquired from the EROS Data Center in Sioux Falls, South Dakota, whenever available.

The U.S. Environmental Protection Agency's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, prepared this report for the Agency's Environment Services Division in Region 5 and Great Lakes National Program Office.

re 2. Approximate locations of Landsat images and dates analyzed for the spring survey. Approximate scale 1:3,600,000.



e 6. Image analysis of Great Lakes study area, May 15, 1984. Approximate scale 1:1,000,000.



re 7. Image analysis of Great Lakes study area, March 29, 1984. Approximate scale 1:1,000,000.

PHOTO ANALYSIS

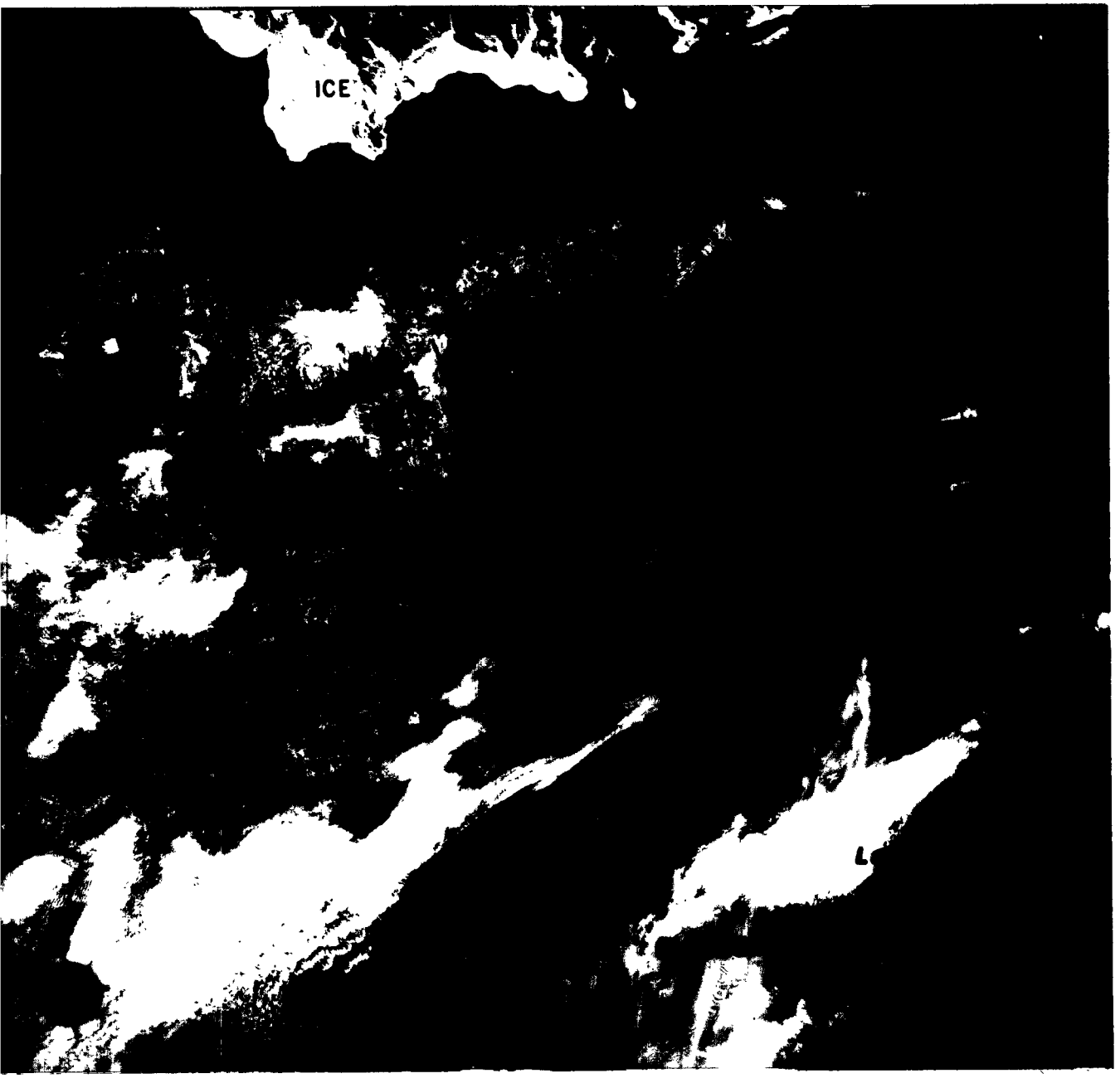
SPRING SURVEY

A total of 12 Landsat band 2 images were acquired which correspond with the spring lake survey. These images provide coverage for most of Lake Michigan, Lake Huron, and Lake Erie. The approximate locations of these images and date of acquisition are shown in Figure 2. The interpretation of each image is presented Figures 3 through 14.

Six of these images provide coverage for nearly all of Lake Michigan (Figures through 8). Visual interpretation of these images resulted in the detection of fi apparent sediment outfalls. Three of these were identified by name and are annotated in Figures 7 and 8. The two remaining tributaries (Figures 5 and 8) cou not be identified by name and were marked as unknown tributaries. Additional turbidity was observed in Figures 5, 7, and 8 which could not be attributed to any point source. Consequently, these patterns were marked as originating from an unknown source. The source of turbidity observed in Figure 8 may be obscured by i which was detected along that shoreline.

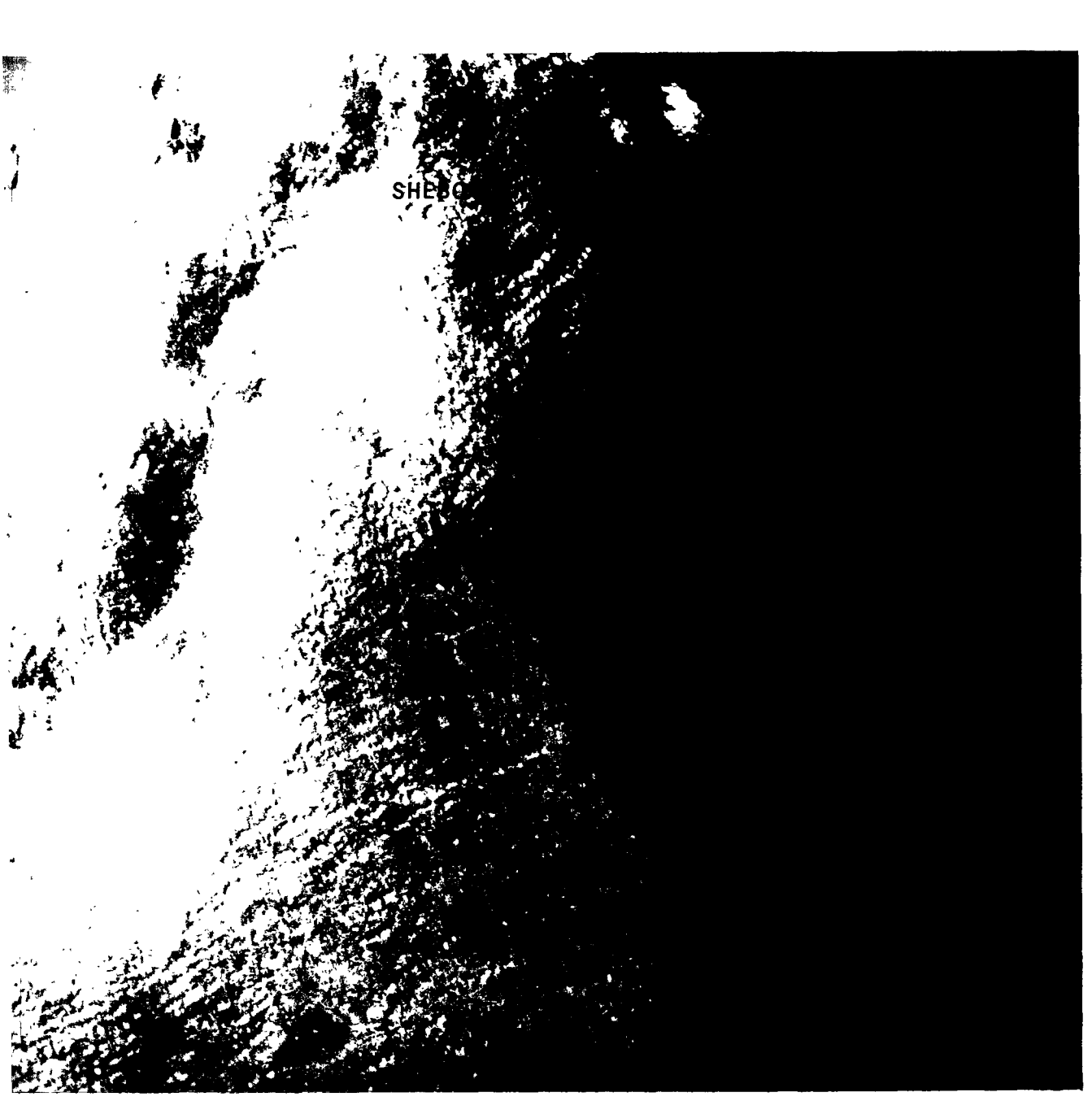
Figures 9, 10, and 11 provide coverage of most of Lake Huron during the spring. The only location where sediments were observed was in Saginaw Bay (Figur 11). The Saginaw River, Quanicassee River, and Wiscoggin Drain all seem to be contributing to the turbidity of that bay. The turbidity patterns indicate that t flow is north out of the bay and under the ice (Figure 10), flowing around the poi and proceeding south along the west shore of the lake. The ice, which is still remaining along much of the shoreline, may be obscuring additional sediment inputs

The final area of analysis for the spring survey was Lake Erie (Figures 12, 1 and 14). Ten tributaries were observed which appeared to be discharging turbid water into the lake. All of these were identified by name. Most are located alon the southern shoreline near Sandusky, Ohio (Figure 12). Several additional sedime plumes were observed but could not be traced to their source. The most prominent these is in the southwestern section of the lake (Figure 12). This plume appears originate to the west of the image, somewhere in the vicinity of Toledo, Ohio.



e 3. Image analysis of Great Lakes study area, April 29, 1984. Approximate scale 1:1,000,000.

re 4. Image analysis of Great Lakes study area, April 21, 1984. Approximate scale 1:1,000,000.



e 5. Image analysis of Great Lakes study area, May 7, 1984. Approximate scale 1:1,000,000.

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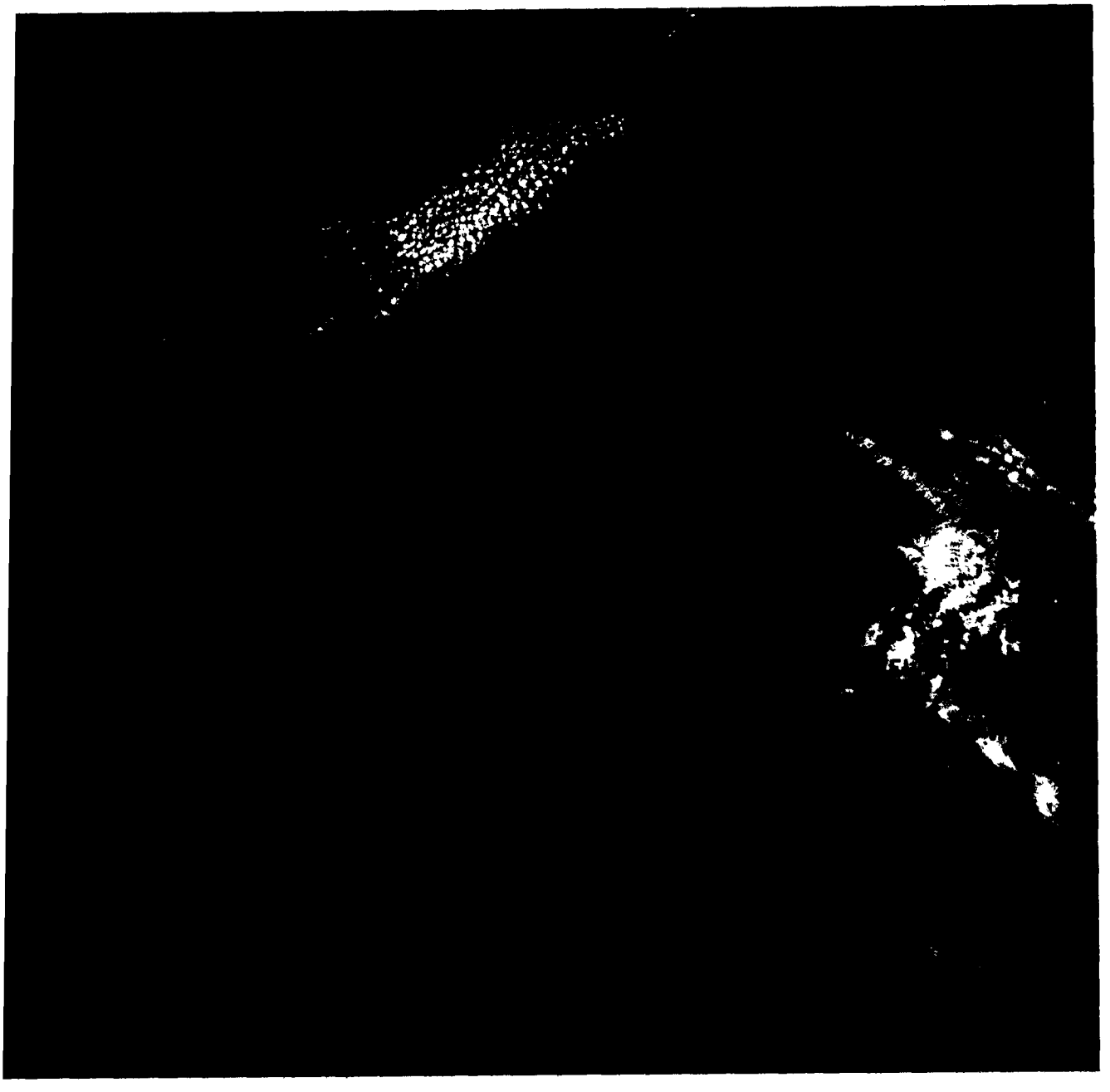
re 9. Image analysis of Great Lakes study area, April 8, 1984. Approximate scale 1:1,000,000.

e 8. Image analysis of Great Lakes study area, March 29, 1984. Approximate scale 1:1,000,000.



re 12. Image analysis of Great Lakes study area, April 25, 1984. Approximate scale 1:1,000,000.

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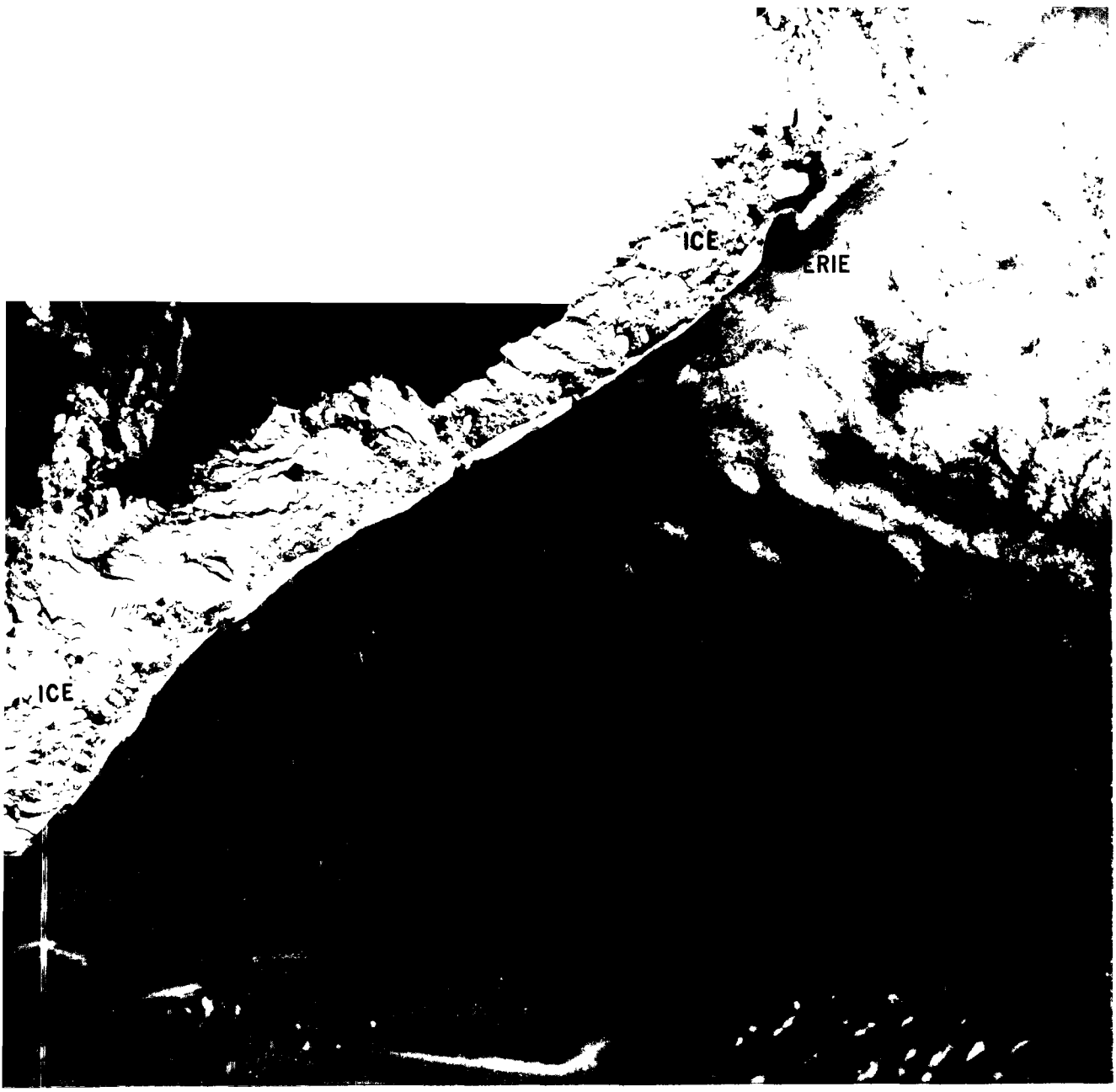
e 13. Image analysis of Great Lakes study area, April 10, 1984. Approximate scale 1:1,000,000.



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e 14. Image analysis of Great Lakes study area, April 2, 1984. Approximate scale 1:1,000,000.

e 15. Approximate locations of Landsat images and dates analyzed for the summer survey. Approximate scale 1:3,600,000.

PHOTO ANALYSIS

SUMMER SURVEY

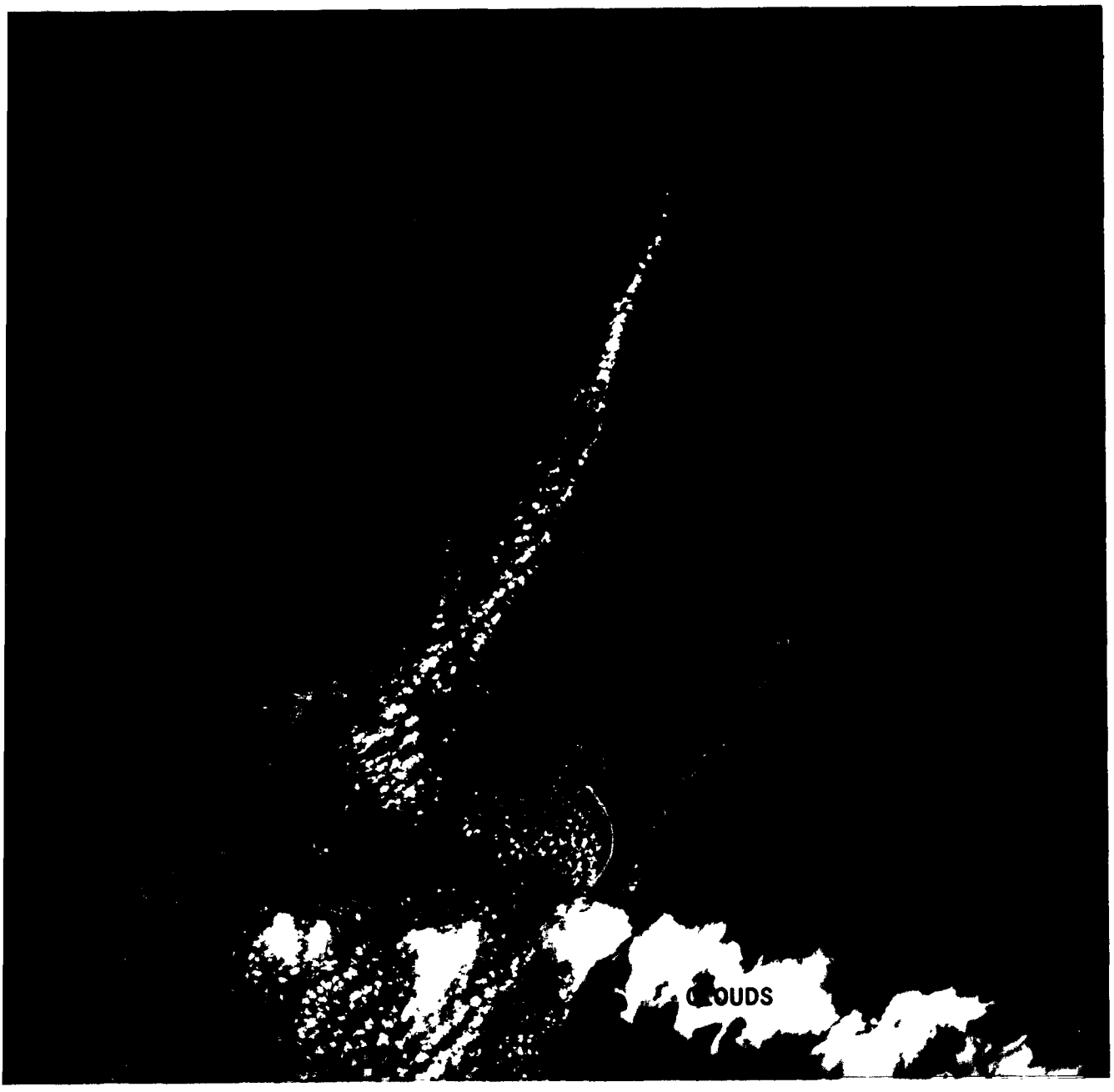
Nineteen Landsat band 2 images were selected which corresponded with the summ lake survey. These scenes provide complete coverage of Lake Michigan, Lake Huron, and Lake Erie. Figure 15 shows the approximate locations of these scenes as well the date of acquisition. The interpretation of each image is presented in Figures 16 through 34.

Figures 16 through 23 provide coverage of Lake Michigan. Analysis of these images identified turbidity patterns which appear to originate from the outfall of several tributaries. A total of 12 tributaries were identified as apparent source of sediment input. Six of these were identified by name while the remaining six were marked as unknown tributaries. All of these were located along the eastern o southern shoreline of the lake. Turbidity patterns were also observed within Gree Bay (Figure 17) but could not be traced to a source point.

The analysis of Lake Huron was performed using Figures 20, 24-27, 29 and 30. Interpretation of these images resulted in the identification of five sediment outfalls. Three of these were identified by name as the Saint Mary's River (Figur 24), Saginaw River, and Quanicassee River (Figure 27). The remaining two were marked as unknown tributaries. An additional sediment plume was observed along th southern shore of the lake (Figure 27) but could not be traced to its origin. It appeared to originate to the east, beyond the edge of the image. That area is sho in Figure 30 but because the satellite coverage was not of the same date, no conclusions about the sediment source could be made. Additional light tonal patterns were observed in the middle of the lake in Figure 26 but appear to be the result of fog.

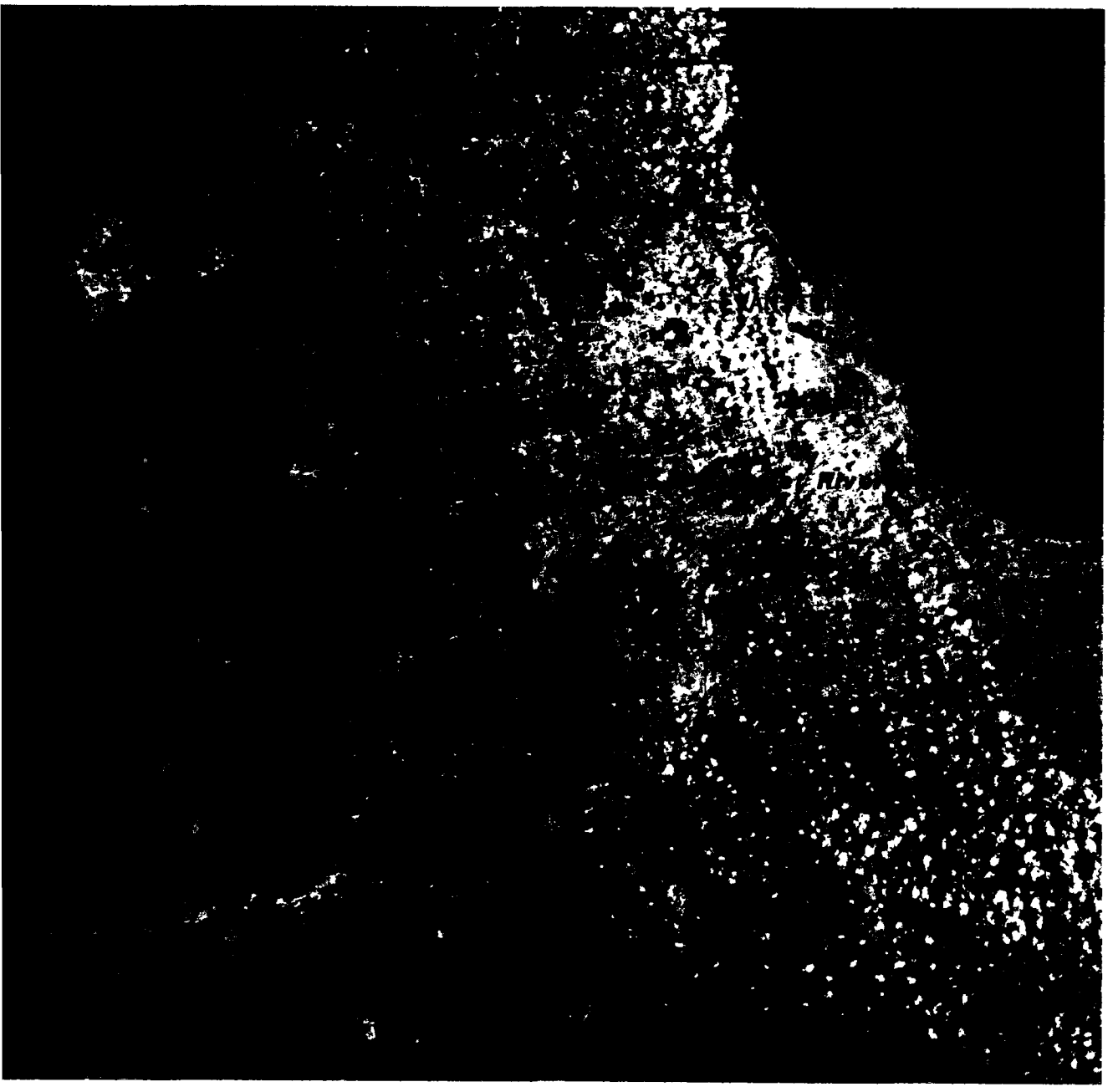
The final area to be analyzed for the summer survey was Lake Erie. Coverage this lake is provided by Figures 28 and 30 through 34. Analysis of these images detected several tributaries which appear to be discharging turbid water into the lake. Six of these tributaries are located at the west end of the lake (Figures 2 and 31) and are identified by name. The Toussaint and Sandusky Rivers were annotated on each of these two image dates because of overlap between adjacent Landsat images. A light haze was also observed in this area for one of the dates (Figure 28) and should not be misinterpreted as turbidity. Two additional point sources were identified in Figures 32 and 34 but could not be named. Finally, turbid waters were observed along the north shore of the lake (Figure 30) but no source could be delineated. Clouds are obscuring part of this plume and may also covering the source point.

e 16. Image analysis of Great Lakes study area, August 19, 1984. Approximate scale 1:1,000,000.

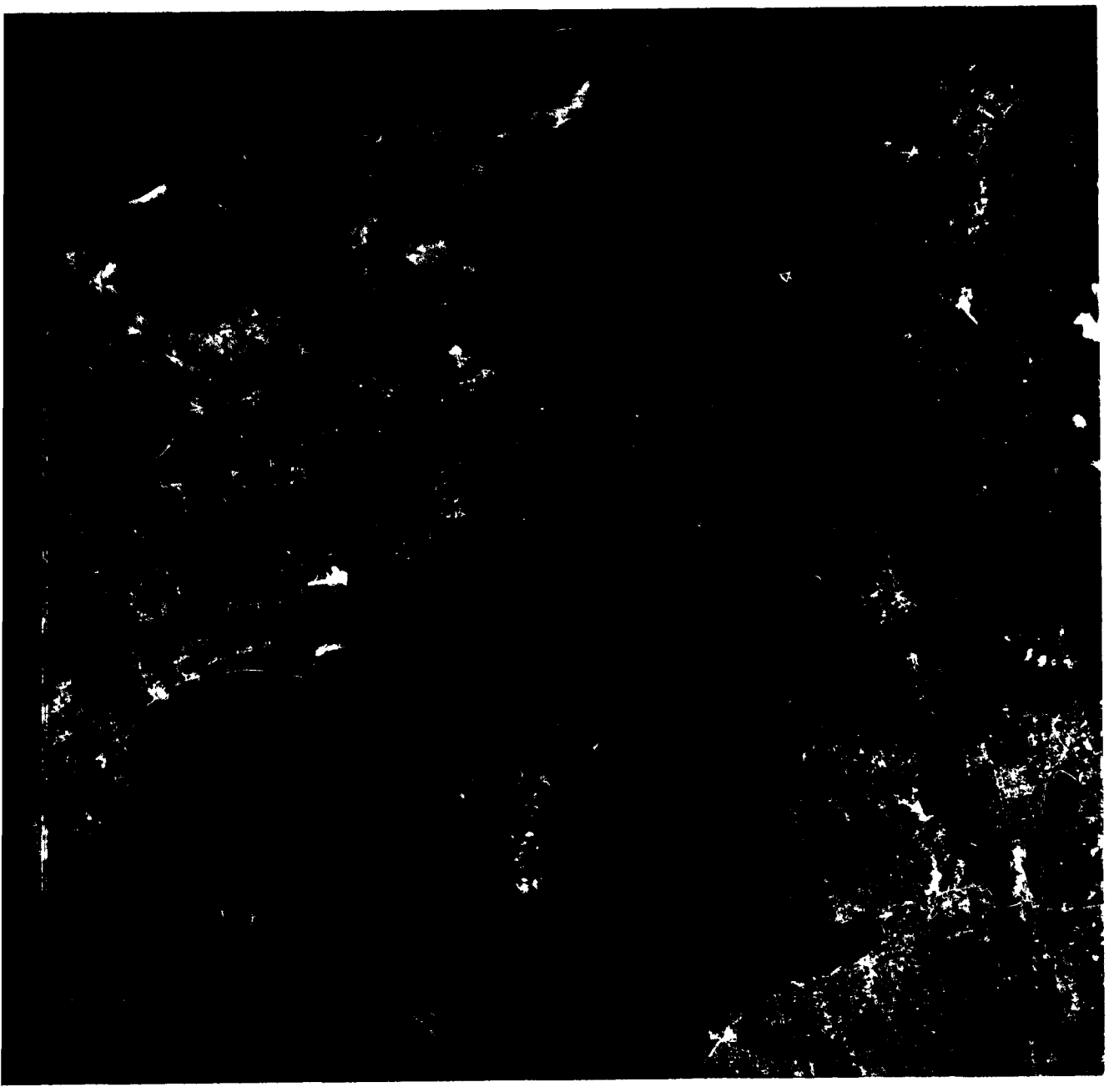


re 17. Image analysis of Great Lakes study area, August 19, 1984. Approximate scale 1:1,000,000.

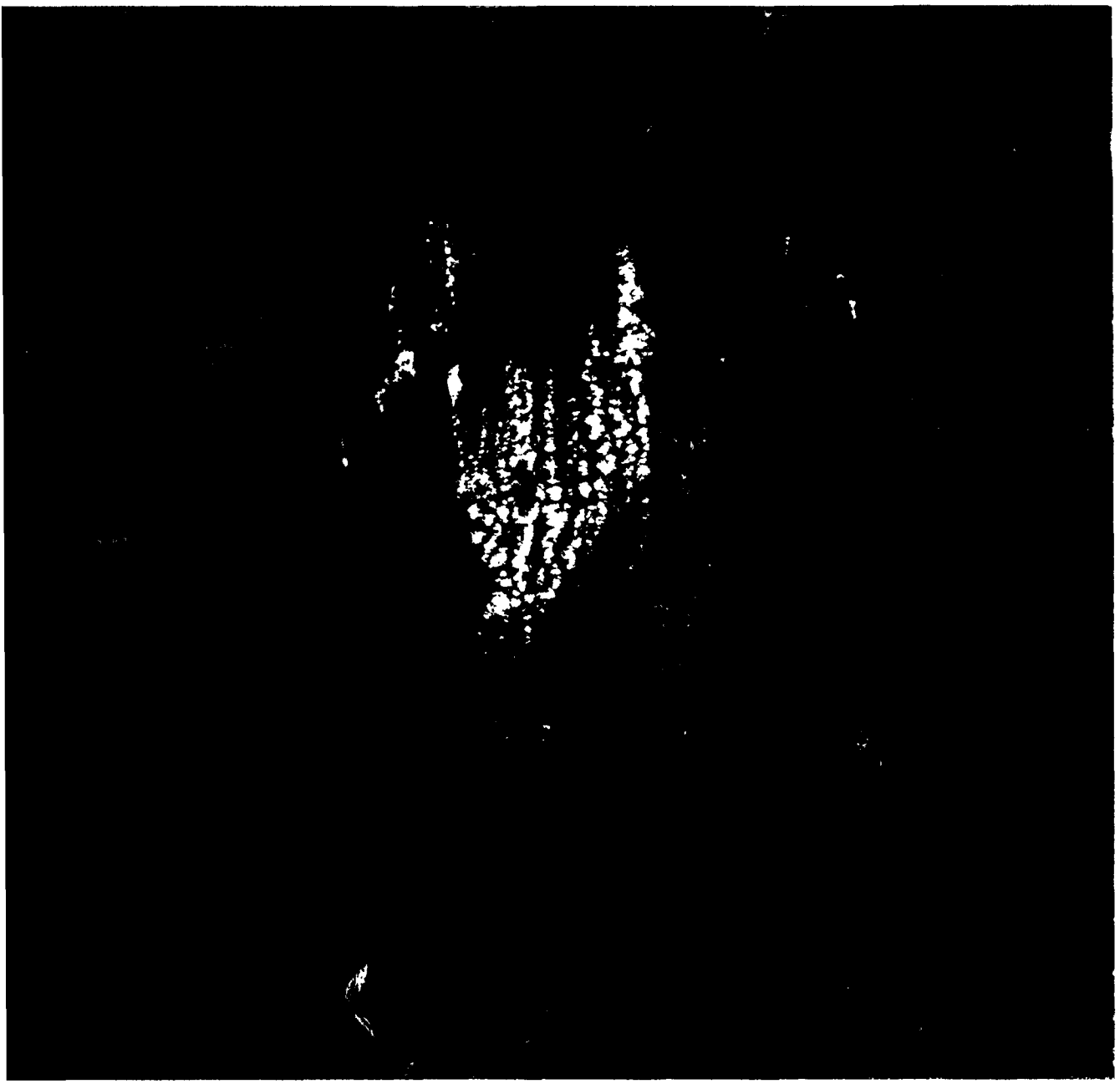
re 18. Image analysis of Great Lakes study area, July 18, 1984. Approximate scale 1:1,000,000.



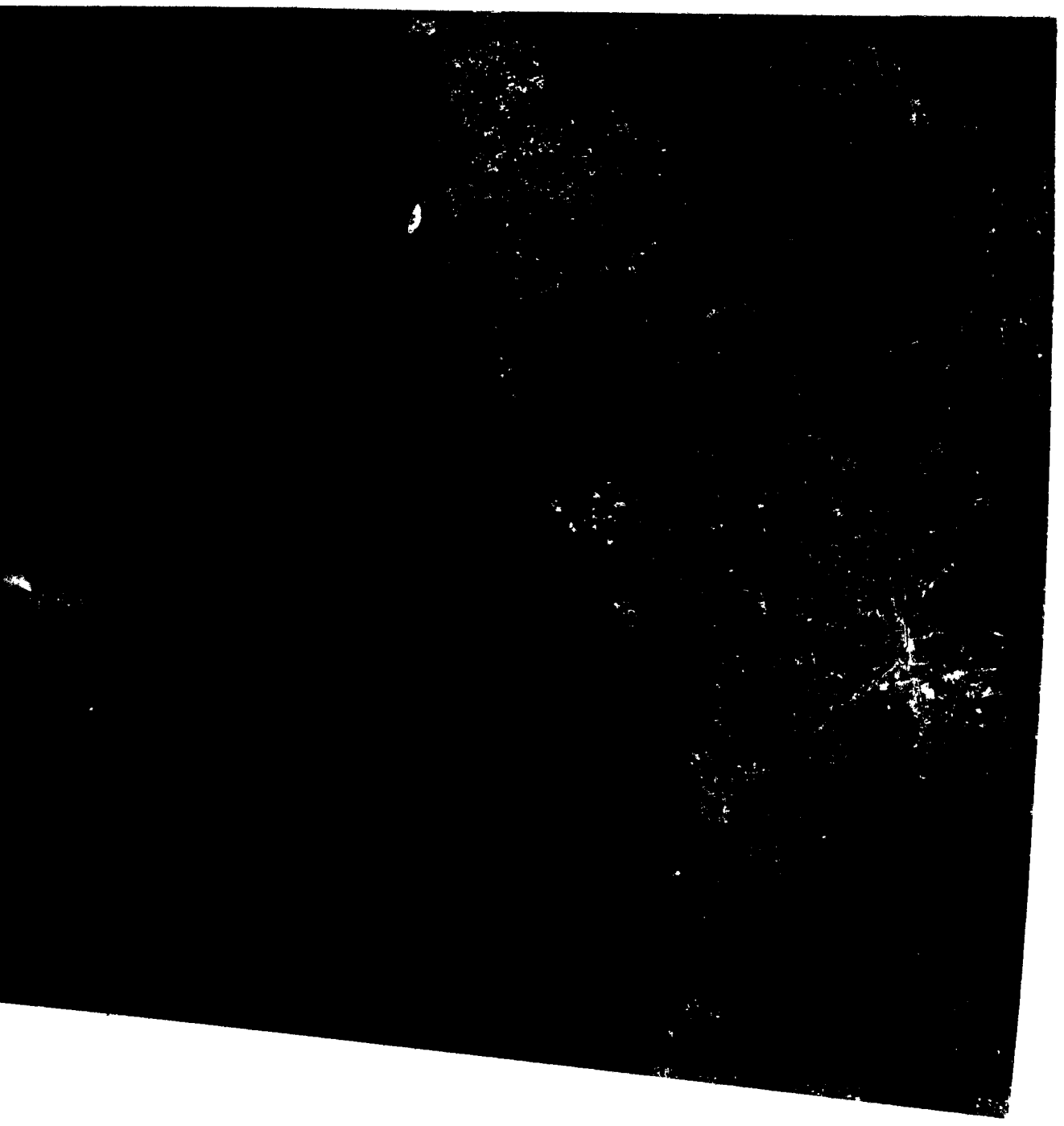
e 19. Image analysis of Great Lakes study area, July 18, 1984. Approximate scale 1:1,000,000.



re 20. Image analysis of Great Lakes study area, August 12, 1984. Approximate scale 1:1,000,000.



e 21. Image analysis of Great Lakes study area, August 12, 1984. Approximate scale 1:1,000,000.



2. Image analysis of Great Lakes study area, August 12, 1984. Approximate scale 1:1,000,000.

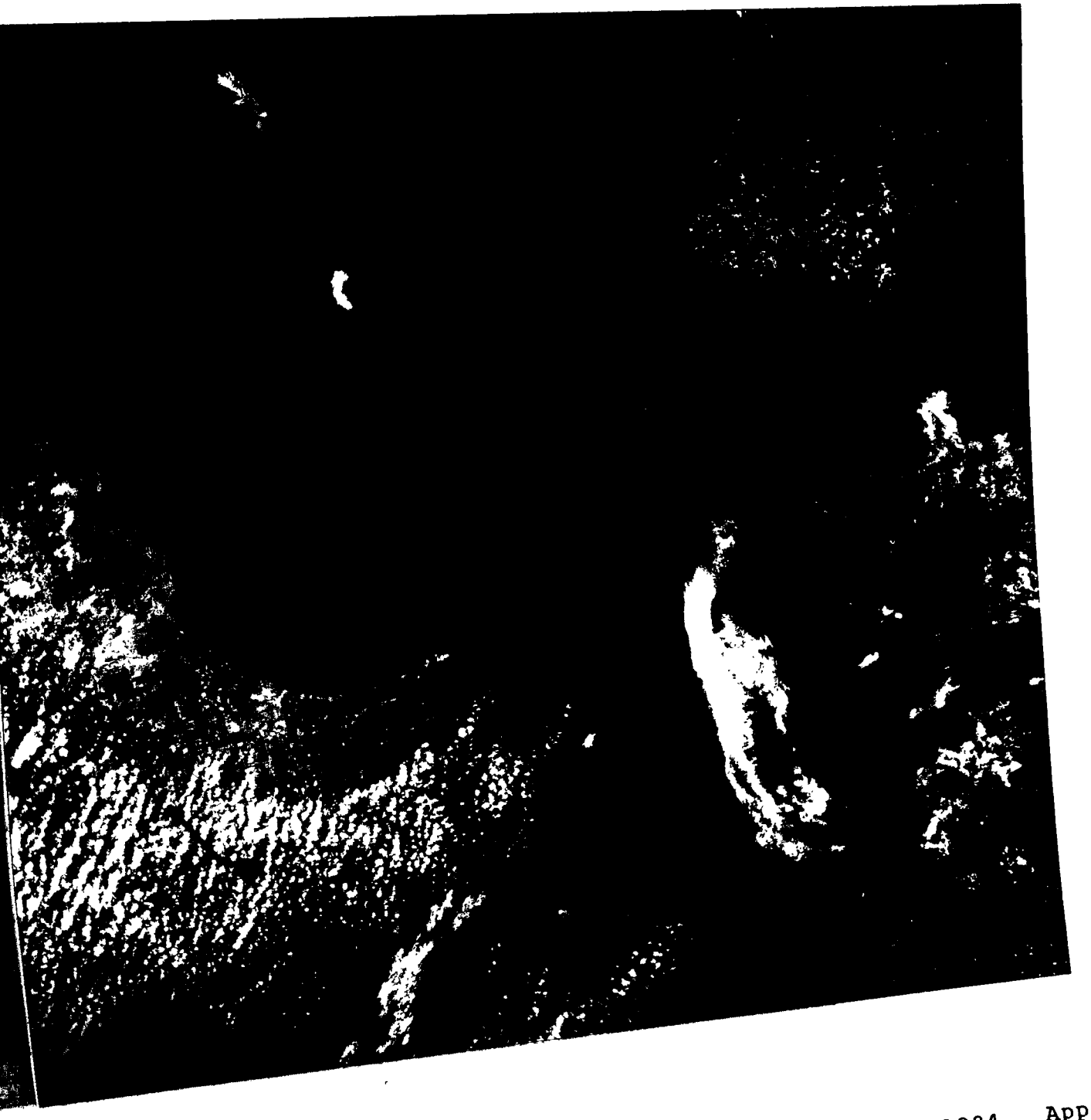
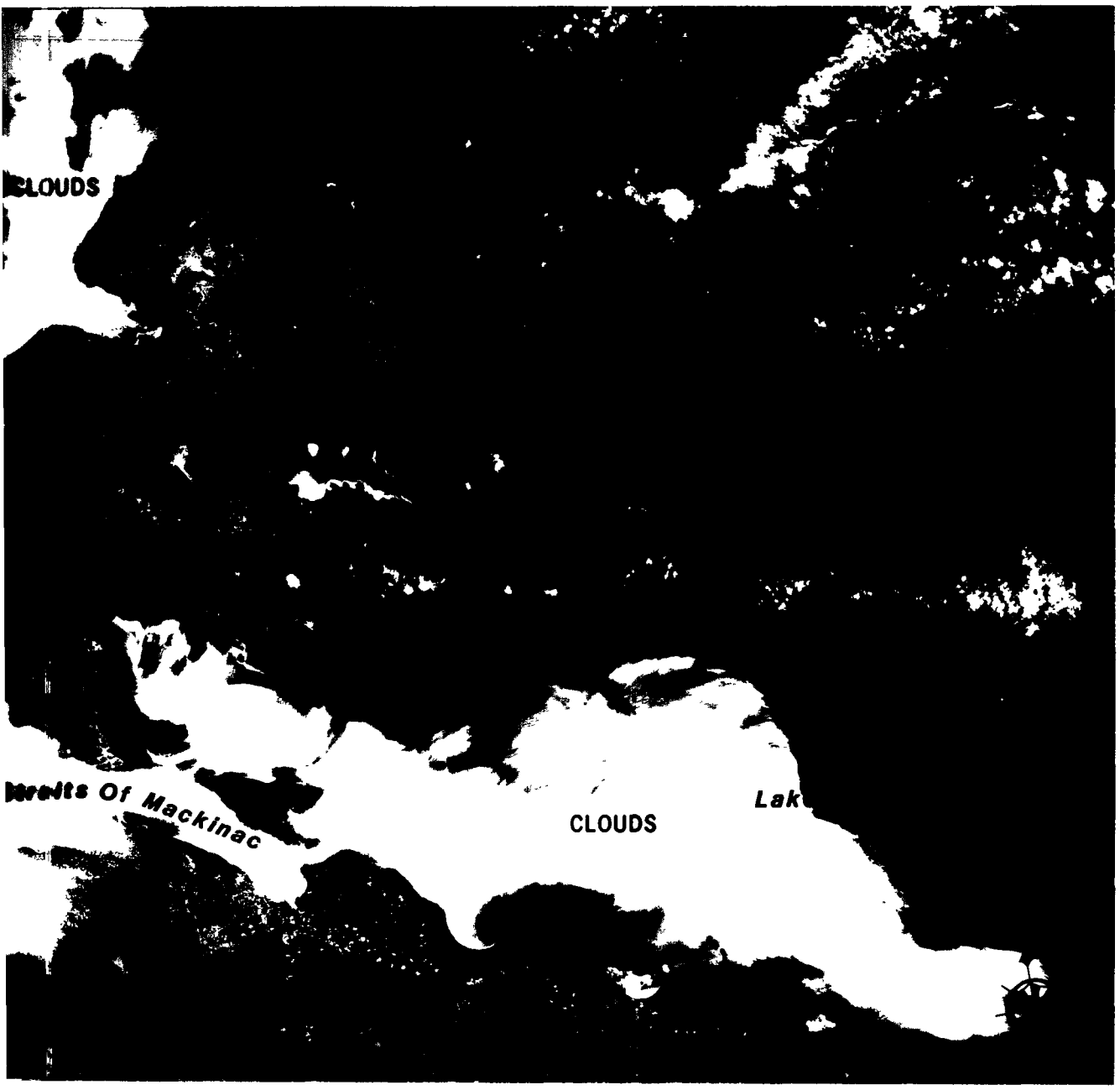
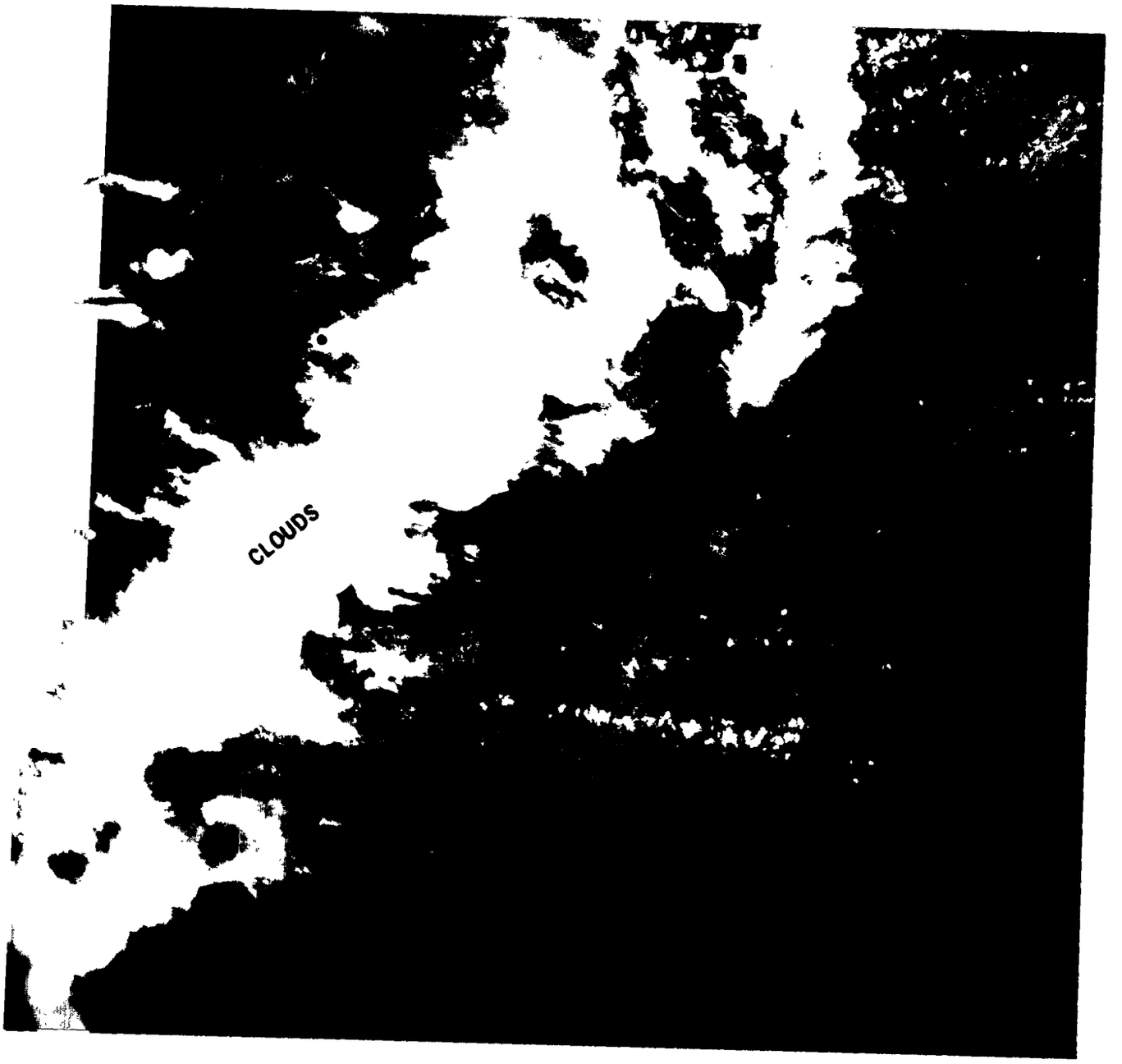


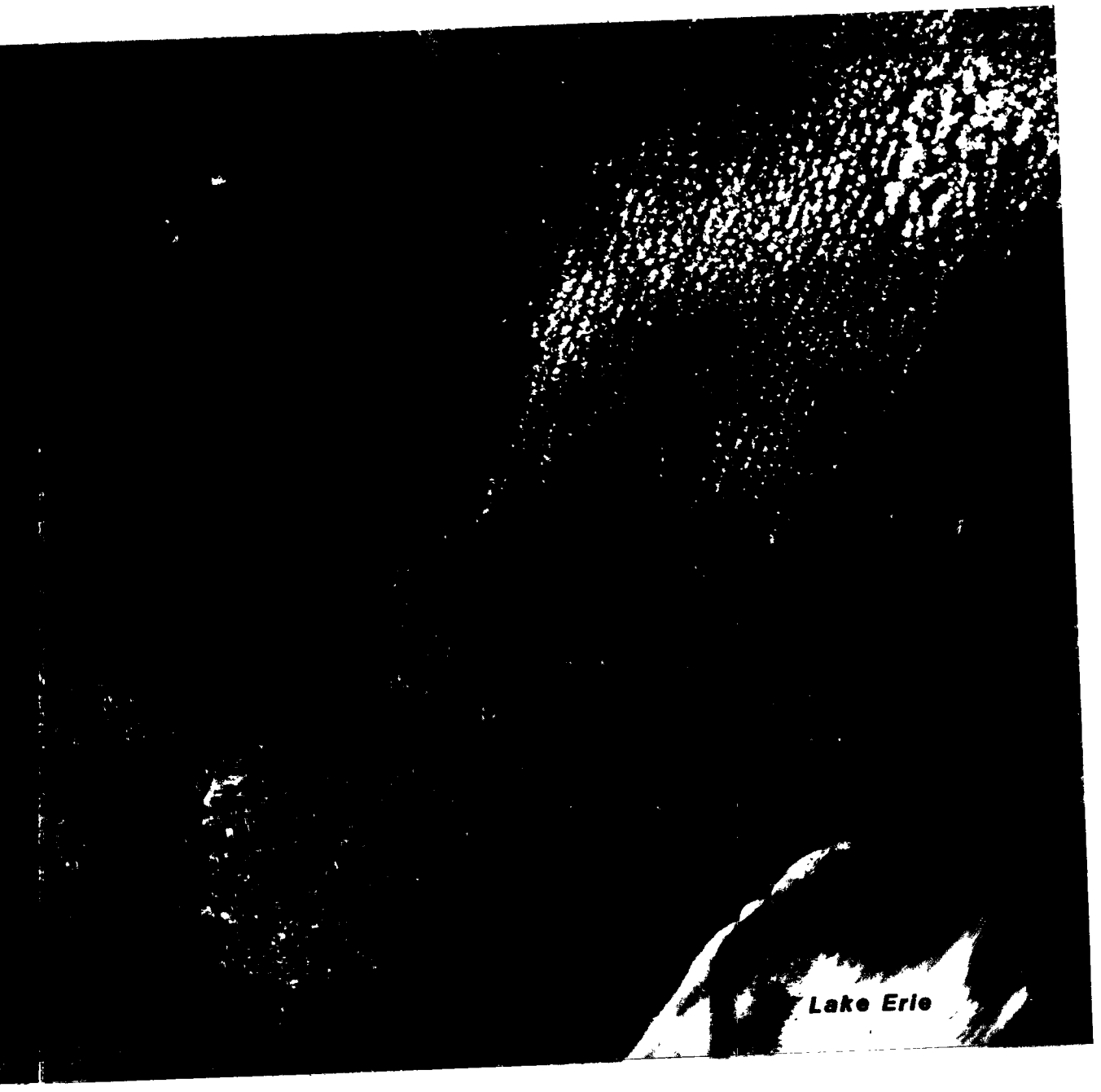
Figure 23. Image analysis of Great Lakes study area, August 12, 1984. Approximate scale 1:1,000,000.



e 24. Image analysis of Great Lakes study area, July 20, 1984. Approximate scale 1:1,000,000.



re 25. Image analysis of Great Lakes study area, July 29, 1984. Approximate scale 1:1,000,000.



ure 30. Image analysis of Great Lakes study area, July 22, 1984. Approximate scale 1:1,000,000.

e 31. Image analysis of Great Lakes study area, August 15, 1984. Approximate scale 1:1,000,000.

ure 32. Image analysis of Great Lakes study area, August 16, 1984. Approximate scale 1:1,000,000.

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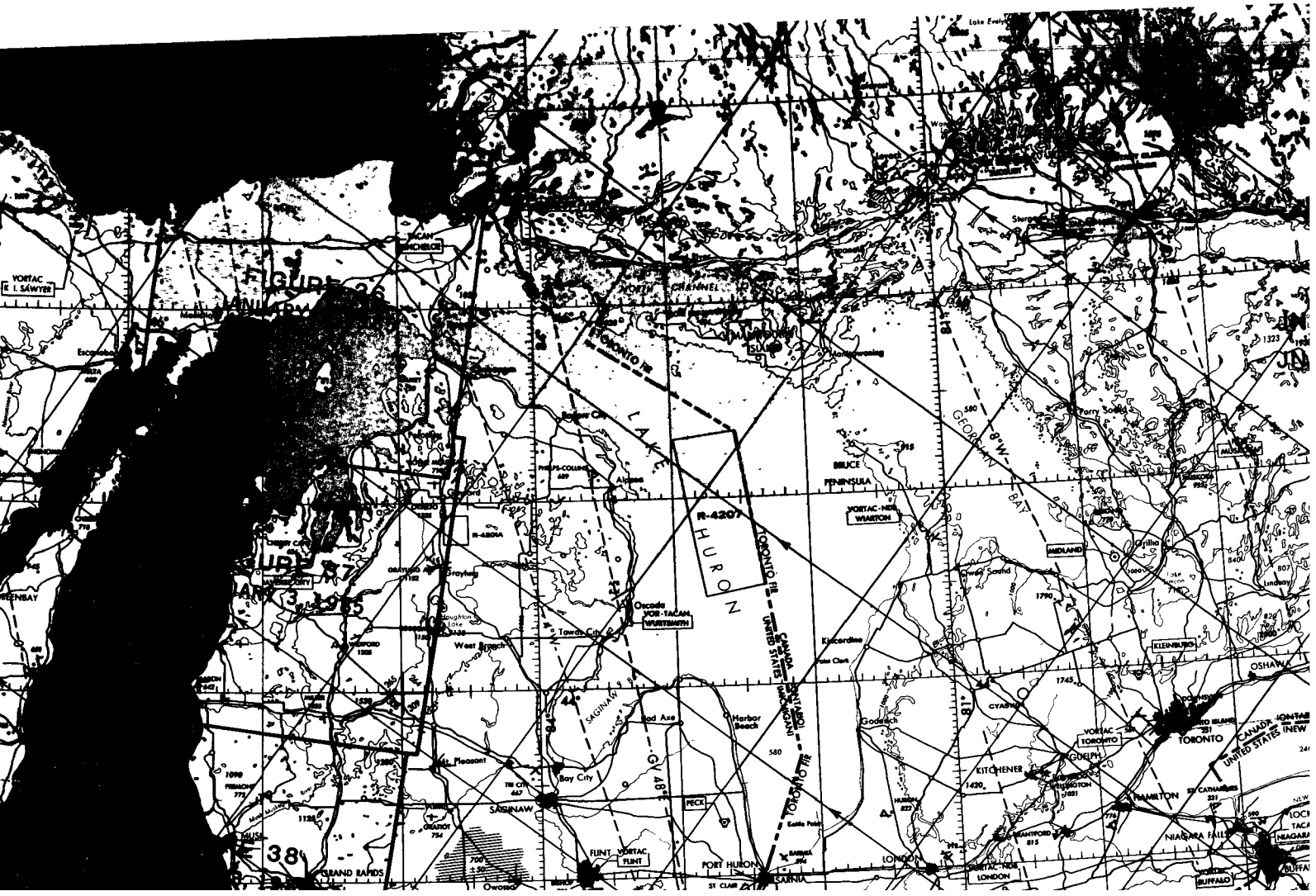
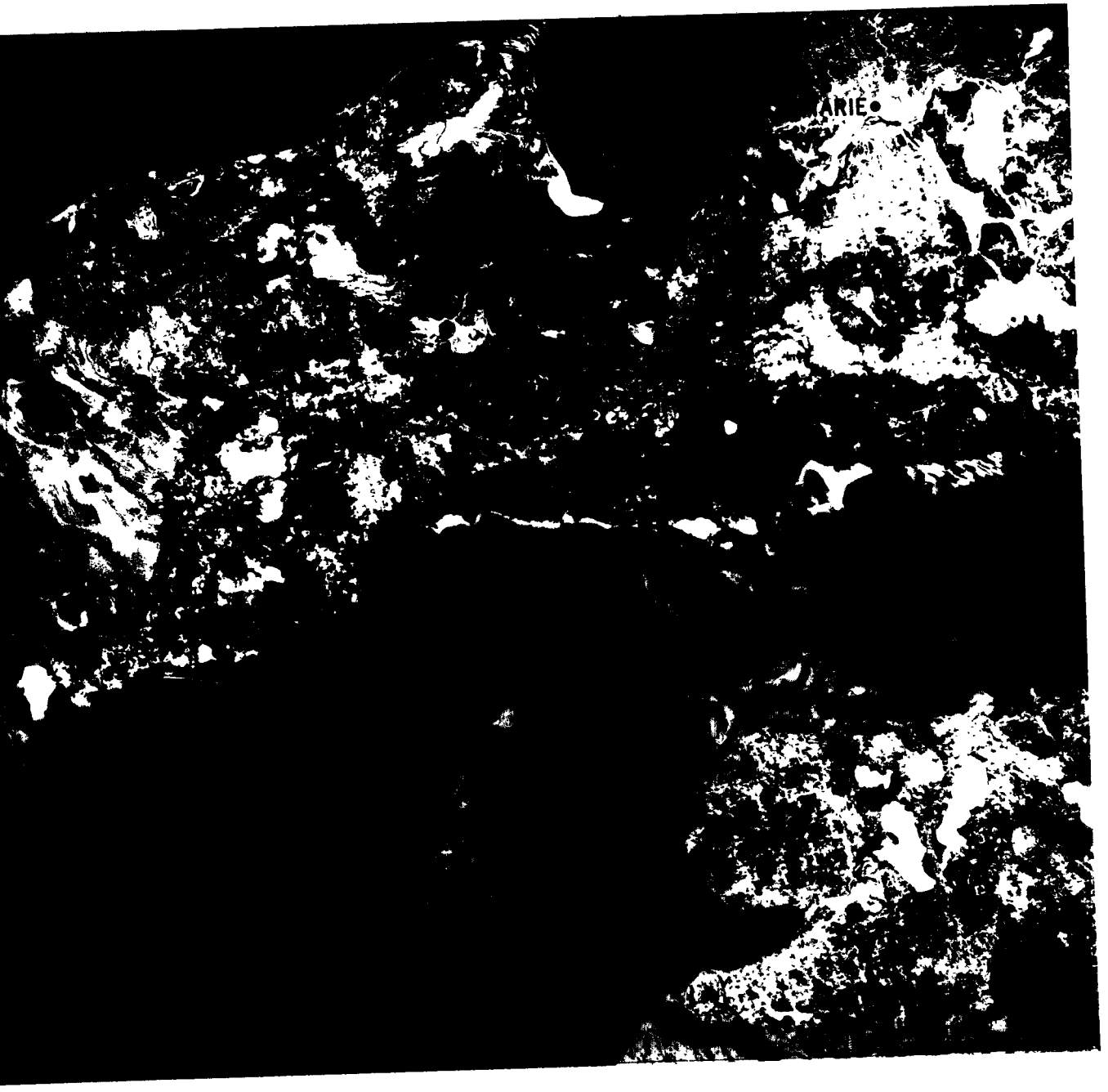


PHOTO ANALYSIS

WINTER SURVEY

Four Landsat band 2 images were used to identify sediment input from tributaries during the winter lake survey. These images provide coverage of the western shoreline of Lake Michigan (Figure 35). No other images were available fo the study area because of cloud cover and data processing delays at the EROS Data Center. The interpretation of these images is presented in Figures 36 through 39.

Visual interpretation of these images resulted in the detection of six appare sediment outfalls. Five of these were identified by name and are marked on the attached overlays in Figures 37-39. The remaining outfall which could not be name is marked as an unknown tributary (Figure 39). Additional sediments were observed to the south of these outfalls in the vicinity of Michigan City, Indiana. Analysi of these turbidity patterns indicates that shoreline currents are flowing north. This indicates that the source of these sediments is to the south and therefore under the clouds. Consequently, the sediments were annotated as coming from an unknown source.



ure 36. Image analysis of Great Lakes study area, January 3, 1985. Approximate scale 1:1,000,000.

PHOTO ANALYSIS

WINTER SURVEY

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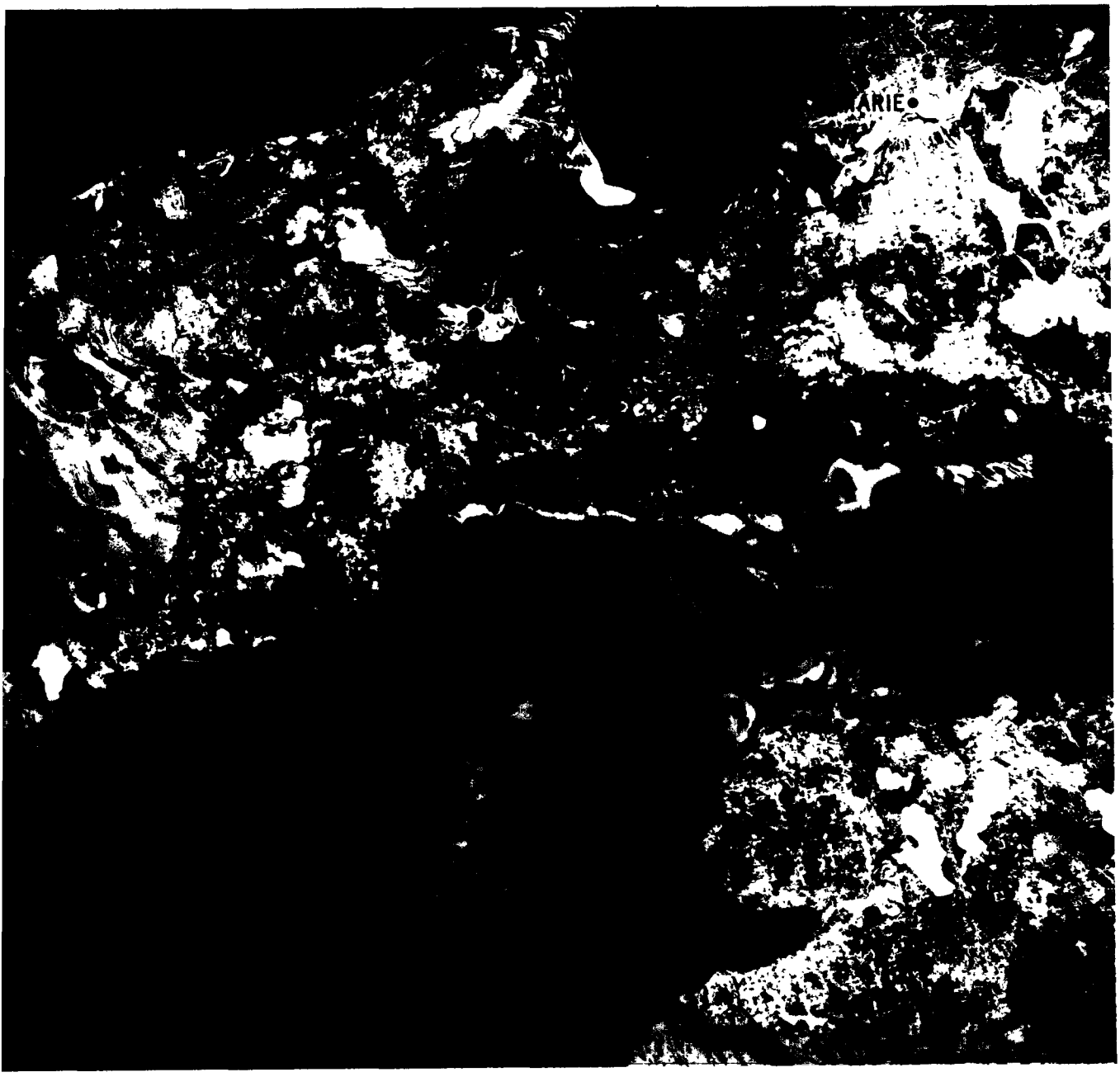
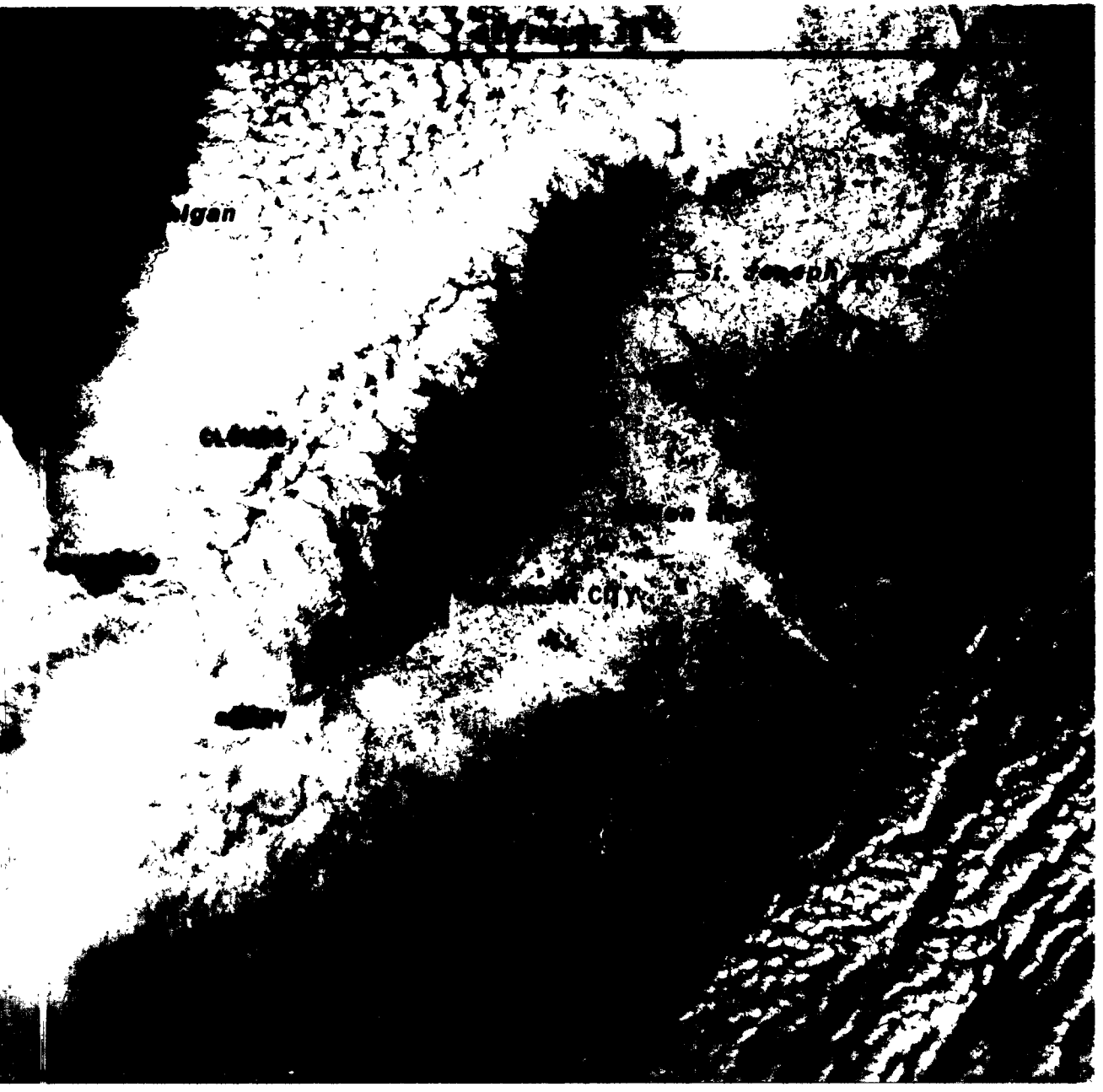


ıre 36. Image analysis of Great Lakes study area, January 3, 1985. Approximate scale 1:1,000,000.



39. Image analysis of Great Lakes study area, January 3, 1985. Approximate scale 1:1,000,000.

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Hoffer, R. "Biological and Physical Considerations in Applying Computer-Aided Analysis Techniques to Remote Sensor Data," chapter 5 of Remote Sensing: The Quantitative Approach, Swain, P., and S. Davis, eds., McGraw-Hill, New York, New York, 1978.