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ABSTRACT

The disappearance of planes and ships in the Great Lakes area is the focus of the three activities in this unit. Activity A involves studying the locations of missing craft and personnel. Activity B, which treats the loss of the freighter Edmund Fitzgerald as an example of a Great Lakes tragedy, consists of plotting bathymetric contours, investigating weather conditions on the day of the wreck, and constructing a model to study ship design. Finally, in Activity C students listen to and analyze "The Wreck of the Edmund Fitzgerald" ballad. Both a student workbook and a teacher's manual are provided. The latter includes an overview of the unit, a materials list, objectives, teaching suggestions, and answer keys to student activities. (Author/WB)

OEAGLS- Oceanic Education Activities for Great Lakes Schools

THE GREAT LAKES TRIANGLE

by
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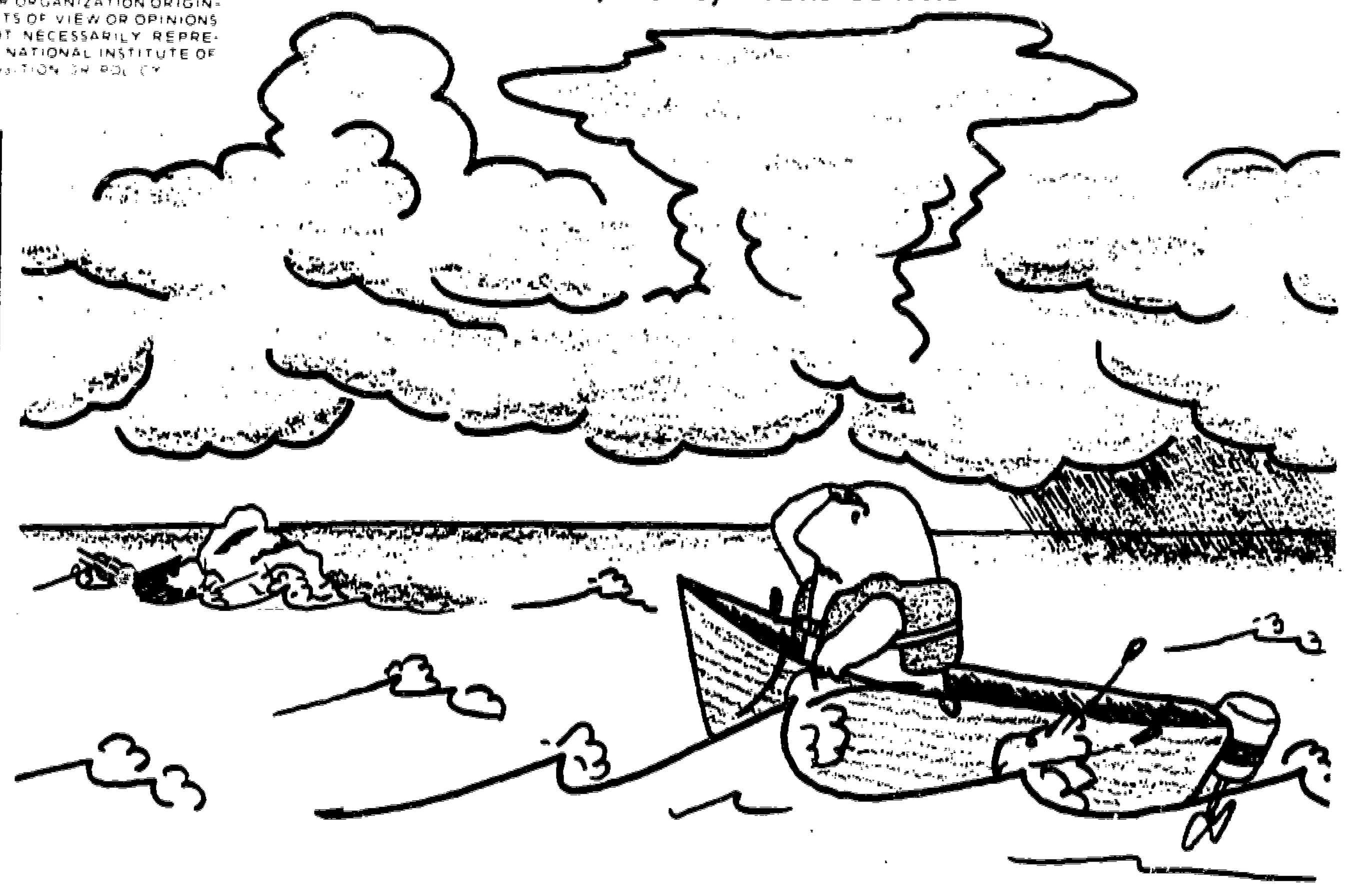

Ohio Sea Grant Program
Charles E. Herdendorf, Program Director
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OEAGLS Investigation #11
Completed September, 1980

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INVESTIGATION

THE GREAT LAKES TRIANGLE

INTRODUCTION

In 1974, Charles Berlitz wrote in his famous bestseller, The Bermuda Triangle:

> THERE IS A SECTION OF THE WESTERN ATLANTIC, off the southeast coast of the United States, forming what has been termed a triangle, extending from Bermuda in the north to southern Florida, and then east to a point through the Bahamas past Puerto Rico to about 40° west longitude and then back again to Bermuda. This area occupies a disturbing and almost unbelievable place in the world's catalogue of unexplained mysteries. This is usually referred to as the Bermuda Triangle, where more than 100 planes and ships have literally vanished into thin air, most of them since 1945, and where more than 1,000 lives have been lost in the past twenty-six years, without a single body or even a piece of wreckage from the vanishing planes or ships having been found.

Former aviator Jay Gourley has since written a book called The Great Lakes Triangle (1977), which claims that the Great Lakes account for more unexplained disappearances than the Bermuda Triangle. This is no small comparison, considering that the Bermuda Triangle is sixteen times larger than the Great Lakes area

> Because of the irregular shape of the Great Lakes, pilots--aware of dangers within--ordinarily circumnavigate the lakes, even when overflying might be shorter. It is almost impossible for even the slowest aircraft to be more than 20 minutes from land. Today's airliner can cross Lake Erie through the middle in ten minutes. Faster aircraft can do it in much less than four minutes. Over any point on any of the Great Lakes it is possible for the pilot of any jet airliner to shut down all his engines and literally glide to land. There are hundreds of ground-based, sea-based and air-based radios constantly monitoring emergency frequencies for any sign of trouble.

Aware of the curious incidents over the Great Lakes, the Federal Aviation Administration several years ago instituted a special "Lake Reporting Service"; pilots on Great Lakes overflights make continuous reports to ground stations. A ten-minute delay in such a report automatically launches search-and-rescue operations. This service has saved many lives that would have been lost to ordinary accidents, but the high incidence of inexplicable disasters has remained unaffected.

OBJECTIVES

When you have completed this investigation you will be able to:

1. Explain what is meant by the Great Lakes Triangle.

2. Describe how bathymetric charts are constructed.

3. Explain how weather information is mapped.

4. Describe the characteristics of a Great Lakes freighter.

5. Discuss at least two possible explanations for the sinking of the Edmund Fitzgerald.

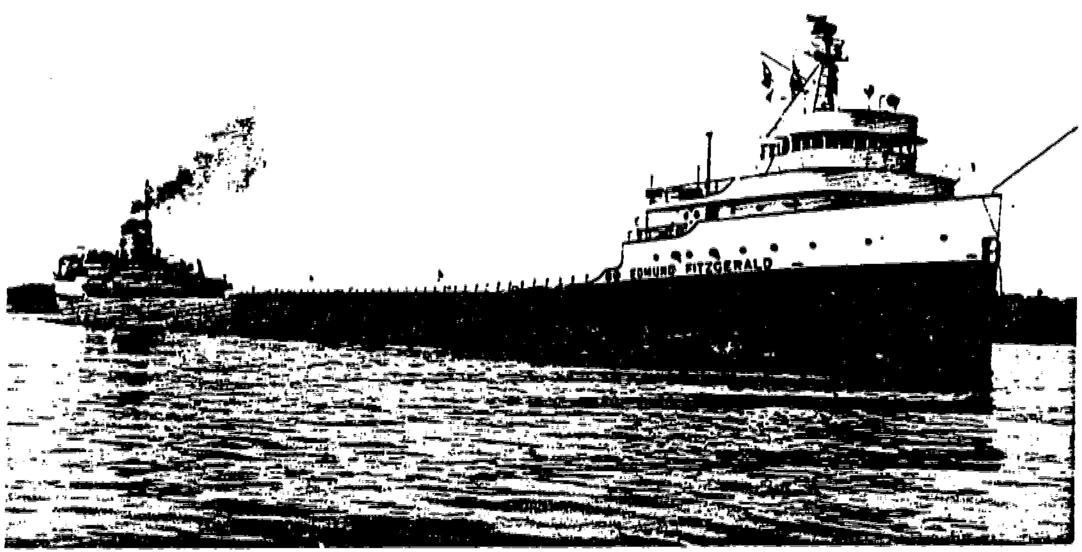


Figure 1: One of the last photographs taken of the Edmund Fitzgerald.

ACTIVITY A WHAT IS THE GREAT LAKES TRIANGLE?

MATERIALS Map of vessel and aircraft disappearances in the Great Lakes area, Table I from the Teacher's Guide.

Figure 2 shows the last position of disappearing ships and planes in the area of the Great Lakes Triangle. Look at the map symbols and their locations to answer the questions on the next page.

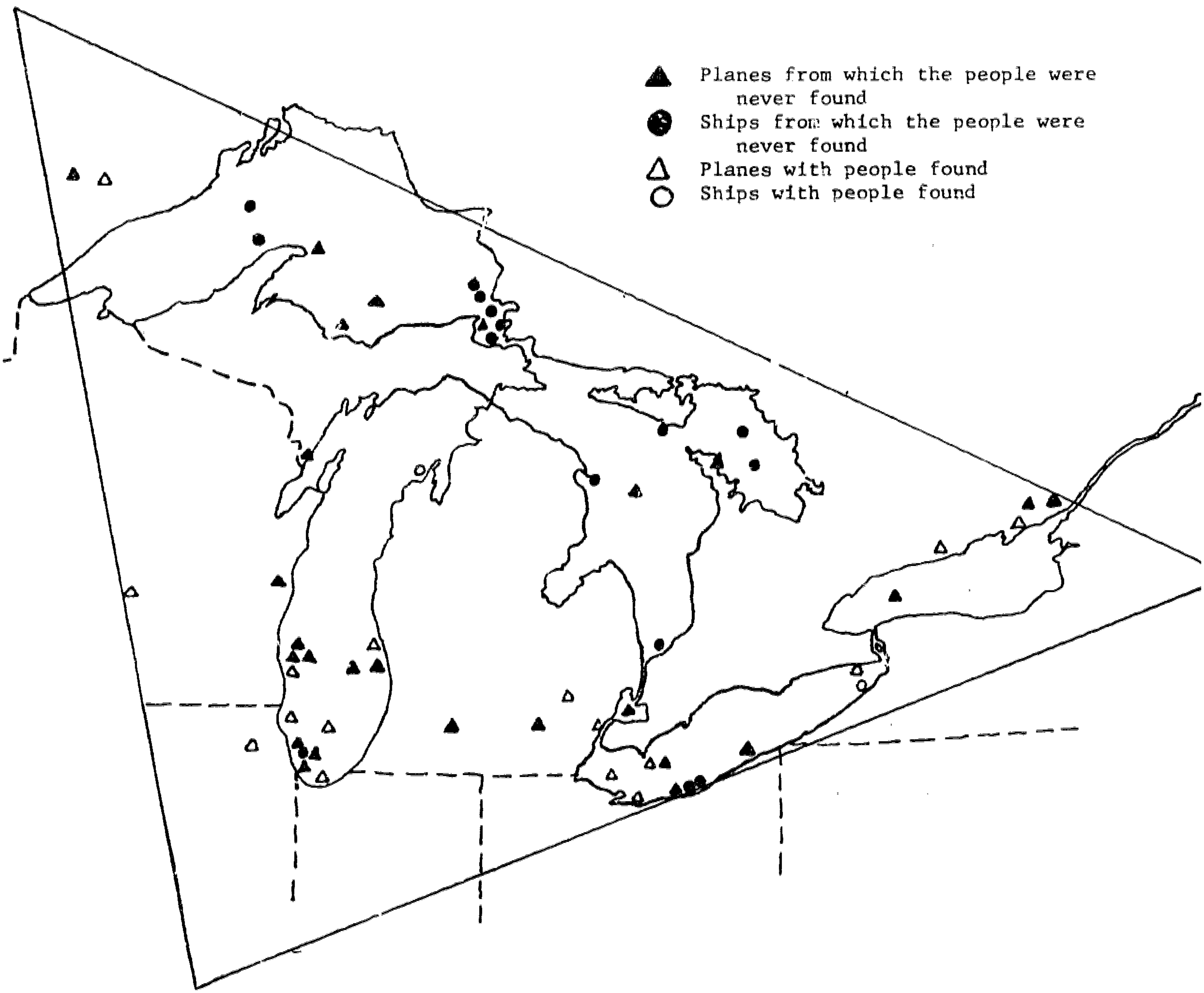


Figure 2. Estimated locations of disappearances described in Gourley's The Great Lakes Triangle.

1. Are there some areas where large numbers of losses have occurred? If so, where?

2. Are there logical explanations for large numbers of losses having occurred at these particular areas? What explanation?

3. Do most of the losses include missing people?

4. Why do you think some of the planes, ships and people have never been found?

If you are interested in learning more about the planes and ships in Figure 2, your teacher can post a copy of the list from which the map was made.

ACTIVITY B HOW CAN DISAPPEARANCES WITHIN THE TRIANGLE BE EXPLAINED?

It the nature of the scientist to look for logical explanations for what is observed. In this activity you will explore some factors about ships and the Great Lakes environment that could help explain the disappearances you noted in Activity A.

MATERIALS

Navigational chart of eastern Lake Superior; cardboard tubes; plastic beads or aquarium gravel; wax pencil; outline maps of Lake Superior; weather data for November 10, 1975; pencil or pen; tracing paper.

PROCEDURE

You will be assigned to investigate and produce examples of one or all of the following topics.

1. Great Lakes bulk carrier design
2. Tracking a severe lake storm
3. Lake bottom characteristics

All the materials needed for your assignment are included in this booklet. If you have been assigned Topic 1, use pages 7-9. For Topic 2 use pages 10-16, and for Topic 3 pages 17-19.

After your investigations have been completed your teacher will conduct a class discussion. Findings from all three topics will be brought together. The discussion will help you answer the questions below. It may be helpful to read the questions before you begin work, but do not try to answer them until all the investigations have been completed.

1. Could ship design be responsible for the loss of some vessels in the Triangle areas? ____________Explain.____________________

   ____

   ____

2. How bad is a severe storm on the Great Lakes:

   a. Wind speeds? ____________

   b. Wave heights? ____________

   c. Duration (how long the storm lasts)?

   ____

   d. Visibility? ____________

3. What kinds of areas in lakes and oceans may be safer when a storm is in progress? ____________________

____

____

4. How are bathymetric measurements made?

____

____

5. Is it possible that there are features on lake and ocean bottoms that mariners don't know about?

______________Explain. ____________________

____

____

6. What are the "Three Sisters" in the mariner's language? ______________________________

____

____

7. Consider the <u>Edmund Fitzgerald</u> as an example of a Great Lakes Triangle disaster. Are there natural forces that could explain the sinking, or is there a need for other kinds of explanations?

____

____

8. Considering the storm, the water depth and temperature, and what possibly happened to the <u>Fitzgerald</u>, why do you think the bodies of the crewmen were never found? ______________

____

____

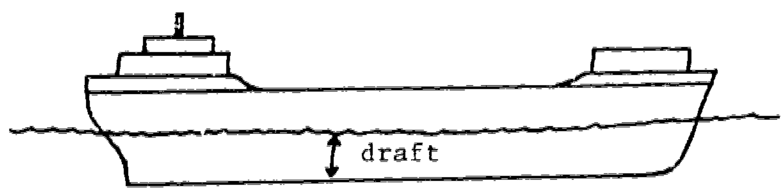
TOPIC 1

GREAT LAKES BULK CARRIER DESIGN

INTRODUCTION

The Edmund Fitzgerald sank in the Great Lakes Triangle area on November 10, 1975. The Coast Guard and the National Transportation Safety Board both decided that the wreck was caused by a hatch cover which let water enter the hold. If you examine the general shape and parts of the Fitz, you will be able to point out to your classmates some ways that ship design could have been at least a partial cause of the sinking.

The ships that carry iron ore (taconite pellets) on the Great Lakes are designed to haul huge loads with very little draft. Draft is the depth of water necessary to float a vessel. If a ship "draws" (has a draft of) 30 feet, it can only go in water that is more than 30 feet deep. Because of underwater rocks and the necessity of going through locks from one lake to another, most lake vessels draw 25 feet or less when fully loaded. This means that a large load must be spread out in a "thin layer." If a ship is designed for use on one lake only, it can have a larger draft.



A bulk carrier is a ship that carries a large amount of unpackaged material like grain or minerals. Great Lakes bulk carriers are usually about ten times as long as they are wide, and about half as deep as they are wide. The Edmund Fitzgerald was the biggest ore carrier on the lakes when she entered service in 1958. The Fitzgerald was 727 feet long, 75 feet wide, and drew 25 feet of water.

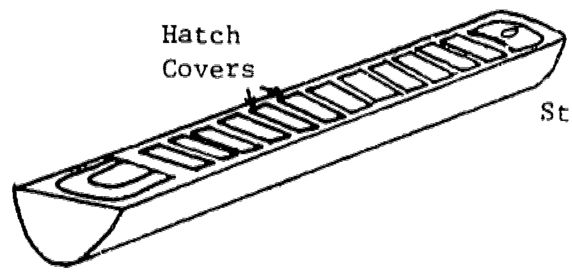
MATERIALS

Cardboard tube at least 45 cm long; tape; small plastic beads or aquarium gravel; marking pen.

PROCEDURE

A scale model is a small version of anything, with all sizes cut down by the same proportion. Architects, car designers, and such make scale models to see how a product is going to look before they invest in the real thing. The model of an 80 x 60 foot house might be 80 x 60 inches, or 8 x 6 inches, or 4 x 3 inches. For each of the model sizes given, the original measurements have both been divided by a certain number.

1. Build a scale model of the Edmund Fitzgerald using the dimensions given in paragraph 3 on page 7. Use a cardboard tube which you flatten on one side to form the deck. Draw hatch covers on the deck and outline the positions of other deck structures



2. Seal one end of the "hull" with tape and pour small plastic beads or aquarium gravel into the hold until it is about 3/4 full. Seal the open end so that none of the "ore" can get out.

   This simulates the cargo of an ore carrier like the Fitzgerald. The hold of the ship is a single open chamber. It does not have any dividers, or "bulkheads," to separate one section from another. Ore pellets are loaded through the hatches on deck.

3. Experiment with your model to find the answers to the following questions:

   A. Balance the model on the side of a pencil. What do you have to do to find the balancing point (center of gravity)? ______________________________

   B. Suppose the ore is loaded and the ship is balanced for its trip across the lake. A storm comes up. Wind and high waves cause the ship to roll (rock from side to side) and pitch (rock from end to end). Which motion, roll or pitch, is more likely to shift the cargo out of balance? ______________________________

   C. Waves break over the ship one after another. The water from one wave doesn't even clear the deck before more water piles on. How could this affect the ship's balance? ______________________________

   ____

   D. A hatchway caves in or comes unsealed, letting water enter the hold. How could this affect the ship's balance? ______________________________

   ____

   E. A series of waves raises up the stern and rolls under the ship toward the bow. If the cargo shifted strongly toward the bow, what could happen to the ship?

   ____

   ____

   F. The *Fitzgerald* was 727 feet long. She sank in 530 feet of water. What could happen to the ship if it suddenly nosedived to the bottom?

   ____

   ____

4. Prepare to explain to the class how ship design could be at least partly responsible for the loss of some vessels.

5. Share with the class the meaning of these terms: draft, scale model, hull, bulkheads, center of gravity, pitch, and roll.

TOPIC 2 STORM TRACKING

INTRODUCTION

Weather conditions on the water can sometimes create freak accidents that appear to be more supernatural than natural. Sightings of "ghost ships," sea monsters, and the like often occur during periods of unusual weather. Natural forces and a good imagination are probably responsible for many of the "unexplained" phenomena of the Great Lakes and Bermuda Triangles.

The mariners of the world's oceans and the Great Lakes are always watchful of the weather. Their lives depend on how prepared they are for conditions on the water. Regardless of their preparedness, however, accidents happen. A storm may build up far more strength than weather predictions forecast, and the tremendous force of a raging sea may be more than a ship can take. Such an accident occurred on November 10, 1975, with the sinking of the ore freighter Edmund Fitzgerald.

MATERIALS

Transparencies of Lake Superior, wax pencils, overhead projector.

PROCEDURE

All over the world, every six hours at 1 and 7 P.M. and 1 and 7 A.M. Eastern Standard Time, observers report weather conditions at their location. Wind speed and direction are noted. Precipitation for the previous six hours is measured. Temperature, visibility and any other weather conditions are also recorded. The information is then put into an international code, sent to collection centers within each country, and exchanged internationally. In this country, the information is collected and analyzed by the U.S. Weather Bureau.

At the centers receiving the coded weather information, weather maps are prepared. The messages are decoded and the conditions reported are translated into figures and symbols. These are grouped around a small circle drawn on a map at the position of the station reporting the information. The circle on the map, with the figures and symbols describing the weather conditions at that location is called a station model. The method of construction of a station model and an interpretation of its information are shown in Figures 3–5.

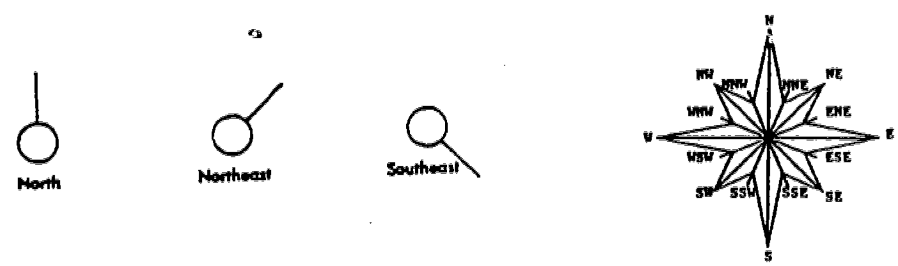


Figure 3: Method for showing wind direction. Circle is placed at location of station, and bar points to where wind is coming from.

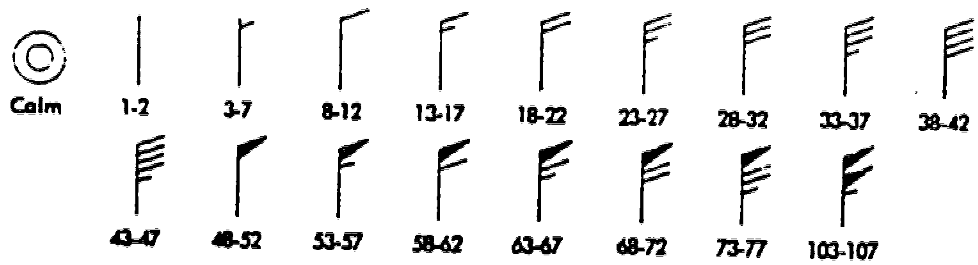
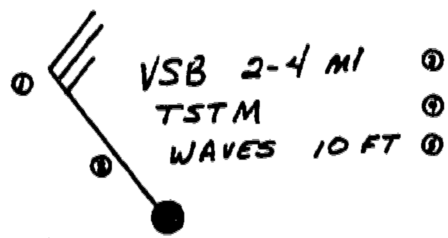


Figure 4: Symbols used to indicate wind speed (in knots).



1. Force of wind = 25 knots
2. Wind direction: from northwest
3. Visibility 2-4 miles
4. Thunderstorm in progress
5. Waves

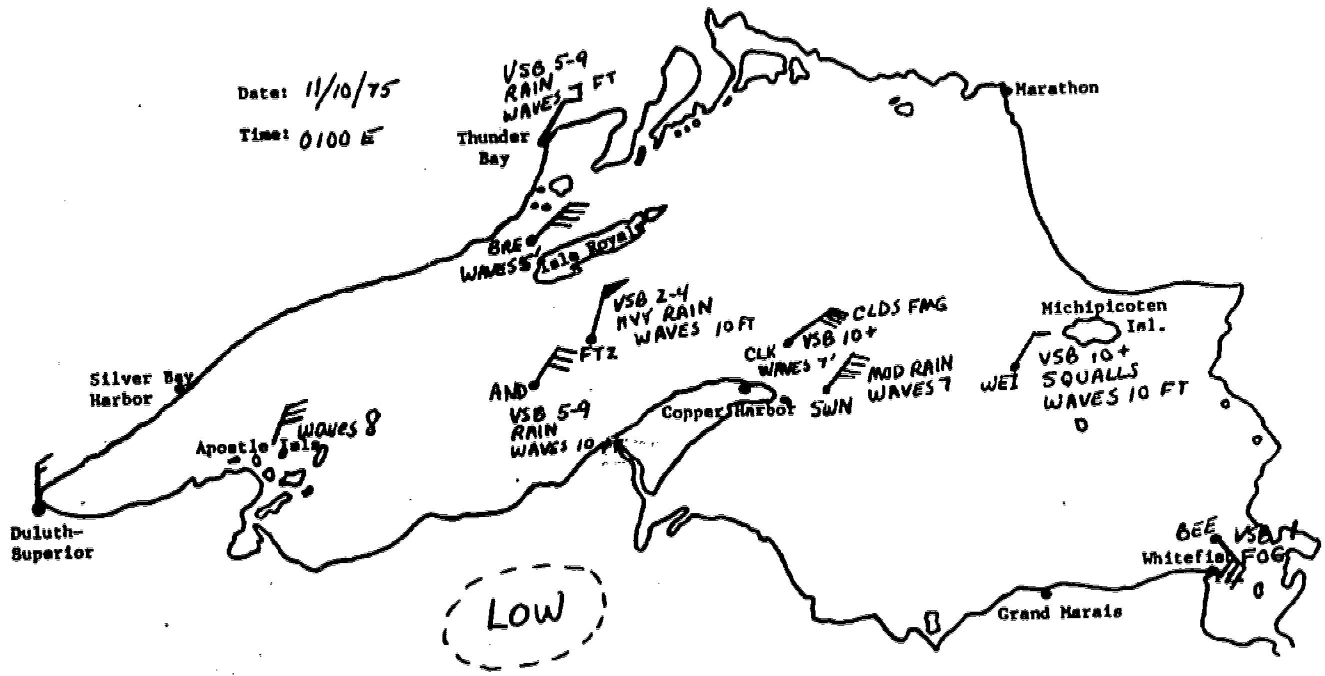
Figure 5: Interpretation of a Station Model

You are to examine and report data (information) on weather conditions during the storm that caused the Fitzgerald's sinking.

Figures 6 and 7 show the weather data for 1 and 7 a.m. (Eastern Standard Time) on November 10, 1975. The abbreviations used stand for ships that reported in as weather stations. This data was taken from the actual transcripts of hearings following the sinking of the Fitzgerald. From your teacher get transparencies of Lake Superior numbered 3-4, and record on them the following information:

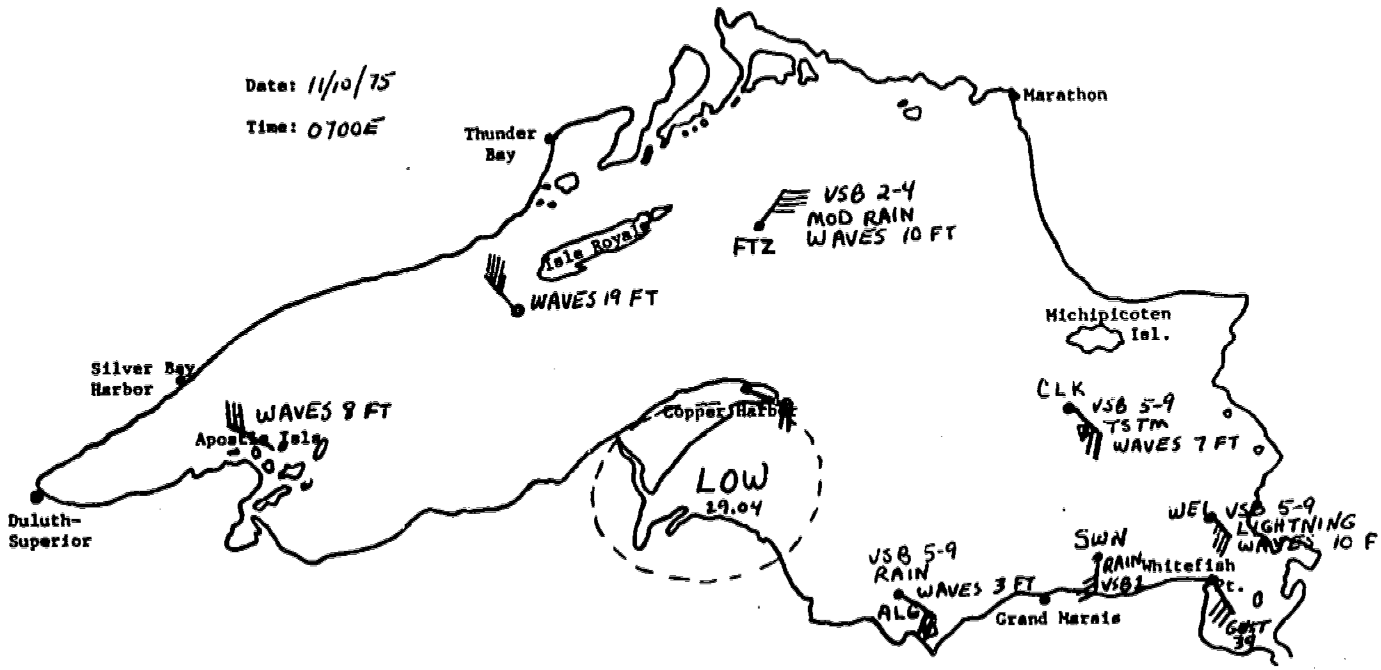
A. Date and time (plot a new map for each different time).

B. Wind, wave, precipitation and visibility data for the stations listed. (Some stations are on land; others are reports from ships at the positions given.) The information to be plotted is in the chart on page 14.



Date	Time	Station Location	Wind Speed (Knots)	Wind Direction	Wave Height (Feet)	Precip.	Visibility (Miles)
11/10/75	0100E	Anderson (AND)	32	NE	10	Rain	5-9
		Fitzgerald (FTZ)	52	NNE	10	Heavy Rain	2-4
		Duluth	15	N			
		Apostle Isls.	30	NNE	8		
		Thunder Bay	10	NE	7	Rain	5-9
		BRE	38	NE	5		
		CLK	42	ENE	7	Clds Forming	10+
		SWN	40	NE	7	Mod. Rain	
		WEI	30	NE	10	Squalls	10+
		BEE	30	SE		Fog	1

Figure 6. Weather data from 1 AM, November 10, 1975.



0700E	FTZ	35	NE	10	Mod. rain	2–4
	Apostle Isls.	30	WNW	8		
	SW of Isle Royale	45	NW	19		
	Copper Harbor	20	ESE	6		
	ALG	20	SE	3	Intmt. rain	5–9
	CLK	26	SE	7	TSTM	5–9
	SWN	25	S		Rain	1
	WEI	35	SE	10	Lightning	5–9
	Whitefish Pt.	30	SE			
		gust 39				

Figure 7. Weather data from 7 AM, November 10, 1975.

Table 1. Weather data for maps 3 and 4 (transparencies).

Date	Time	Station Location	Wind Speed (Knots)	Wind Direction	Wave Height (Feet)	Precip.	Visibility (Miles)
	1300E	AND	20	SE	10	Clds forming	10-24
		Duluth	25	NW			
		Silver Bay	20	NW	5	Clds dissolving	10-24
		SW of Isle Royale	40	WNW	10		
		BEE	49	NW	7	Mod. Snow	1
		TAD	53	NW	15	Heavy Snow	½
		Copper Harbor	60	WNW	8		
		Slate Isl.	25	NNW	7		
		SIM	44	W	7		10-24
		Caribou Isl.	40	W	6		
		CLK	41	S	13	Mod TSTM	5-9
		Whitefish Pt.	20	SW	15	Lt. Snow	2-4
	1900E	Duluth	10	WNW			
		Copper Harbor	40	NW	10		
		Grand Marais	55	W	13		
		ARM	25	NW	8	Clds dissolving	10+
		NE of Isle Royale	40	NW	5		
		off Marathon	25	NW	5		
		FTZ (sank)	49	NW	16	Drizzle & Snow	10+

Answer the following questions based on your maps:

1. In what direction was the storm moving? (Note the movement of the low pressure center.)

   ____

2. Do the winds around a low pressure center blow clockwise or counter-clockwise? ______________
   Toward or away from the center? ______________

   ____

   Are wind speeds greater or less as they get closer to the low pressure center? ____________

   ____

3. On weather maps 1-4, check the station models for coastal weather and mid-lake weather. Which areas, coastal or mid-lake, had higher wind and waves? __________________________________

   ____

4. Which areas had higher wind and waves, island areas or mid-lake areas? ________________________

5. Which side of the lake, Canadian or U.S., had more severe weather conditions? __________________

6. The map below shows the courses taken by the <u>Fitzgerald</u> and a following ship, the <u>Anderson</u>.

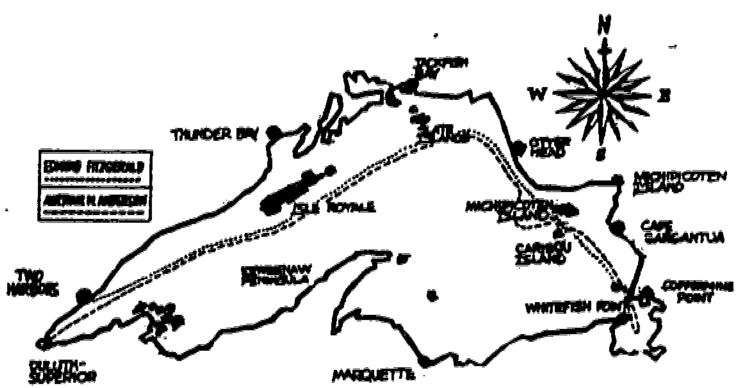


Figure 8: Courses steered by the *Arthur M. Anderson* and the *Edmund Fitzgerald* on the night of November 10, 1975.

Was this the best possible course in view of the weather conditions?_______________

7. Plot a recommended course for the *Fitzgerald* on a third transparency. Be prepared to defend your choices for the rest of the class.

TOPIC 3

LAKE BOTTOM CHARACTERISTICS

INTRODUCTION

How deep is the water? Every mariner must be aware of water depth in order to know if his vessel will float without bumping the bottom.

Exploring water depths began with crude lead-weighted ropes on wires lowered from ships. Knots or marks on these sounding lines were recorded as depth measurements. "Mark twain," for example, meant that the water came up to the second mark on the line and was two fathoms (about 4 meters) deep.

In World War I the echo sounder was developed. A sound sent out from an instrument aboard a ship bounces off the sea floor or lake bottom. When the echo returns to the ship, depth is calculated. Sound waves travel through water at a speed of 5000 feet per second. If the sound takes one second to reach the bottom, its echo takes one second to return and the water is 5000 feet deep. Using the results of echo sounding, scientists can draw a bathymetric chart. ("Bathy" means deep and "metric" means measured.) Such a chart shows the characteristics of the sea floor or lake bottom.

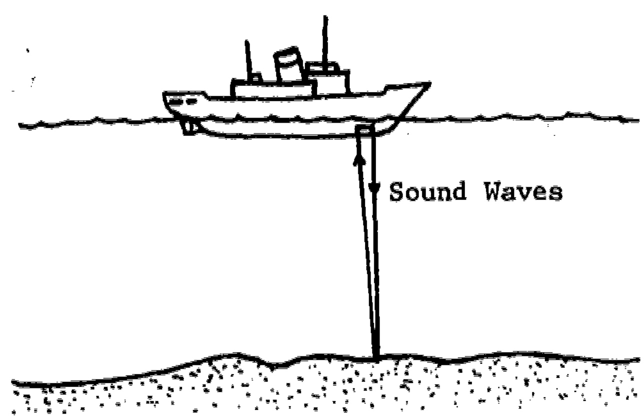


Figure 9: A ship using an echo sounder.

MATERIALS

Nautical chart of eastern Lake Superior (St. Mary's to Au Sable Point), transparent sheet, wax pencil.

PROCEDURE

A contour line is a line connecting points of equal elevation or depth. We can construct bathymetric contours in the following way:

1. The numbers on the nautical chart on the next page are the soundings at various locations in a small lake. The larger the numbers are, the deeper the water. The zeroes indicate shoreline areas, where the water depth becomes zero. All the zeros around the edge of the map have been connected to show the shape of the lake.

Are there other zeros besides the lakeshore ones?

____

What kind of a feature has been drawn at point A?

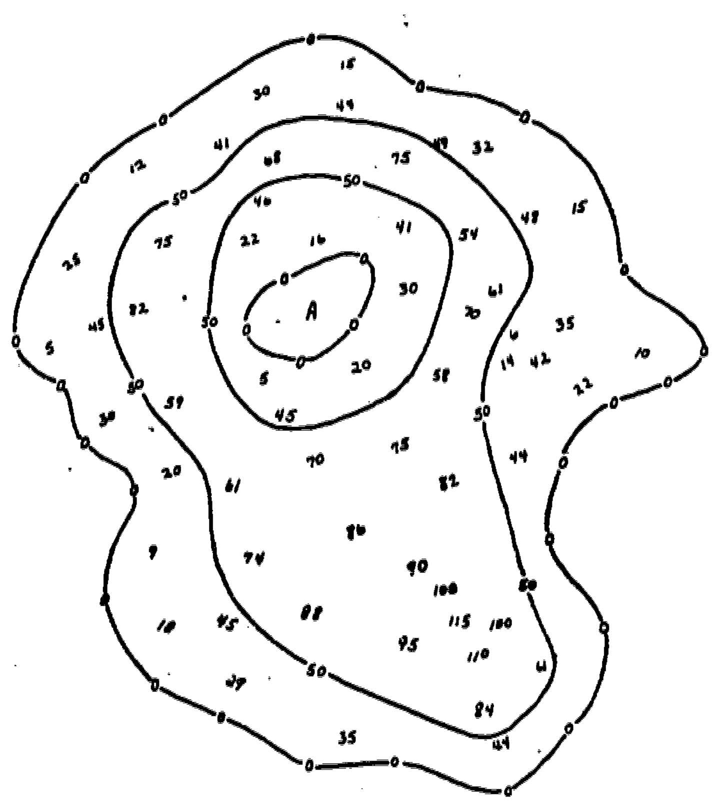
____

2. Now find a line that roughly shows where the water is 50 feet deep. (Mariners do not use the metric system yet.) The line goes between the numbers greater than 50 and the numbers less than 50. Contour lines do not end unless they go off the edge of the map, so the ends of the 50 foot line are connected.

   There are two 50-foot bathymetric contours for this map. One surrounds the feature at A and another is around the inside of the entire lake. Be sure you understand why these lines were drawn where they are.

3. Put a Y on a part of the lake that has some very shallow areas close to the 50-foot line. This is a place where there is a rocky area or a <u>shoal</u> underwater. Sailors would have to be very careful not to bump their boats into this.

4. Draw a 100-foot contour line in the lake. Put an X on the deepest point in the lake.



Practice Map: Soundings in a Small Lake.

5. On the large map showing the eastern end of Lake Superior, place a transparent sheet so that its short bottom edge is on the line labelled 46°50' and the long left hand edge is on the 85°0' line of longitude. Trace the shoreline onto your paper.

6. In the area covered by the tracing paper, draw 50-foot bathymetric contours. Be sure to look around for the depths far out in the water that may need to be enclosed in such lines.

7. Also draw a 75-foot contour. Your map should now show places of shallow water that are surrounded by very deep water.

8. Label the town of Coppermine Point on your transparency. On November 10, 1975, the Edmund Fitzgerald sank off Coppermine Point in 530 feet of water. Put an X on the place where the sinking probably occurred. (The ship was coming from the northwest.)

9. The Fitzgerald's hull was 37 feet deep. In a storm with large waves the hull might dip down to a depth of about 50 feet. Locate areas where hidden shoals might be (depths of 50 feet or less, and areas where few depth measurements have been made). Be prepared to show the class the areas where the Fitzgerald could have struck bottom.

ACTIVITY C

WHAT HAPPENED ABOARD THE EDMUND FITZGERALD?

On November 10, 1975, the Great Lakes ore carrier *Edmund Fitzgerald* sank in the area of the Great Lakes Triangle. Though its wreckage was found, no members of the ship's crew were ever recovered. The sinking thus became not only a new piece of the triangle's mystery; it became a human story as well.

Strong emotions are often expressed more effectively through an artistic creation than through spoken words. A violent painting or a joyful dance can communicate feelings that anyone can understand. The deep sorrow felt in the lakes country when the *Edmund Fitzgerald* sank was expressed in a haunting ballad by a Canadian singer, Gordon Lightfoot.

MATERIALS

Recording of Gordon Lightfoot's "The Wreck of the *Edmund Fitzgerald*," words to that song, pencil or pen.

Song removed due to copyright restrictions.

PROCEDURE

1. Listen to the recording. How does it make you feel?

   ____

   For each of the following things about the song, tell how it helps to produce this general feeling:

   A. the singer's voice________________

   ____

   B. the tempo (how fast the song is)____

   ____

   C. the instrument being played_________

   ____

   D. Sounds in the background____________

   ____

   E. the words (list words or phrases that help create the feeling)

   ____

   ____

2. Imagine that you are aboard the Fitzgerald on the night of the storm. The darkness and the cold rain are uncomfortable, but until now no one has doubted that you will reach your destination.

   [redacted] "At 7 P.M. a main hatchway caved in." Write a one-page description of what you might have witnessed aboard the ship as it sank. This can be done as if you are recording events in a diary or writing a last letter to a friend. Since you have probably decided for yourself what must have happened that night, this is a way or providing the world an "eye-witness" account of the events.

Some people have survived the "close encounters" with the Bermuda Triangle, others have not. The last messages from ships and planes that have disappeared are examined in Berlitz's book, Without a Trace, a follow-up to The Bermuda Triangle. The book also includes the testimony of witnesses and survivors. It serves to enlarge the mystery of the triangle as it searches for the natural or supernatural causes for happenings there. As you read these accounts, search for ways to explain the happenings naturally. Both Berlitz's and Gourley's books imply that forces from outer space are responsible for triangle disappearances. Though this idea is an interesting one, most scientists would tell us that science fact is stranger than science fiction. It is very likely that some natural factors such as those you investigated in this activity have been responsible for disappearances in both the Great Lakes and Bermuda Triangles.

There are more things in heaven and earth...
than are dreamt of in our philosophy.
Shakespeare

A FINAL NOTE

As this activity was being prepared, another incident was added to the Great Lakes Triangle mystery. This incident did not result in the loss of the plane or any lives, but it is the type of accident that makes people believe that unnatural things are happening in the Triangle. Try to figure out what natural forces could have caused this near-disaster.

Columbus Dispatch F FRI., APRIL 6, 1979

Survival Of Supersonic Dive Called Miracle

DETROIT (AP) — The 80 passengers aboard the TWA flight from New York to Minneapolis had just eaten a midair snack when they felt the craft begin to vibrate.

Suddenly, the plane swerved to the right, completed a 360-degree barrel roll and nose-dived from 39,000 to 12,000 feet — five miles — in a matter of seconds at a speed apparently exceeding that of sound.

"YOU COULD FEEL your face pressed back and the blood rush to your head," said Chell Roberts, 22, a University of Utah student who was aboard. "Everyone was screaming. I thought it was over."

"We were just through eating when it happened ... people started to scream and a flight attendant started to cry," he said. "It's really a funny feeling to see what everybody does before they think they are going to die."

But nobody died Wednesday night. Only three people aboard suffered minor injuries.

FEDERAL AVIATION Administration (FAA) inspectors said it was "miraculous" and "unprecedented" that the Boeing 727 jetliner survived such midair trauma before being brought under control in a desperation maneuver. Langhorne Bond, head of the FAA, commended the pilot, identified only as H. Gibson of Chicago.

"I can't think of any other incident where a (commercial, passenger) plane has done a complete 360-degree rollover and survived," Bond said Thursday. "The miracle is that it held together under such extraordinary speed and circumstances."

Preliminary evidence, Bond said, indicated that the flight waz "very routine in clear weather" when the plane "began to vibrate, went out of cruise control, rolled to the right, did a complete turnover and dived to the ground."

"WE DON'T KNOW what caused it at this time," Bond said.

At that point, the pilot tried to slow the descent by deploying devices on the plane designed to increase drag. But the wing flaps, spoilers and leading-edge slats proved ineffective at the speed the plane was traveling and were torn off.

The pilot then lowered the landing gear.

"It is clear that that is the event that allowed the crew to regain control of the plane," Bond said.

"THERE IS NOTHING in the manual to tell you what to do," he said, commending the pilot.

Bond and other FAA officials flew in from Washington to survey the damaged craft at Detroit Metropolitan Airport. The plane, with a seven-member crew, made an emergency landing at 10:30 p.m. Wednesday.

Propped up by jacks, the plane sat on an airport side runway as mechanics, FAA officials and reporters examined the damage. Flaps on the right wing were ripped off during the descent. Pieces of metal hung from that wing and from the fuselage around the landing gear doors on both sides. Inside the airliner, newspapers and magazines were strewn on the floor. A large sack of used airsickness bags stood in the aisle.

TWO TAPES, ONE recording cockpit conversations and one recording radio conversations with the ground, were sent for study to the National Transportation Safety Board in Washington.

Chuck Foster, associate administrator of the FAA for aviation standards, said the plane was flying about 500 mph before the trouble hit, but in the dive apparently exceeded 650 mph — above the speed of sound at that altitude and temperature.

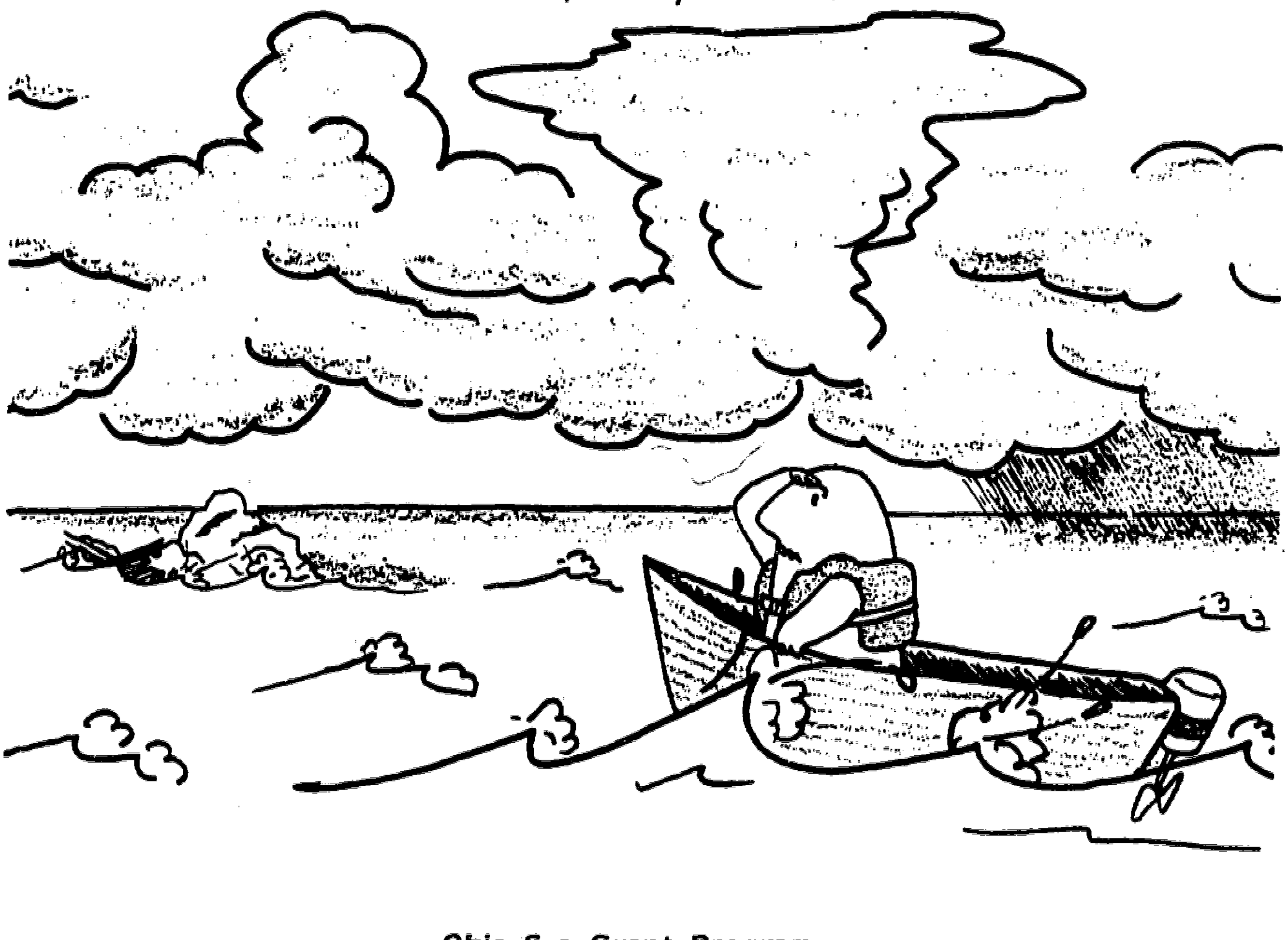
"I've been told that the airspeed indicator was pegged all the way over to the edge," Foster said. "If that proves to be the case, it will be the first time in FAA history that an airplane (not designed for it) had exceeded those speeds and survived."

OEAGLS- Oceanic Education Activities for Great Lakes Schools

THE GREAT LAKES TRIANGLE

by

Rosanne Fortner, The Ohio State University
and
Daniel W. Jax, Bexley Public Schools



Ohio Sea Grant Program
Charles E. Herdendorf, Program Director
Victor J. Mayer, Principal Investigator

TEACHER GUIDE

OEAGLS Investigation #11
Completed September, 1980

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INVESTIGATION THE GREAT LAKES TRIANGLE

OVERVIEW

This investigation includes three activities leading to a consideration of fact and fiction about the disappearance of planes and ships in the Great Lakes area. The first activity involves studying the locations of missing craft and personnel. Students examine concentrations of the disappearances and speculate on their causes.

Activity B is actually three activities which are to be performed by different classroom groups simultaneously. If time permits, all three activities can be done by the entire class. This would probably increase the general level of student understanding of the three ideas. The activities treat the wreck of the Edmund Fitzgerald as an example of a Great Lakes Triangle tragedy. One topic involves plotting bathymetric contours in eastern Lake Superior and pointing out locations where hidden shoals could exist. A second topic requires preparation of a series of transparencies plotting weather conditions on the day of the wreck, and a third topic uses a model of the Fitzgerald to illustrate how ship design could have contributed to the disaster. When all three topics have been considered the teacher will lead a discussion to consider whether the wreck of the Edmund Fitzgerald was an accident resulting from natural causes or whether other supernatural or extraterrestrial forces were at work.

Finally, Activity C focuses on how an art form can convey emotions as well as provide information. The class will listen to the ballad "The Wreck of the Edmund Fitzgerald" and tell how the song conveys its mood. Each student will then write a short letter or diary entry explaining "what really happened" when the Fitzgerald went down.

PREREQUISITE STUDENT BACKGROUND

None.

MATERIALS

Overhead projector, four transparent sheets, wax pencils, cardboard tube 45-55 cm long, tape, marking pen, aquarium gravel or plastic ESCP beads, bathymetric chart of eastern Lake Superior, and recording of Gordon Lightfoot's "The Wreck of the Edmund Fitzgerald.

OBJECTIVES

Students who have completed this investigation will be able to:

1. Explain what is meant by the Great Lakes Triangle.
2. Describe how bathymetric charts are constructed.
3. Explain how weather information is mapped.
4. Describe the characteristics of a Great Lakes bulk carrier.
5. Discuss at least two possible explanations for the sinking of the Edmund Fitzgerald.

SUGGESTED APPROACH

Activity A should be done together by the entire class as an introduction to the topic.

Assign students to one of three teams for Activity B, or have them read all three topics if the class is to work as a unit. Activities A and B can usually be completed in two class periods.

Additional class time will be needed if all students do all parts of Activity B. Plan to lead a discussion based on the three topics when work on them is completed. (A recommended question sequence is included in this guide).

As a follow-up and means of evaluating the impact of the entire investigation, Activity C can be assigned for completion outside of class once the recording has been played.

The bathymetric chart of "St. Mary's to Au Sable Point" (Nautical chart #14962) for Activity B can be obtained from:

Distribution Division, C44
National Ocean Survey
Riverdale, MD 20840

The 1980 price for the map is $3.25.

ACTIVITY A — WHAT IS THE GREAT LAKES TRIANGLE?

PROCEDURE

Table 1 (shown on pages 4-6 of the Teacher's Guide) lists the disappearances or wrecks of ships and planes within the area shown as Figure 1 in the Student Guide. Please post the table where students can refer to it.

Answers to questions are as follows:

1. Yes, there are some areas with many disappearances. These include eastern Lake Superior, western Lake Erie, and areas around Milwaukee and Chicago.

2. Allow for guessing on this question. The areas in Lake Michigan are around busy airports. Eastern Lake Superior is full of islands and has a narrow approach route into St. Mary's River.

3. Yes, most losses included missing people.

4. This question calls for speculation. All answers should be accepted.

TABLE 1: Great Lakes Triangle Disappearances*

Date	Craft	Location at Time of Disappearance	People Missing
6/23/50	Northwest Airlines Flight 2501	70 miles east of South Haven, Mich.	58
11/10/75	Edmund Fitzgerald	Off Coppermine Point, Lake Superior	29
2/15/64	Twin engine plane	Western basin, Lake Erie(Detroit headed for Akron)	2
2/12/63	Small plane	Over Niagara Falls	0
11/21/02	Bannockburn, small freighter	Middle of Lake Superior	all
7/21/72	Piper plane	Offshore from Milwaukee, Lake Michigan	1
5/15/56	Canadian twin jet	Just Northeast of Lake Ontario	all
12/15/72	Lear Jet	Just south of Detroit	0
3/26/61	Small plane	Just west of Lake Michigan in Wisconsin	all
10/28/92	W.H. Gilcher steel grain ship	West of Straits of Mackinack, Lake Superior	all
10/28/92	Ostrich wooden schooner	Off Manitou Islands, Lake Superior	all
10/28/52	Small plane	35 miles northeast of Marquette, Michigan	4
12/7/27	Kamloops steamer	Isle Royale	all
8/20/99	Hunter Savidge Schooner	Lake Huron near Alpena, Michigan	5
4/19/74	Helicopter	Near NE shore of Lake Ontario(Ottawa to Greenville, Michigan)	0
12/19/66	Light plane	Over water between Cleveland and Erie	1
9/9/63	Light plane	Sandusky, Ohio	0
6/8/55	Light plane	North of Lake Superior(from Kapukasing, Ontario to Kenora, Ontario)	0

* Jay Gourley, The Great Lakes Triangle. Greenwich, Connecticut: Fawcett Publications, Inc. 1977.

Date	Craft	Location at Time of Disappearance	People Missing
9/23/60	Cessna 140	Just south of Milwaukee over Lake Michigan	0
11/12/13	The Price Ship	Lake Huron, southern tip	All (some bodies recovered)
11/24/18	Inkerman Minesweeper	Lake Superior(near Soo Locks)	All
11/24/18	Cerisolles Minesweeper	Lake Superior(near Soo Locks)	All
12/1/08	D.M. Clemson Steamer	Lake Superior(near Soo Locks)	All
11/28/52	CF-FUV plane	Lake Superior(between Keweenaw Pt. and Whitefish Pt.)	All
12/19/66	Cessna 172	Lake Erie, near Ashtabula	All
11/6/69	Twin turbojet	Lake Michigan(15 miles east of Milwaukee)	7
7/21/72	Twin Piper PA-31	Lake Michigan(15 miles east of Milwaukee)	1
12/7/72	Plane	Lake Michigan between Milwaukee & Chicago	1
11/30/72	Beech Expeditor	Lake Michigan(Detroit to Milwaukee)	1
3/20/65	Cessna 170B	Lake Michigan(near Chicago)	1
1/14/67	Plane	Lake Michigan(near Muskegon)	3
5/21/69	Beech 35	Northwest shore of Lake Michigan (near Menominee, Michigan)	4
5/21/59	Piper PA-18	Lake Superior(near Teggan Lake, Ontario)	2
12/16/59	Aero Design 560E	Lake St. Clair	2
3/20/73	Beech F18S	Lake Erie(Cleveland to Detroit)	1
4/20/73	Lake Seaplane	Lake Erie(few miles east of Howell,Mich.)	1
3/17/66	Twin-engine Piper	Lake Huron(Wiarton,Ont. to Alpena, Mich.)	1
11/22/79	Waubuno Steamer	Georgian Bay, Lake Huron	24
9/26/30	Our Son Schooner	Lake Michigan, Straits of Manitou	0
8/4/65	Mong Sport Plane	Lake Michigan	0

Date	Craft	Location at Time of Disappearance	People Missing
8/23/54	Twin jet interceptor	North shore of Lake Ontario, near Ajax, Ontario	0
7/20/62	Light plane	Alliance, Ohio, to Detroit, Mich. (Over west end of Lake Erie)	0
8/27/53	Jet	Over South Lake Michigan	1
11/21/36	Hibou passenger steamer	Georgian Bay	7
12/18/50	Sachem tug boat	Lake Erie, 11 miles North of Dunkirk	0
12/2/42	Admiral Stout ship	Lake Erie(8 miles from Avon Pt, 11 miles west of Cleveland)	14
12/2/42	Clevco tanker barge	Lake Erie(8 miles from Avon Pt, 11 miles west of Cleveland)	32(some re-covered, some not)
9/27/60	Twin jet interceptor	Lake Ontario	1
8/2/56	CF-100	Bruce Peninsula near Georgian Bay	2
11/26/13	Rouse Simmons schooner	Lake Michigan, just north of Chicago	17
11/29/60	Piper plane	Lake Michigan, just off Chicago	3
11/25/81	Jane Miller passenger steamer	Colpoys Bay near Georgian Bay	28
10/9/07	Cyprus steel freighter	Off Coppermine Point, Lake Superior	all but 1
12/10/67	Multi-engine Beech H-18	Lake Monona, near Madison, Wisconsin	0
9/6/64	Twin-engine piper	Markham, Illinois	0
.2/8/56	Aero commander	North shore of Lake Erie near Buffalo	0
.2/4/72	Cessna 320	East shore of Lake Michigan	0
4/4/70	Beech 36	Lake Michigan near Gary, Indiana	0
6/12/71	Cessna 180	Whitmore Lake, Michigan, 10 miles North of Ann Arbor	0
6/17/69	Piper PA-28	Few miles North of Chicago over Lake Michigan	0

ACTIVITY B HOW CAN DISAPPEARANCES WITHIN THE TRIANGLE BE EXPLAINED?

PROCEDURE

Keywords: station model, scale model, draft, center of gravity, roll, pitch, contour lines, bathymetric, echo sounder.

Divide the class into three groups or have the entire class complete all the activities for these topics:

Topic 1: Great Lakes Bulk Carrier Design
Topic 2: Storm Tracking
Topic 3: Obstacles Beneath the Waves

Information and instructions for all topics are included in the Student Guide. Upon completion of activities for the three topics have students present their results and ideas as you lead them in a discussion. The following sequence of questions is recommended for bringing out the major points (Topics are addressed as if they were done by separate teams):

Teacher: We have noted that many ships and planes have disappeared in the Great Lakes area. Does this indicate that some unusual forces are at work in the area, causing vessels and people to vanish into thin air, or could natural causes explain the losses?
(No pause for answer)
Let's examine some things that might cause a ship to sink in the Great Lakes. Team 1, show us how a Great Lakes bulk carrier is built and loaded.

Team 1: Presents a model of Fitzgerald. Be sure they explain what a scale model is and tell what is meant by draft of a ship.

Teacher: When you experimented with your model, Team 1, show us what you discovered about the balance of such a ship.

Team 1: Tells what was done with the model and how they answered questions A to F.

A. Cargo must be positioned exactly right to balance the ship.

B. Pitch will shift the cargo out of balance more.

C. Waves pile up water on deck and weight the ship down more. (They could also cause it to have a greater draft temporarily, so it could strike an obstacle underwater).

D. Water sloshes as the ship rolls and pitches. The water makes cargo shifting even more likely.

E. The ship could dive to the bottom.

F. It could snap into pieces or the front part could be buried in the lake bottom.

Teacher: (Show picture of Fitzgerald wreck, Figure TG 1, page 10. Could this have happened in the way you described? (Answer depends on Team 1's previous answers.) If E and F were correct, answer here should be "yes."

Teacher: Team 2 has investigated the weather conditions on the day the Fitzgerald sank. Team 2, please explain when and how a station model is constructed.

Team 2: Gives the requested information from pages 10-11 of Student Guide.

Teacher: What was the weather like on November 10, 1975?

Team 2: Shows Figures 6 and 7, then two transparencies and points out the general direction in which the storm was moving (toward the northeast, as shown by maps 1-3). Figures TG 2 and 3 show correct station models for Maps 3 and 4.

Teacher: When a low pressure center is on the map, it generally means unsettled weather. How do winds blow around a low pressure center?

Team 2: Gives answer to question 2, page 15. (Counter-clockwise flow toward the center, with stronger winds near the center.)

Teacher: On your transparencies, show us what types of areas have higher winds and waves.

Team 2: Gives answers to questions 3-5 and shows transparency sections to illustrate:

Higher in coastal areas than mid-lake (Map 1, Figure 6)
Mid-lake and islands about the same (Map 1)
Canadian and U.S. sides about the same (Map 3)

Teacher: Team 2, did the Fitzgerald choose the safest route or could you plot a safer one?

Team 2: Shows the transparency with the Fitzgerald route and explains the reasons for choosing the route.

General discussion of Team 2's choice. There are no correct answers.

Teacher: Team 3 has information about the bottom of Lake Superior and how underwater features could cause ships to wreck. Team 3, how do we know what's on the floor of a lake or ocean?

Team 3: Responds according to the introduction to their activity. Shows map they did as practice. (See Figure TG 4).

Teacher: Let's look at the area where the Fitzgerald sank. Team 3, what do the bathymetric contours tell us about the lake bottom in this area?

Team 3: Shows tracing of contours and points out shallow areas. (Figure TG 5).

Teacher: Tells about the "Three Sisters" waves described in article on pages 16-17 (a fourth explanation of what might have happened).

At this point the teacher should pull together the information from all teams and emphasize the following:

1. A combination of natural forces and possible human error could account for the sinking of the Fitzgerald.

2. Many disappearances within the lakes triangle are in heavy traffic areas (narrow stretches of water, busy airports, etc.) Compare this with the accident rate on the busiest street in your community and the accident rate on a little-travelled route.

3. There is probably no single explanation for all the accidents in the Great Lakes Triangle, but it is likely that logical reasons for the losses could be found.

4. This investigation has been a piece of scientific detective work--the putting together of pieces of information to reach a logical conclusion.

Figure TG 1: The Edmund Fitzgerald as it appears on the bottom of Lake Superior (Artists conception based on Coast Guard Data, Northern New England Marine Education Project, Shipping, Ships, and Waterways, 1978).

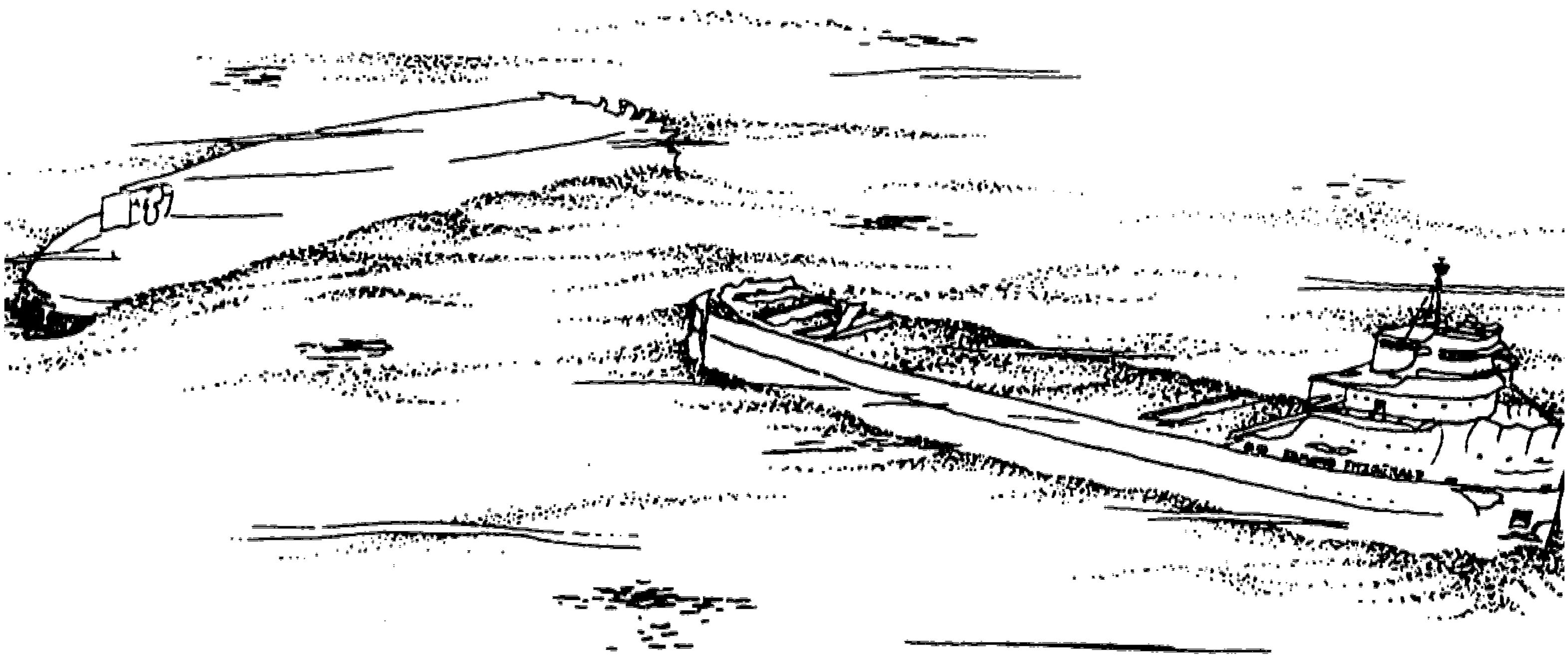


Figure TG 2: Correct station models for students' Map 3.

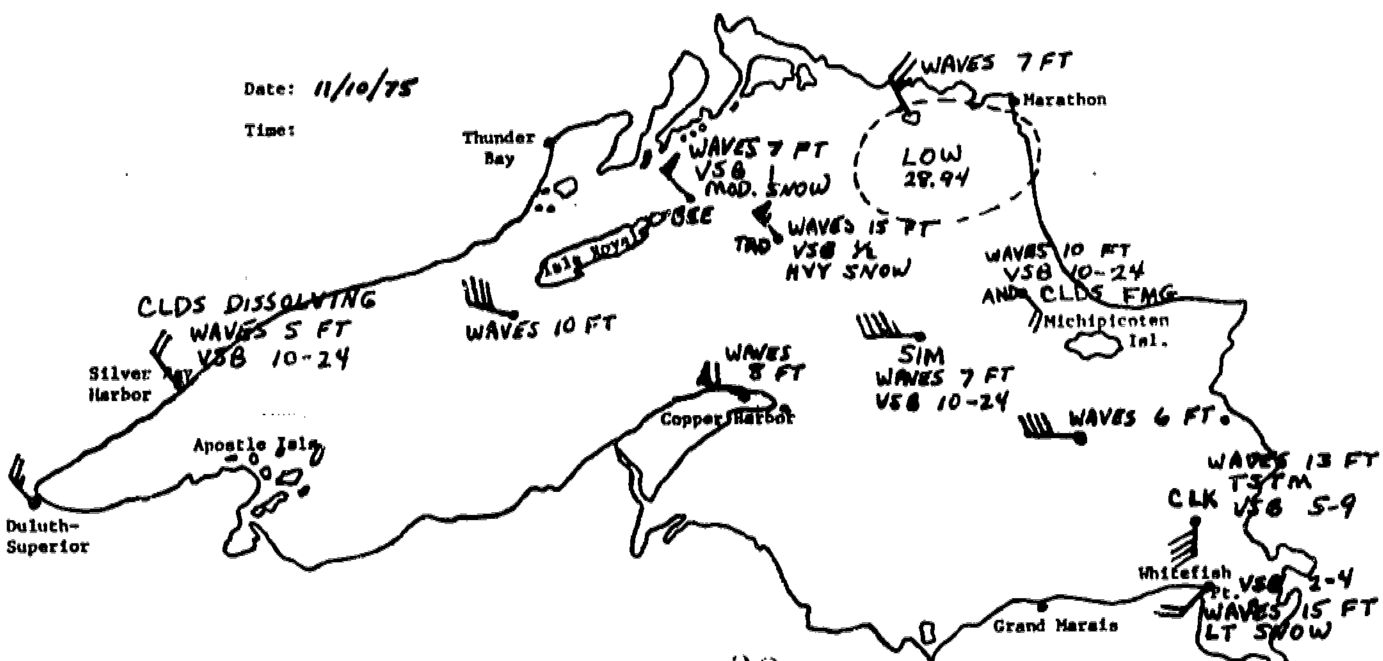


Figure TG 3: Correct station models for students' Map 4.

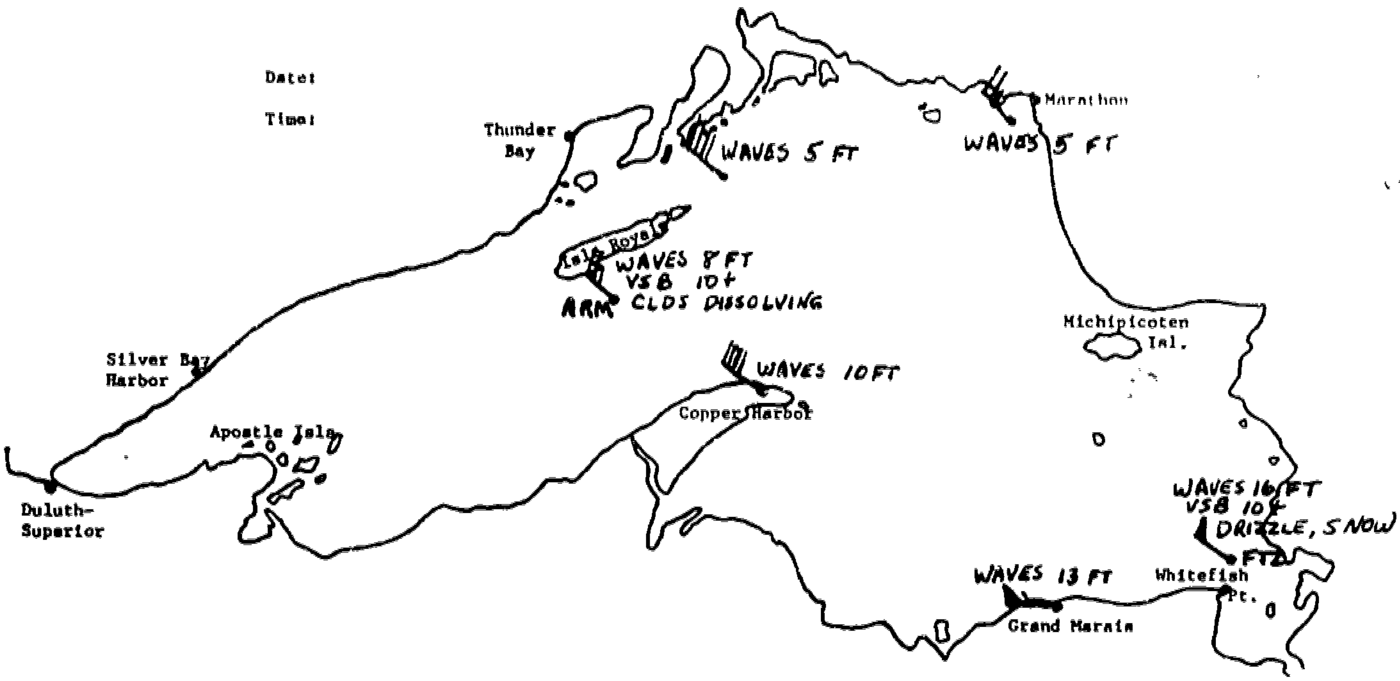


Figure TG 4: Key to practice map of soundings in a small lake.

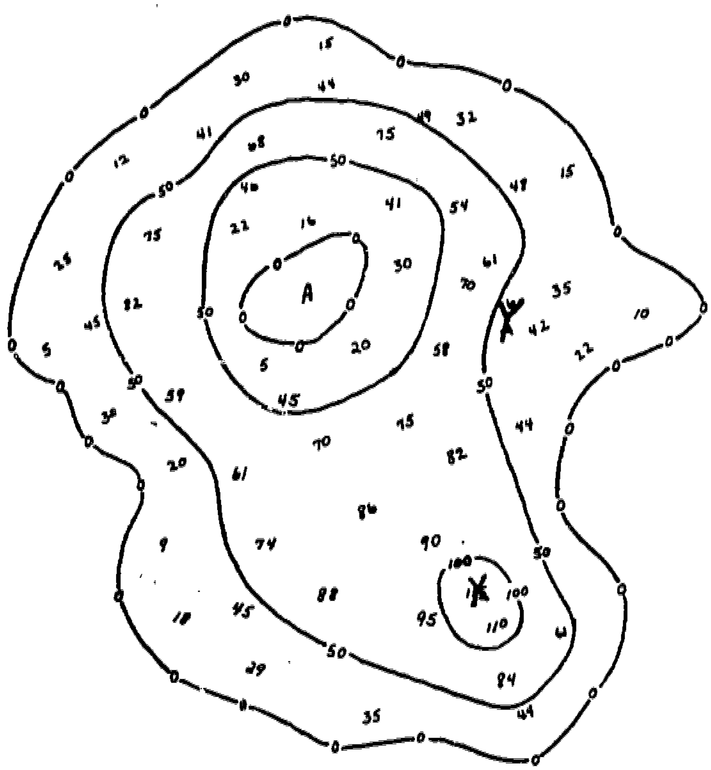


Figure TG 5: Bathymetric Contours of Eastern Lake Superior

ACTIVITY C — WHAT HAPPENED ABOARD THE EDMUND FITZGERALD?

PROCEDURE

Play the recording while students listen and look at the lyrics of the song.

1. Student feelings will differ but will probably be expressed as worried feelings followed by sadness.

   A. The singer's voice is low and clear. "He sounds sad," many students say.

   B. The tempo is very slow and rhythmic. It seems to roll and lumber along.

   C. The instrument is a steel guitar. The rhythmic rise and fall is created with a "bottle slide."

   D. Background sounds are like storm waves rising and breaking against the ship. After the ship sinks, storm waves are no longer heard.

   E. Lyrics that create a mood include: never gives up her dead, gloomy, a bone to be chewed, the witch of November, slashin', peril, the words turn the minutes to hours, etc.

2. This is to be an exercise in creative writing. Students imagine what actually happened aboard the Fitzgerald as it sank and write a first-person account as if they had been there.

REFERENCES

Berlitz, Charles. The Bermuda Triangle. New York: Doubleday and Company, 1974.

Berlitz, Charles. Without a Trace. New York: Ballantine Books, 1977.

Gourley, Jay. The Great Lakes Triangle. New York: Aaron M. Priest, Inc., 1977.

EVALUATION ITEMS

1. The Great Lakes Triangle

   a. includes all of the Great Lakes and some surrounding areas.
   b. is smaller than the Bermuda Triangle.
   c. has more unexplained disappearances than the Bermuda Triangle.
   *d. all of the above.

2. The draft of a ship is the

   a. amount of water it displaces.
   b. depth of its cargo hold.
   c. number of tons of cargo it can carry.
   *d. depth of water it needs to float.

3. The "three sisters" are

   a. three freighters that sank together in Lake Superior in 1975.
   *b. a series of three waves that are higher than average.
   c. three lighthouses on the shore of Lake Michigan.
   d. Buffalo, Detroit and Chicago.

4. Which statement is true concerning Great Lakes ore freighter design?

   a. All freighters are more than 300 feet long.
   b. Most freighters have a draft of 80 feet.
   c. Cargo holds keep cargo in a small, concentrated area.
   *d. The freighter is often about 10 times longer than it is wide.

5. What factor(s) could throw a ship out of balance?

   a. A hatchway caves in, letting water into the hold.
   b. The ship pitches and rolls, causing the cargo to move around.
   c. A series of waves suddenly hits the ship.
   *d. All of the above.

6. In the Great Lakes area the winds around a low pressure center blow

   a. toward the center and clockwise.
   *b. toward the center and counterclockwise.
   c. away from the center and clockwise.
   d. away from the center and counterclockwise.

7. The depth of a lake is determined using

   a. scuba divers.
   *b. echo sounding.
   c. weighted rope.
   d. light waves.

8. What is the mood of the song "The Wreck of the Edmund Fitzgerald?"

   a. Happy
   b. Hopeful
   *c. Sorrowful
   d. Frightful

The Sunday Journal

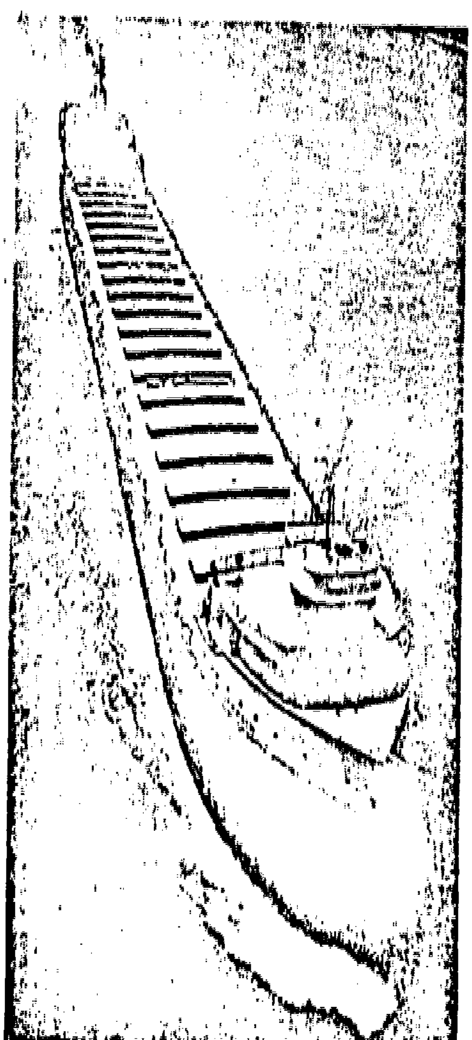
First Section

Marquette, Michigan

25 cents

Did 'three sisters' pull it down?

Fitzgerald: Another theory



THE EDMUND FITZGERALD

EDITOR'S NOTE: Lyle McDonald, who now lives in Laurium, is a former commercial fisherman on eastern Lake Superior at Grand Marais. His family has been in the commercial fishing business for years. Some of the shoals and reefs in the area of the Fitzgerald sinking were discovered by and named for his ancestors. An uncle was keeper at the Caribou Island light for many years.

By LYLE MCDONALD
Special to the Sunday Journal

Seafaring men and their families throughout the world waited almost two years to learn the findings of the U.S. Coast Guard board of inquiry regarding the sinking of the freighter Edmund Fitzgerald.

The statement released recently by the board that the ship probably sank because of seepage through the hatch covers was somewhat of a disappointment. One hesitates to dispute the judgment of such a group of knowledgeable people who spent so much time and money to come up with their findings, but they certainly did not release any information as to how the disaster could have been avoided or how future similar situations could be avoided.

It seems to be the consensus among sea-going men that seepage could have been somewhat of a contributing factor. However, the lip-seal design of hatch covers on freighters is such that very little seepage could occur.

The Fitzgerald was a relatively new ship. We should give the captain, crew, owners and designers some credit. No captain and crew would leave a Lake Superior port at that time of year without first insuring the hatch covers were properly secured and battened.

My license to make the above statements and offer my explanation of this traumatic disaster has been earned through many years as a captain of commercial fishing tugs on Lake Superior, primarily out of Grand Marais—very close to the present location of the Fitzgerald.

Throughout the years, the greatest battles with Lake Superior have been waged by commercial fishermen. Personally, I have waged many such battles. Knowledge of the sea's actions, the size and capabilities of the ship, courage, judgment and the Grace of God have enabled me to win all of those battles and respectfully submit my version of the tragedy.

The Fitzgerald went to the bottom of Lake Superior by means of submarining, due to excessive water weight on the decks of her forward section, immediately aft of the pilot house.

THREE SISTERS

The absolute key to this tragedy lies in the Three Sisters—or three big seas! I am amazed that this phenomenon has not been considered. Commercial fishermen, and all men who have spent considerable time on Lake Superior during storms, know that at irregular intervals, three larger waves appear. Fishermen, throughout the years, have timed and utilized these three big waves to successfully gain entrance to dangerous harbors when the wind is blowing off the lake.

To further understand this phenomenon, stand on the beach when the wind is blowing off the lake, and periodically, three waves will come higher on the sand than the others. This phenomenon of the three big waves is much more pronounced during a big storm, in the middle of Lake Superior, and in the fall and winter months.

Although the three big seas was the key to the disaster, many other elements have to have been precise to conquer this gigantic, magnificent ship. Some of the factors that have to be considered are: Wind direction and velocity, speed of seas, distance between seas, direction of ship, speed of ship, weight of cargo, buoyancy-displacement ratios, depth of water, contour of ship bow and inertia.

We know the wind was blowing approximately 70 mph out of the northwest. The speed of the ship would have been approximately 16 mph. A look at the chart will show that the course to Sault Ste. Marie, at the point where the ship was found, would have been approximately southeast.

44 15

Fitzgerald: Another theory

(Continued from page 1)

Importantly, note also that it had become necessary to change course after clearing Crisp Point, shortly before the tragedy. Consequently, the ship was traveling almost directly before the seas.

On Lake Superior, in November in deep water when the wind is blowing at 70 mph, the seas travel at approximately 25 mph and are spaced between 100 and 150 feet apart. We know that her decks had been awash previously. When the captain changed course, it enabled the three big seas to sweep up the full length of her decks, and the back-wash from the first sea was met by the second, and the backwash from both were met by the third. Since the seas were traveling almost twice as fast as the ship, this permitted a tremendous fluid weight to remain on the forward section.

The actual time lapse from the time the first big sea hit aft of the pilot house until the third one hit would have been approximately 10 seconds. Because of her great width, these three seas would have remained on her forward deck for approximately 20 seconds.

The ship was 729 feet long and had an 80-foot beam. The area of the forward 325 feet of the ship would be 26,000 square feet. If those three big seas massed on this section of the ship for 20 seconds, the adding water weight would be 10 million pounds at an average depth of six feet. During this time the ship would have moved forward approximately 50 feet.

HEAVILY LADEN

She was laden with 52 million pounds of iron ore pellets. This additional 10 million pounds of water for 20 seconds, and a travel distance of only 50 feet, caused the entire plane of the ship to depress from horizontal to from 5 to 15 degrees below horizontal. At this point, her decks were under or almost under the surface. Because her bow and sides were perpendicular to the water, her buoyancy-displacement factor became decreased to a point where inertia prevailed and she continued her course to the bottom.

With the terrific weight, speed and the forward force of the propellor, it is doubtful if the angle of descent would have increased much during the relatively short distance of 350 feet to the bottom. This angle would increase somewhat as the ship descended, because water pressure increases with depth. When the bow plowed into the clay bottom of the lake, the stern section would have been close enough to surface to permit time and space for the stern section to capsize after she snapped.

Were we to believe the findings of the Coast Guard board of inquiry, whereby she sunk because of seepage through the hatches, she would likely have seeped water through hatches both forward and aft, and would have settled to the bottom on a horizontal plane, and the aft section would not have had space or time to be upside down.

WHY IT HAPPENED

We have dealt with how this tragedy occurred, now let us consider why it happened, how it could have been prevented and what lessons it can teach people who put out to sea in boats.

The Edmund Fitzgerald lies on the botom of Lake Superior today, with it's full crew of 29 men trapped inside her, because the captain did not realize he was in danger. Prior to this tragedy, the Great Lakes ships had become so large, so well constructed, so fast and so completely equipped that the captains thought they were unsinkable.

Had the captain realized the storm could sink his ship, he could have gained shelter on the south side of Michipocoten Island or, later in the day, sought shelter under the north shore, on the Canadian side of the lake.

Had he known the ship could sink, he could have reduced his speed or utilized the old sailboat tactic of "tacking" before the wind. Had his speed been half, that massive body of water would have dissipated twice as fast.

Those of us who operate ships, regardless of size, should have learned many things as the result of this tragedy in which Lake Superior was able to swallow a ship of the magnitude of the Fitzgerald. Books have been written, and probably should be revised because of the tremendous number of relatively small pleasure craft, on water safety.

The cardinal lesson to be learned from the Fitzgerald tragedy is that one should never underestimate the ferocity and power of Lake Superior. Conversely, never overestimate the capabilities of your craft. A good operator does not get caught in a storm greater than the capabilities of his boat. However, if it does happen, common sense should prevail.

Any ship will survive a storm much better if the speed is reduced. If the situation gets to a point where shelter cannot be reached, any ship will weather a storm much better if she is held into the wind, with just enough propulsion to maintain steerageway.

8 The Journal, Lorain, Ohio Thursday, September 29, 1977

Fitzgerald Hit Reef, Latest Report Says

DULUTH, Minn. (AP) — The Lake Carriers' Association says the ore carrier Edmund J. Fitzgerald sank after striking a shoal, or underwater reef, nearly two years ago in storm-tossed eastern Lake Superior.

The association rejected the theory of the U.S. Coast Guard, which found that the "most probable cause" of the disaster was loss of buoyancy and stability resulting from massive flooding of the cargo hold through ineffective hatch closures.

The association, composed of 15 domestic bulk shipping companies operating 135 vessels on the Great Lakes, filed its position paper Wednesday with the National Transportation Safety Board, asking that it be considered in the board's deliberations in the case.

The paper was written by Paul E. Trimble, a retired Coast Guard admiral who is association president.

Trimble cited 40 years' experience with the type of hatch covers and closure clamps in use and said if they were ineffective there would have been many watery cargoes to unload.

This would have been a "costly problem that vessel and cargo owners would not tolerate," he said.

Testimony about improper hatch closure procedures on other vessels in other than heavy weather conditions "should under no circumstances be assumed to have been the case on the Fitzgerald in the weather she was experiencing," Trimble said.

He cited testimony before the board about the Fitzgerald's course shortly before it sank Nov. 10, 1975. Some of it was presented by the captain and a mate of the ore carrier Arthur Anderson, which was providing navigational assistance to the Fitzgerald after radar failure.

While no plot of the Fitzgerald was maintained, the captain of the Anderson said the Fitzgerald was close to SixFathom Shoal north of Caribou Island.

Trimble's other arguments in opposition to the Coast Guard's findings included:

—MINUTES after passing Six Fathom Shoal, the Fitzgerald reported a list and said two tank vents had been carried away and that two ballast pumps were operating.

—THE CAPACITY of the ballast pumps—14,000 gallons per minute—was adequate to handle the volume of water that could enter through the eight-inch diameter vents.

—THERE SHOULD have been no list, particularly in 10 to 15 minutes, from water from this source.

—THE FITZGERALD'S report of listing in such a brief period "can only be readily explained by holing of the vessel's ballast tanks caused by striking Six Fathom Shoal."

—THERE WAS NO REPORT of hatch damage or hatches opening.

—IT IS QUESTIONABLE that water in the cargo hold would have resulted in a list since it would not have been restricted to one side of the vessel.

—THE FITZGERALD'S MASTER reported the pumps were operating and "we are holding our own" minutes before the ship disappeared from view on the Anderson's radar.

—THE QUANTITY of water needed to sink the Fitzgerald "could not have seeped through the hatch covers."

Trimble said the Fitzgerald "labored in heavy, quartering seas for over three hours" after the initial damage caused by shoaling.

When buoyancy became marginal, a large wave or series of waves could have raised the stern, starting the bow's dive under water, Trimble theorized.

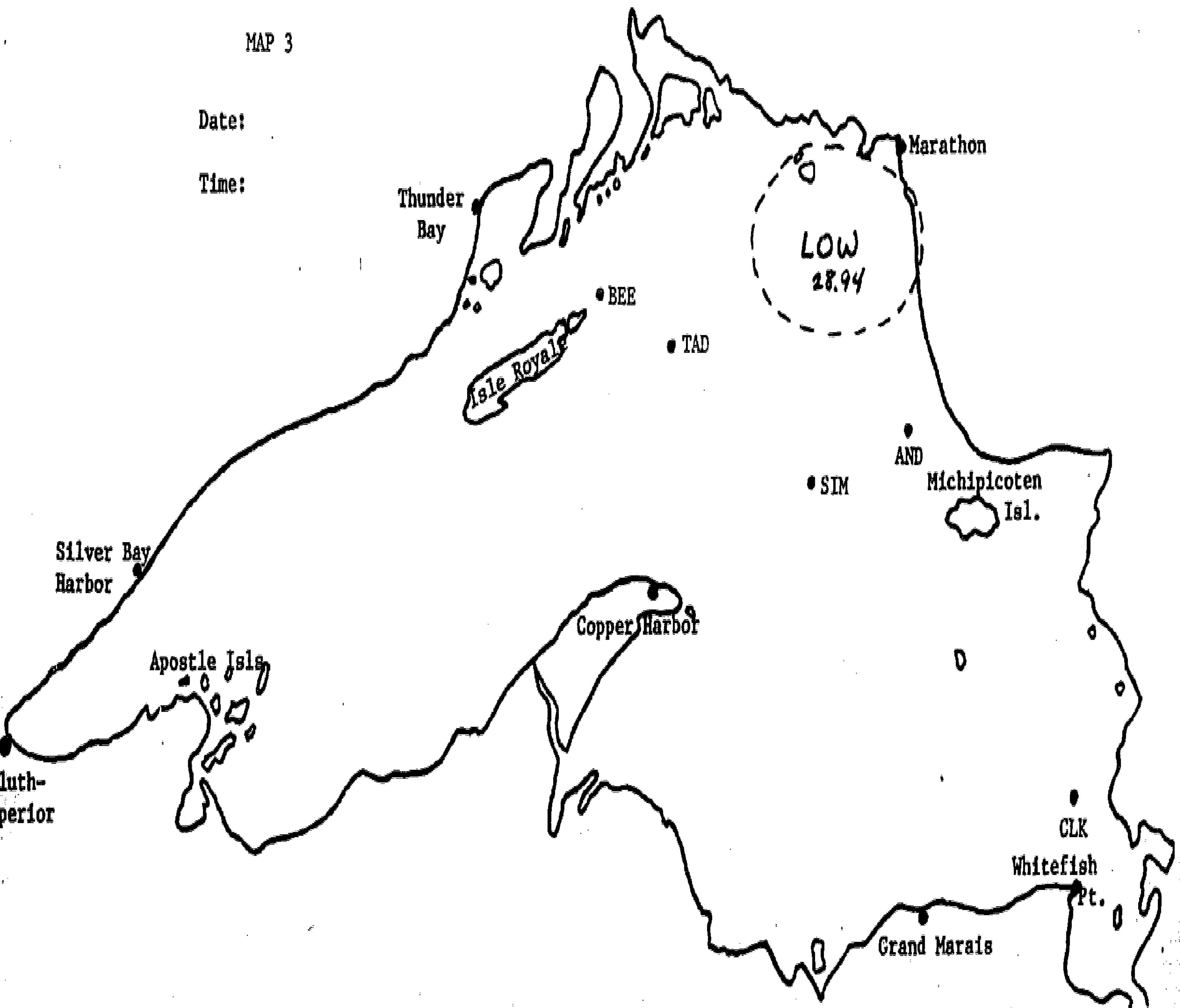
He said hatch covers could have been blown off by compressed air in the cargo compartments as water entered from the sides or bottom, or they could have sprung from the weight of taconite pellets cargo as the vessel dove in 530 feet of water.

Underwater photographs of the wreckage, he said, do not support a conclusion that the hatch clamps were not properly closed, he said.

MAP 3

Date:

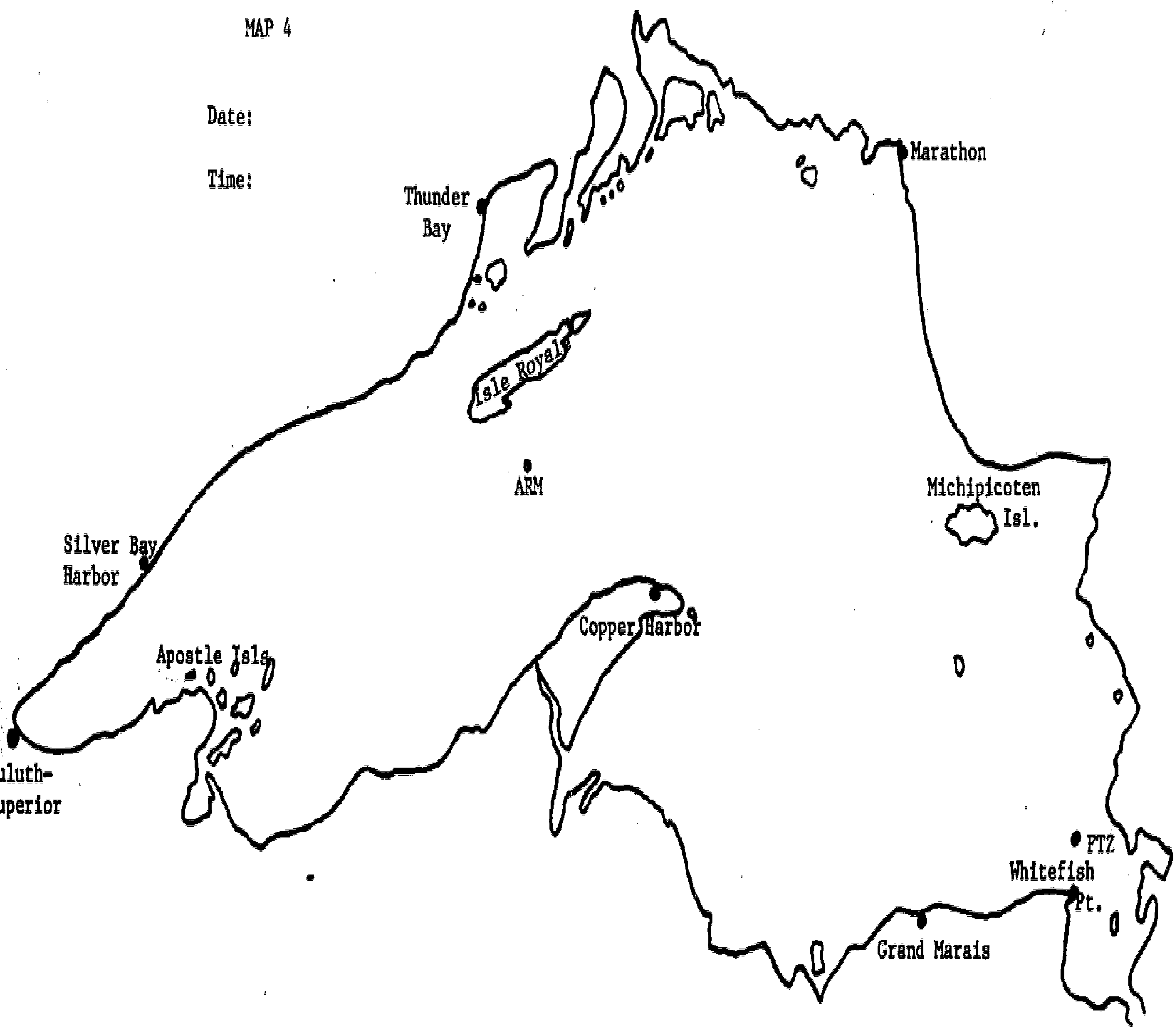
Time:

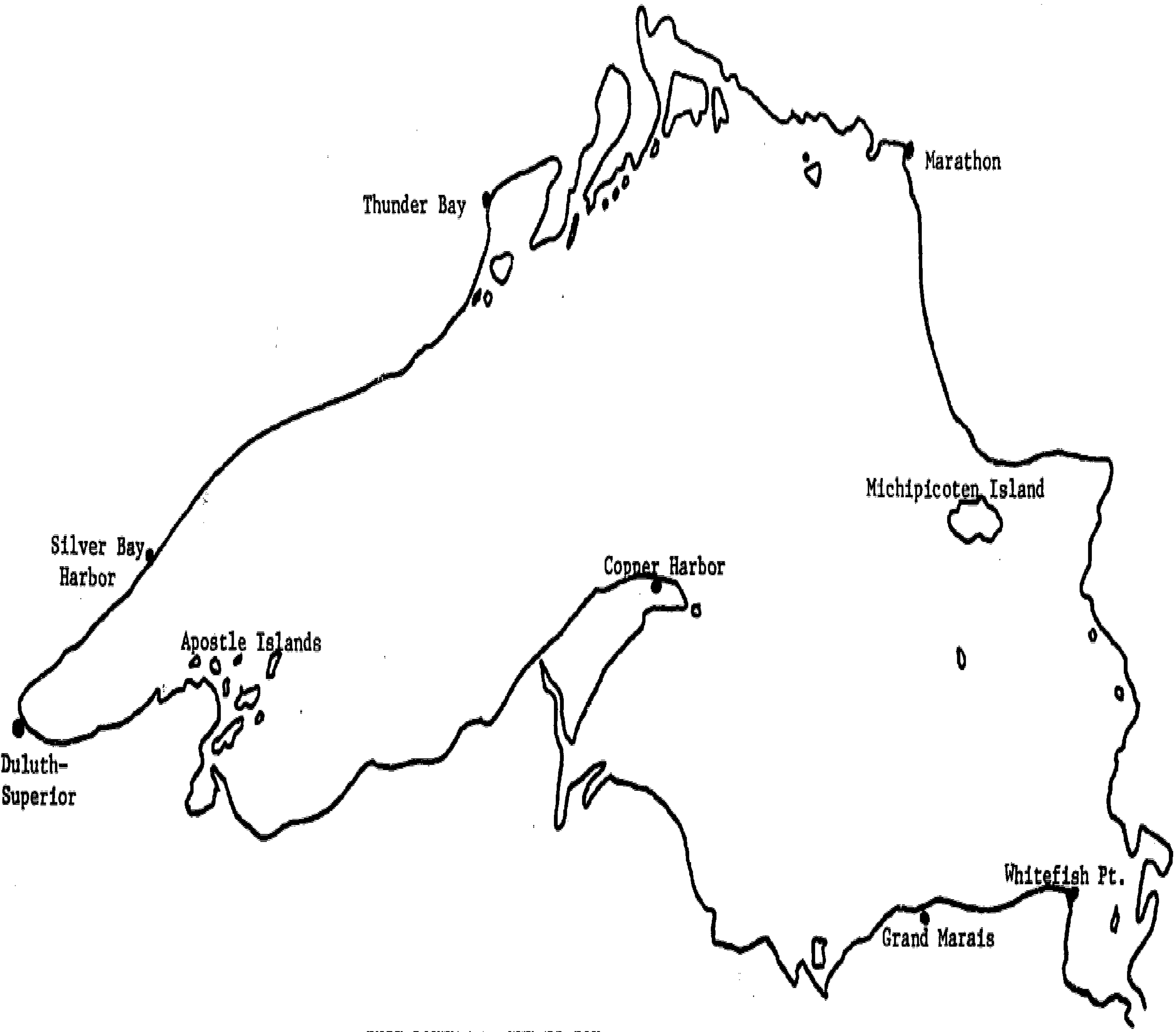


MAP 4

Date:

Time:





BEST ROUTE FOR THE FITZGERALD