OFFICE COPY

Report on Phase I Marine Magnetometer Survey in Death's Door Passage, Door County, Wisconsin, 1989

By

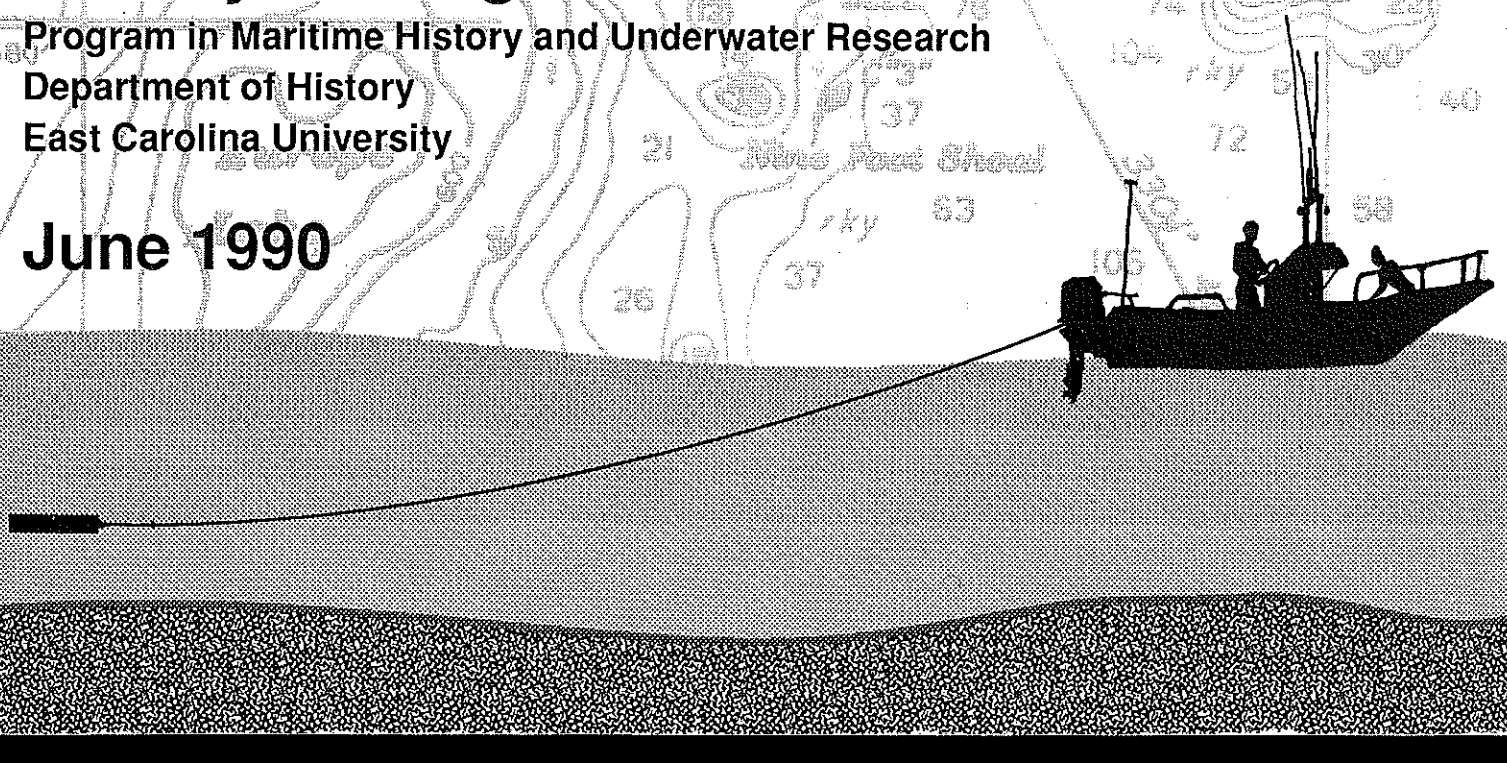
David J. Cooper

Underwater Archeology Program
Division of Historic Preservation
State Historical Society of Wisconsin

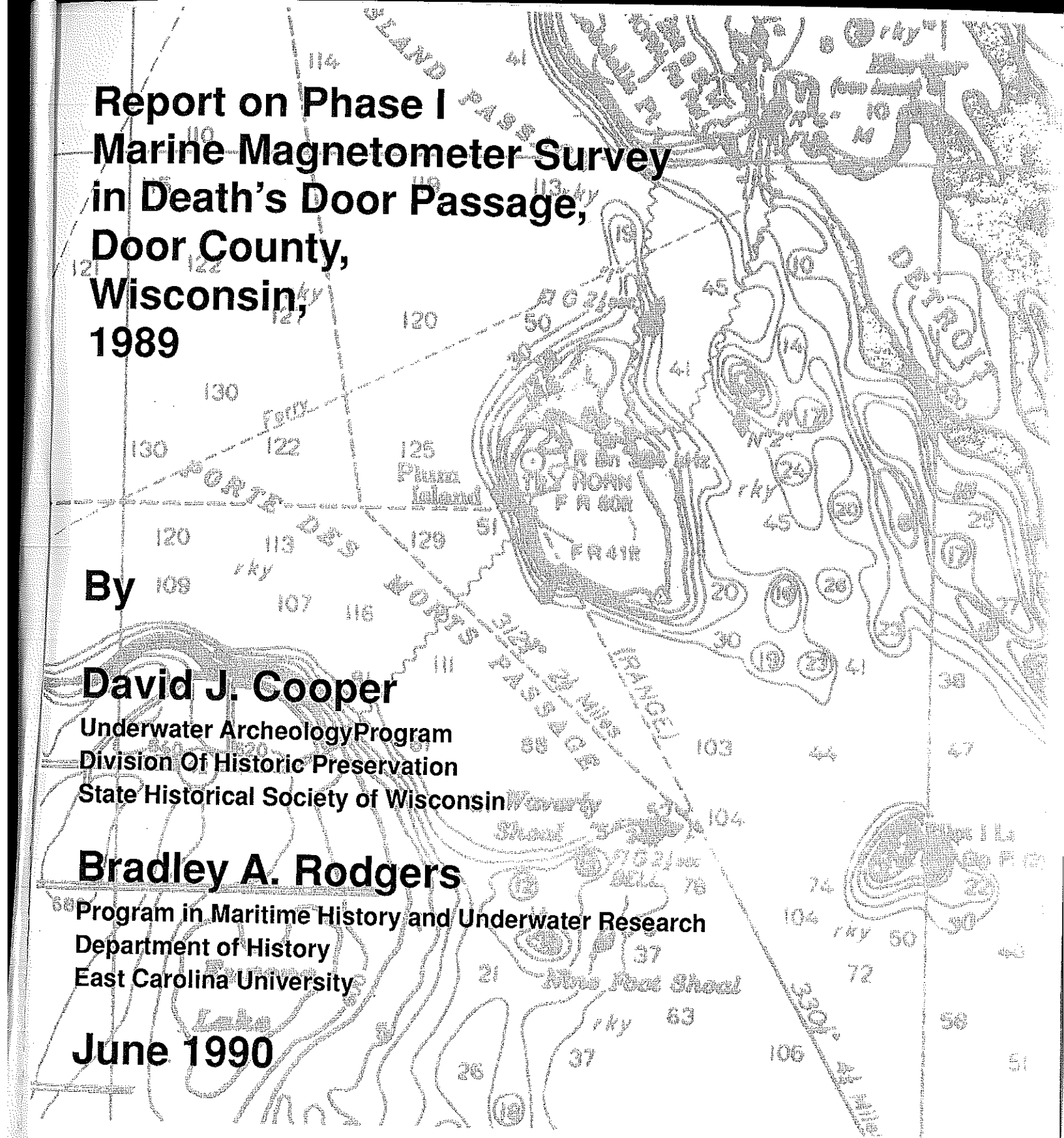
Bradley A. Rodgers

Program in Maritime History and Underwater Research
Department of History
East Carolina University

June 1990



Report on Phase I Marine Magnetometer Survey in Death's Door Passage, Door County, Wisconsin, 1989



By

David J. Cooper

Underwater Archeology Program
Division Of Historic Preservation
State Historical Society of Wisconsin

Bradley A. Rodgers

Program in Maritime History and Underwater Research
Department of History
East Carolina University

June 1990

The State Historical Society of Wisconsin 1846

East Carolina University

Wisconsin Coastal Management Program

Sea Grant Institute

FORWARD

The Wisconsin Coastal Management Program was established in 1978 to direct comprehensive attention to the state's 820 miles of Lake Michigan and Lake Superior coastline. The WCMP analyzes and develops state policy on a wide range of Great Lakes issues, coordinates the many governmental programs that affect the coast, and provides grants to stimulate better state and local coastal management. Its overall goal is to preserve, protect, and develop the resources of Wisconsin's coastal areas for this and succeeding generations.

ABSTRACT

Between July 5 and August 3, 1989, a joint marine archeological survey of submerged cultural resources was conducted off northern Door County, funded in part through a grant from the Wisconsin Coastal Management Program. The project was co-directed, staffed, and equipped by the State Historical Society of Wisconsin and the East Carolina University Program in Maritime History and Underwater Research, with additional equipment provided by UW-Sea Grant and the Mercury Marine Company of Fond du Lac.

The survey was directed at locating, identifying, and evaluating submerged cultural resources in selected coastal target areas for the purpose of inventorying such resources on state bottomlands and formulating recommendations for their management and protection. The survey covered approximately 9.42 square kilometers, consisting of 128 survey lanes over approximately 248 linear kilometers. Sixty-four magnetic anomalies and anomaly clusters were identified and recorded in the vicinities of Pilot and Plum islands in the southeast end of the Death's Door Passage. Significant material relating to twelve historic shipwrecks received preliminary assessment and documentation by divers, including measured sketches and photography.

Identification of submerged cultural resource concentrations of in the project area have largely been completed, with additional ground-truthing and site documentation to follow. The 1989 survey succeeded in locating the most significant inshore cultural remains in the southeast Death's Door Passage with their accompanying debris fields, providing a much better understanding of the distribution of these resources, how these shipwrecks have been affected by the Door's high energy environment, and what type of remains have been preserved to the present day.

ACKNOWLEDGEMENTS

The assistance of which has been provided to the underwater archeology program by various institutions, businesses, and individuals has been vital in augmenting our slim resources and in making such survey possible. As in past years, we are grateful to both East Carolina University and University of Wisconsin Sea Grant Institute in making available staff and resources for the project. Thanks go to Dr. Charles Calhoun, ECU Department of History Chairman, and Dr. Robert Ragotzkie, UW Sea Grant Institute Director and Acting Director, UW Marine Studies Center for their continued support. Also, many thanks to Mr. Jim Buckholtz of Marine Studies Center for his invaluable technical assistance.

Many thanks also to the program's new supporter, Wisconsin Coastal Management Program (WCMP), Department of Administration. The operational funding for the 1989 magnetometer survey was principally the result of a matching grant from WCMP. Special thanks go to Dave Jones and Jo Ann Savoy of WCMP for assistance with obtaining and administering this grant.

We are very grateful to Mercury Marine Company of Fond du Lac and President Thomas R. Weight for the generous donation of a 25 h.p. Mercury outboard engine for the program's workboat, and for Mercury's support for protecting and managing Wisconsin's marine recreational resources.

The authors would also like to acknowledge the assistance and cooperation of the following individuals:

Commander Richard Losea, BM-1 Joseph Michael, and the Coast Guard Station Plum Island crew for allowing access to Pilot and Plum islands for the temporary installation, operation, and maintenance of survey equipment, and overnight storage of a project workboat.

Dan and Kevin Kaniff of Aqua Adventures dive charters for sharing information on the locations of shipwrecks which they had located in the Pilot Island vicinity.

Jon Van Harpen for photographs of the J.E. GILMORE and the PINW1 and 2 sites.

Finally, special thanks must go to both the project survey crew and the State Historical Society of Wisconsin staff in bringing this project and report to completion. These individuals are:

Chris Gober, John Jensen, Lolly Ritchie, Steve Sellers, and David Tennessen (survey crew); Jeff Dean, State Historic Preservation Officer; Robert Birmingham, State Archeologist; Judy Patenaude and Amy Wencel (cover graphics); and Paul Hass (report editing).

Errors, omissions, and interpretations in the report are the sole responsibility of the authors.

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1
2.0	PROJECT AREA	3
	2.1 History	3
	2.2 Previous Investigations	6
3.0	PROJECT METHODOLOGY	10
4.0	FIELD INVESTIGATIONS	15
5.0	MAGNETIC MAPPING AND TARGET ANALYSIS	21
6.0	CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK	47
7.0	REFERENCES CITED	52

LIST OF FIGURES

Figure		Page
1	Project area: southeast Death's Door Passage	4
2	Vessel losses in Death's Door	7
3	Magnetometer lanes showing survey areas	17
4	Magnetic contour map: Project Area	20
5	Magnetic contour map: NE Quadrant	23
6	Site Plan: Anomaly NE-4	25
7	Site Plan: Anomaly NE-7	27
8	Site Plan: Anomaly NE-9	28
9	Site Plan: Anomaly NE-10	30
10	Site Plan: Anomaly NE-11	31
11	Magnetic contour map: NW Quadrant	32
12	Magnetic contour map: SW Quadrant	41
13	Ground Truthing Priority List	50

1.0 INTRODUCTION

Between July 5 and August 3, 1989, a joint marine archeological survey of submerged cultural resources was conducted off northern Door County. The project was funded in part through a grant from the Wisconsin Coastal Management Program, Department of Administration. The project was co-directed, staffed, and equipped by the State Historical Society of Wisconsin and the East Carolina University Program in Maritime History and Underwater Research, with additional equipment provided by University of Wisconsin Sea Grant Institute, UW Marine Studies Center, and the Mercury Marine Company of Fond du Lac.

The survey was directed at locating, identifying, and evaluating submerged cultural resources in selected coastal areas for the purpose of inventorying such resources on state bottomlands and formulating recommendations for their management and protection. Field survey of resources targeted for management and development is vital for identifying the nature, location, condition, and management requirements of individual sites. Many coastal states have already undertaken similar projects to identify and manage state submerged cultural resources. Additionally, Michigan, Vermont, and Florida have developed marine preserve systems as a means of protecting sites of historical and archeological interest while enhancing their usage through recreation and tourism. Such preserves have succeeded in protecting important resources, have generated considerable public interest in shipwreck preservation and recreation, and have had significant positive impact on local economies.

The State Historical Society of Wisconsin is responsible for conducting inventories of all cultural resources in the state. It also administers programs to identify and preserve these resources, and advises federal, state and local government agencies on their nature, location, and management requirements (44.34 Wis. Stats.). Integrating submerged cultural resources into these programs requires extensive survey and inventory efforts to identify the resource base.

In January, 1988, the Wisconsin state legislature provided initial funding for the State Historical Society to conduct a pilot study of state underwater archeological resources, with an eye to improving the management and protection of historic shipwreck sites and developing them as recreational areas. This pilot underwater archeology program was dovetailed with new state and federal efforts to protect and manage submerged cultural resources in Wisconsin, by means of the 1988 state Omnibus Historic Preservation Act and the federal Abandoned Shipwreck Act of 1987. The latter act charges the states with the protection of historic shipwreck sites, and revised state archeology law (44.47 Wis. Stats.) provides for stricter penalties for those who damage or destroy underwater archeological and historical sites on state-owned lands (including the bottoms of the Great Lakes).

The pilot study began with a literature survey aimed at identifying types and locations of reported or potential submerged cultural resources. This literature-surveyed inventory was used to assess the potential for submerged cultural resources in given areas of state bottomlands to aid in planning archeological field survey.

In accordance with the U.S. Secretary of the Interior's guidelines for conducting archeological fieldwork, field survey operations are conducted in two phases. These phases include (1) reconnaissance and identification of archeological resources in the survey area through visual, remote-sensing, or sampling survey, and (2) evaluation (possibly including test excavation) of these resources for archeological significance according to criteria for listing on the National Register of Historic Places. This report is an analysis of Phase I remote-sensing survey results in a target area selected from literature survey and field survey as a significant concentration of submerged cultural resources requiring field verification and evaluation.

2.0 PROJECT AREA

2.1 History

The survey area for 1989 operations included the southeast end of the Death's Door Passage in the vicinity of Plum and Pilot islands (Figure 1). Death's Door Passage is the chief navigational passage between the bay of Green Bay and Lake Michigan. Death's Door Passage separates the Wisconsin mainland (Door County) from the chain of islands running up to the Garden Peninsula of Michigan (comprising the islands of Plum, Pilot, Detroit, Washington, Rock, and Fish on the Wisconsin end of the chain). It is bounded by high limestone bluffs and rocky shores, littered with scattered shoals and islands, and possessed of shifting, often contrary, currents and winds. The official 1906 Sailing Directions for Lake Michigan, Green Bay and the Strait of Mackinac describes it:

> Porte des Morts (Death's Door) passage. There is a strong current setting in and out according to the direction of the wind, and many vessels have

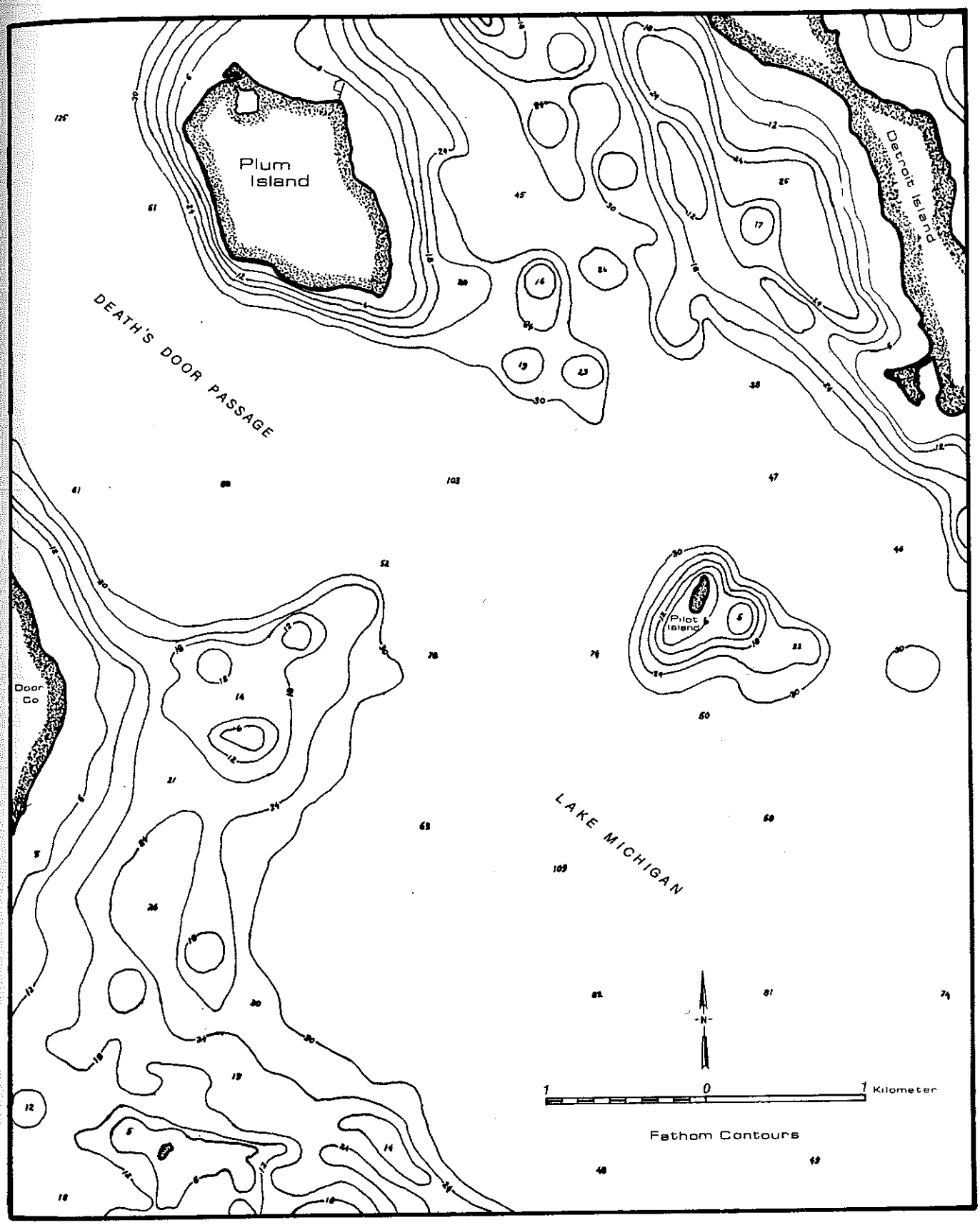

Plum
Island
Detroit Island
DEATH'S DOOR PASSAGE
Pilot
Island
Door
Co
LAKE MICHIGAN
N
1
0
1 Kilometer
Fethom Contours

Figure 1

> been lost in consequence. It is frequently so strong that sailing vessels can not make headway against it. The coast is rock bound and certain destruction awaits the craft going ashore. Sometimes the current is against the wind (Eaton 1974:3).

As a result, commercial sailing vessels were exceptionally susceptible to the navigational hazards of the Door (more so than steamers), despite construction of a light on Plum Island in 1848, a lighthouse on Pilot Island in 1850, and a new Plum Island lighthouse in 1896 (Eaton 1974:6-7; U.S. Lighthouse Board 1896:72-73). The diary of lighthouse keeper Martin Knudsen, kept from 1872 to 1889, indicates that winds, roaring seas, and a shipwreck about twice weekly were normal conditions in the Door. A single week in 1872 saw 100 large vessels lost or seriously damaged in this passage, and the famous Alpena Gale of October, 1880 drove thirty vessels ashore at Death's Door alone (Hirthe and Hirthe 1986:33).

Current historical research indicates that some twenty-four vessels were total losses in the Death's Door area (the vicinity of Plum, Pilot, and Detroit Islands) from 1837 to 1914 and an additional forty were lost on adjacent islands, shoals, and bays from the 1830's up to the 1940's. All of the known total losses in Death's Door were sailing vessels (schooners, barks, or brigs). Many hundred other vessels of all types stranded, foundered, or were otherwise wrecked in Death's Door, but were pulled off and refloated. The maritime mishaps of the twentieth century in northern Door County have been mostly occasional strandings, with a few fires and collisions, most of which took place outside the Door Passage itself (Cooper 1988).

Cold weather, frozen rigging, and frequent storms made autumn navigation through the Door especially difficult for sailing vessels. Of the nineteen vessels reported total losses in the survey area (Pilot Island, southeast reef of Plum Island, and Death's Door Passage in general), 74% wrecked in the fall months, September through November (Figure 2). One-hundred percent of these casualties were strandings of sailing vessels, and for those cases where cause of stranding was known, storms accounted for 64% of the losses. Clearly, a fall storm and Death's Door Passage was a ruinous combination for many nineteenth-century sailors.

2.2 Previous Investigations

Previous research conducted by the State Historical Society of Wisconsin has included an initial inventory of sites compiled from historical literature and interviews with the public (Cooper 1988). Based on this inventory, field survey was then undertaken to identify and evaluate selected sites within the inventoried area (Cooper 1989). Five survey areas were selected for initial reconnaissance in the summer of 1988; Death's Door Passage (Plum and Pilot islands), Whaleback Shoal, Washington Island, North Bay, and Sturgeon Bay. Field crews investigated eleven sites in the five survey areas, comprising the remains of at least fourteen separate nineteenth-century sail and steam vessels.

Investigations in 1988 produced documentation on site location, nature, condition, potential significance, management requirements, and made recommendations for further research. These recommendations included additional survey work around Pilot and Plum islands in the southeast end of the Death's Door Passage, to include remote-sensing coupled with diver inspection of targets (Cooper 1989:75).

Figure 2

Pilot Island Shipwrecks

Vessel Name	Rig	Year Lost	Stranding Cause
Shakespeare	brig	??/1858	unknown
Daniel Slauson	schooner	10/1863	gale
Henry Norton	schooner	09/1863	gale
Lydia Case	schooner	09/1872	unknown
Cleveland	bark	06/1875	gale
E.M. Davidson	schooner	10/1879	unknown
Forest	scow-schooner	11/1891	gale
J.E. Gilmore	schooner	10/1892	gale
A.P. Nichols	schooner	10/1892	gale
Mystic	schooner	10/1895	unknown
O.M. Nelson	schooner	06/1899	fog, gale

Plum Island Southeast Reef Shipwrecks

Lewis Day	schooner	10/1881	missed stay
Berwyn	schooner	11/1908	fog

Death's Door Shipwrecks

Dolphin	schooner	10/1841	unknown
Wisconsin	schooner	09/1847	unknown
Windsor	schooner	11/1853	unknown
Windham	schooner	11/1855	wind shifted while at anchor
Maria Hilliard	schooner	??/1856	unknown
Columbia	brig	06/1859	snow squall

Total Casualties: 19

Dates of Casualties

Month	Number	Percentage
June	3	16%
September	3	16%
October	7	37%
November	4	21%
unknown	2	11%

Casualty Cause (where known)

Cause	Number	Percentage
gale, squall	7	64%
fog	2	18%
misc.	2	18%

Diver survey in 1988 on the northwest side of the island succeeded in mapping and documenting a concentration of wreckage relating to three or more nineteenth-century wooden sailing vessels, including the remains of the schooner A.P. NICHOLS and the scow-schooner FOREST. This work ascertained that the Pilot Island Northwest Site (PINW) was only part of a large debris field running along the north side of the island and fanning out into deeper water. Both visual survey and sport diver reports (Shastal 1988, personal communication) indicated that this scatter included structural debris, rudders, anchors, and other material related to historical vessel losses at Pilot Island (Cooper 1989:74).

Other prior investigations and sport diving activity have brought to light a good deal of additional shipwreck material in the vicinity of Pilot and Plum islands. A site locally but erroneously known as the schooner RIVERSIDE (the RIVERSIDE was in fact salvaged and refloated) is reported to lie in sixty feet of water to the southwest of the island. It is described as the inverted hull of a wooden sailing vessel, intact to the deck level, but broken off at both ends (Boyd 1988, personal communication). Additional material reported from the area includes a brass taffrail log found wedged in a crevice on the northeast side of Pilot, a large anchor recovered in Detroit Island Passage (now reportedly residing at Washington Island airport), and vessel remains scattered from the Plum Island range light on the southwest side of the island to the Plum Island southeast reef (Boyd 1988, personal communication). These latter remains are probably from the schooner RESUMPTION, which stranded at the Plum Island range lights in 1914.

In 1987, dive charter operators Daniel and Kevin Kaniff, using towed side-scan sonar, located two sites of shipwreck remains in Detroit Island Passage in the vicinity of Pilot Island. An effort to document these sites was made by divers from the Atlantic Alliance for Maritime Heritage Conservation in a project co-directed by Jon Van Harpen and R. Duncan Mathewson III. While no final report has yet been submitted on this work, an Alliance draft report (Van Harpen 1987) and a field agent's report to the state archeologist (Cooper 1987) indicate that these sites include the port and starboard sides of one or possibly two wooden nineteenth-century sailing vessels of approximately 400 gross tons, wire-rigged, probably two-masted, and approximately 138 to 140 feet in length.

Together, the two wreckage sections, designated Pilot Island Northwest 1 and 2 (PINW1 & 2), comprise virtually the entire port and starboard sides of a wooden sailing vessel from the stem aft and from the turn of the bilges to the railcap. They are lying flat on the bottom, PINW1 with the hull exterior exposed, and PINW2 with the hull interior exposed, including a row of knees at the former deck level, and with deadeyes still attached to the wire-rigging. A scatter of additional material included a large rudder, a boom or gaff, coal, and a spade. A combination of historical, iconographic, and archeological evidence indicates that PINW1 and 2 may be the wreckage of the schooner J.E. GILMORE (Cooper 1987:5-8; Van Harpen 1987).

The results of 1988 field survey coupled with prior investigations and diver reports produced some understanding of the wrecks in Death's Door Passage. These sites appeared to consist of inshore, scattered wreckage at the point of initial wreck deposition (along reefs and shorelines), with larger sections of wreckage strewn out in deeper water, due to the combined action of seas and ice on the wrecked hulls. While the potential for complete structural integrity seemed minimal with any of the remaining undiscovered shipwrecks (having been primarily shallow water strandings), the probability of large sections being intact, possibly with associated artifactual material, seemed high. This expectation was heightened by reports of potential new material in the vicinity of Pilot Island as brought to light by additional sonar search (Kaniff and Kaniff 1988, personal communication).

3.0 PROJECT METHODOLOGY

Survey in 1989 was geared towards conducting a Phase I investigation in the southeast Death's Door Passage (vicinity of Pilot Island and Plum Island southeast reef) to determine the presence, location, and nature of undiscovered or undocumented submerged cultural resources, particularly shipwreck remains associated with historical navigation of Death's Door. Due to the large area to be covered, marine remote-sensing equipment was chosen as the most efficient means of covering the survey area. The selection of remote-sensing equipment and methodology for the Death's Door survey was established primarily by the area's geologic features, bathymetry, magnetic background, and the anticipated nature of the Door's extant submerged cultural resources. Each of these factors contributed to the choice of the proton precession magnetometer as the most practical remote-sensing instrument for archaeological survey.

Water depth in the survey area rarely exceeds 100 feet permitting the magnetometer to function unhindered by its relatively short range. The benthic geology of the Door, with its large erratic boulder fields, abrupt shoals, and murky water, make use of other remote-sensing devices such as towed video or side scan sonar difficult and hazardous. Finally, and of decisive importance in choosing a remote-sensing device, was the fact that the vast majority of nineteenth-century vessels constructed on the Great Lakes were fastened with iron. The ferrous metals in the submerged ship wreckage create large magnetic anomalies easily detected by the magnetometer.

Remote-sensing surveys must balance accuracy with cost. It would not be cost-effective to survey every square inch of the Door, including all exposed as well as subsurface archeological features and deposits. The remote-sensing methodology selected for the Door is best considered a sampling technique designed to maximize the magnetometer's coverage area while minimizing the chance that significant cultural remains would go undetected. However, it cannot be considered to have produced a comprehensive inventory of every object, feature, or deposit of archeological nature in the survey area. Rather, it detected those sites with a significant concentration of ferrous metals, and is therefore biased towards large concentrations of ship wreckage with iron fastenings or fittings. Sites such as inundated prehistoric sites and aboriginal watercraft (not usually associated with concentrations of ferrous metal) as well as smaller artifacts and debris would not have been detected by the magnetometer.

The marine magnetometer has been widely and successfully used for submerged cultural resource survey (Arnold 1976:3) using systematic survey patterns to ensure complete and accurate coverage of survey areas. Its application requires use of a surface vessel and electrical and/or optical survey controls to coordinate the survey vessel's track.

The magnetometer measures in gammas the earth's magnetic field in the vicinity of a towed sensor, which is indicated to the magnetometer operator in both digital and analogue format. The presence of sharp variations (called "anomalies") in the ambient magnetic gradient are indicative of some type of disturbance, frequently caused by concentrations of ferrous cultural material, such as anchors, hulls, or fastenings in a ship's hull. These gradient changes are recorded by the operator in conjunction with the anomalies' position for contour plotting of the magnetic background. An anomaly's signature is a function of its strength (in gammas), polarity (monopolar or dipolar), and duration of signal (in seconds) (Breiner 1973:17-32). While the signature of an anomaly may be generally indicative of the nature of the background disturbance (natural, cultural, or electromagnetic interference), magnetometer targets need to be ground-truthed to ascertain the exact nature of the disturbance. For marine survey, this usually takes the form of diver investigation, though remote-operated vehicles (ROV's) with photographic or video equipment may be used on deeper sites.

The proton precession magnetometer used in this survey was a Littlemore Scientific Laboratory Type 7702. This instrument consists of a real-time quartz readout and a strip chart recorder linked to a towed sensor probe via thirty-seven meters of protected cable. The Type 7702 magnetometer is analogous to a super sensitive compass, sampling the ambient magnetic background at two-second intervals. During this sampling procedure the liquid dipolar molecules in the sensor align themselves to the earth's background magnetism. If an artificially created magnetic attraction intrudes, overriding the earth's background magnetism, the sensor's molecules rotate to a new alignment. This rotation produces a detectable fluctuation or anomaly. These anomalies are translated by the instrument to a numerical expression measured in gammas.

The Type 7702 is particularly accurate when used in less than 100 feet of water to detect shipwrecks and other sites containing large quantities of ferrous metal fastenings, machinery, or artifacts. It has a sensitivity of plus or minus one gamma, the approximate magnetic intensity of kilogram of iron at a distance of three meters from the magnetometer sensor, or one ton of iron at a distance of forty meters (Breiner 1973:43).

Theoretically a magnetometer can detect anything that might produce a disturbance in the earth's background magnetism such as concentrations of ferrous metals (iron, steel, and their alloys), fired ceramics, fire pits, volcanic activity (faults and vents), and any man-made or natural intrusive objects which displace the natural distribution of magnetite in the soil. Unlike sonar (except extremely low frequency sonar) the magnetometer is virtually unhindered by the depth of overburden over the target.

A magnetometer cannot, however, produce a picture of actual bottom contours or targets as can a side-scan sonar or towed video. The magnetometer is limited to revealing anomalies, the anomalies' magnetic intensity, and the duration of time that the sensor detects the object. Since anomaly intensity and duration are a function of the proximity of the sensor to the magnetic disturbance, the size of the disturbance as well as its orientation, and the speed and in what direction the sensor passes over it, a change in any of these variables will produce a different graphic on the recording strip. A scatter of wire cable, for example, will give larger multicomponent reading than a more massive wrought-iron anchor fixed vertically in the bottom sediments even if all the other variables remain constant. Ground-truthing is therefore usually recommended when using a magnetometer, as it is virtually impossible to positively identify an artifact from its magnetic signature.

Magnetometers are also subject to atmospheric fluctuations such as sun spots, solar flares, and nearby radio transmissions. Most magnetometers are also subject to gradual variations in atmospheric anomalies throughout the day. These diurnal variations can be compensated for using a second magnetometer in a fixed location as a control instrument. However, due to the prohibitive expense of a second instrument and the actual objectives of the Death's Door survey, the magnetic data for this area have not been corrected for diurnal variation. Magnetic sensing is not practical in some instances due to an area's discordant magnetic background. Fortunately, the Door's background, though dynamic, is well within normal tolerances for the production of a detailed magnetic chart of the area. Regardless of the drawbacks, a magnetometer operated by experienced personnel with careful analysis and contour plotting of magnetic anomalies can produce a very accurate map of anomaly distribution in relation to the ambient magnetic gradient and lake bathymetry.

The Death's Door survey was staffed and equipped to conduct remote-sensing operations from a surface vessel, with diving equipment available to ground-truth significant anomalies as field time allowed. Project field staff consisted of one principal investigator underwater archeologist and one field research assistant from the State Historical Society of Wisconsin, and one underwater archeologist/co-director, one graduate assistant, and two graduate students from East Carolina University. Additionally, a diving safety officer from East Carolina University spent a week on site supervising university diving activities.

Project equipment included remote-sensing, diving, surveying, and underwater photographic equipment provided by the State Historical Society, as well as a sixteen-foot inflatable workboat. East Carolina University provided additional survey and diving equipment, as well as a marine proton precession magnetometer. The main survey craft was a twenty-two foot research vessel provided by the University of Wisconsin Sea Grant Institute through the UW-Madison Marine Studies Center. The vessel was equipped with two LORAN-C units, a fathometer, VHF marine radio, and a Motorola Mini-Ranger III ranging and positioning system, with an accuracy of $\pm$ one to three meters.

The Mini-Ranger system provided the locational data for contour mapping magnetic gradients and for relocating anomaly positions for ground-truthing. An optical theodolite and handheld two-way radios were used to establish vessel survey transects, and to assist in keeping the vessel on course. A laser-operated electronic distance meter was employed with the theodolite for miscellaneous surveying of shorelines, Mini-Ranger transponder stations, and basepoints of survey transects. Bathymetry was recorded from the vessel fathometer along survey transects, and LORAN-C coordinates were used to back up Mini-Ranger coordinates for major anomalies.

4.0 FIELD INVESTIGATIONS

Field operations began July 5 and terminated August 1, 1989, with two additional days at each the beginning and end of field operations for setup, breakdown, and transportation of equipment to and from Madison.

Survey operations began with the establishment of Mini-Ranger transponder stations at Plum and Pilot islands, laying out the electrical network for microwave ranging and positioning. Three theodolite stations were placed at Pilot Island for establishing survey vessel transects, with transects running out from the island like the spokes of a wheel (Figure 3). One theodolite station was later established at Plum Island for the purpose of surveying the southeast reef, and for providing supplementary survey transects across the extremities of the Pilot Island transects to ensure complete coverage of the survey area.

Survey transects were run out to a maximum distance of 2,000 meters from each Pilot Island transit station. Several extra 3,000 meter runs were made from Plum Island to cross the extremities of the Pilot Island survey radius. The survey transects were spaced at increments of between one degree, thirty minutes to three degrees as lane spacing requirements dictated. The tightest lane spacing (one degree, thirty minutes) allowed for magnetometer passes 26.07 meters apart at 1,000 meters and 52.15 meters apart at 2,000 meters. Normal survey lane spacing (two degrees) allowed for 34.92 meter spacing at 1,000 meters and 69.85 meter spacing at 2,000 meters. Wide lane spacing of three degrees (used for repeat transects over the Pilot Island areas directed from Plum Island) allowed for lanes of 52.34 meters spacing at 1,000 meters and 104.69 meters at 2,000 meters.

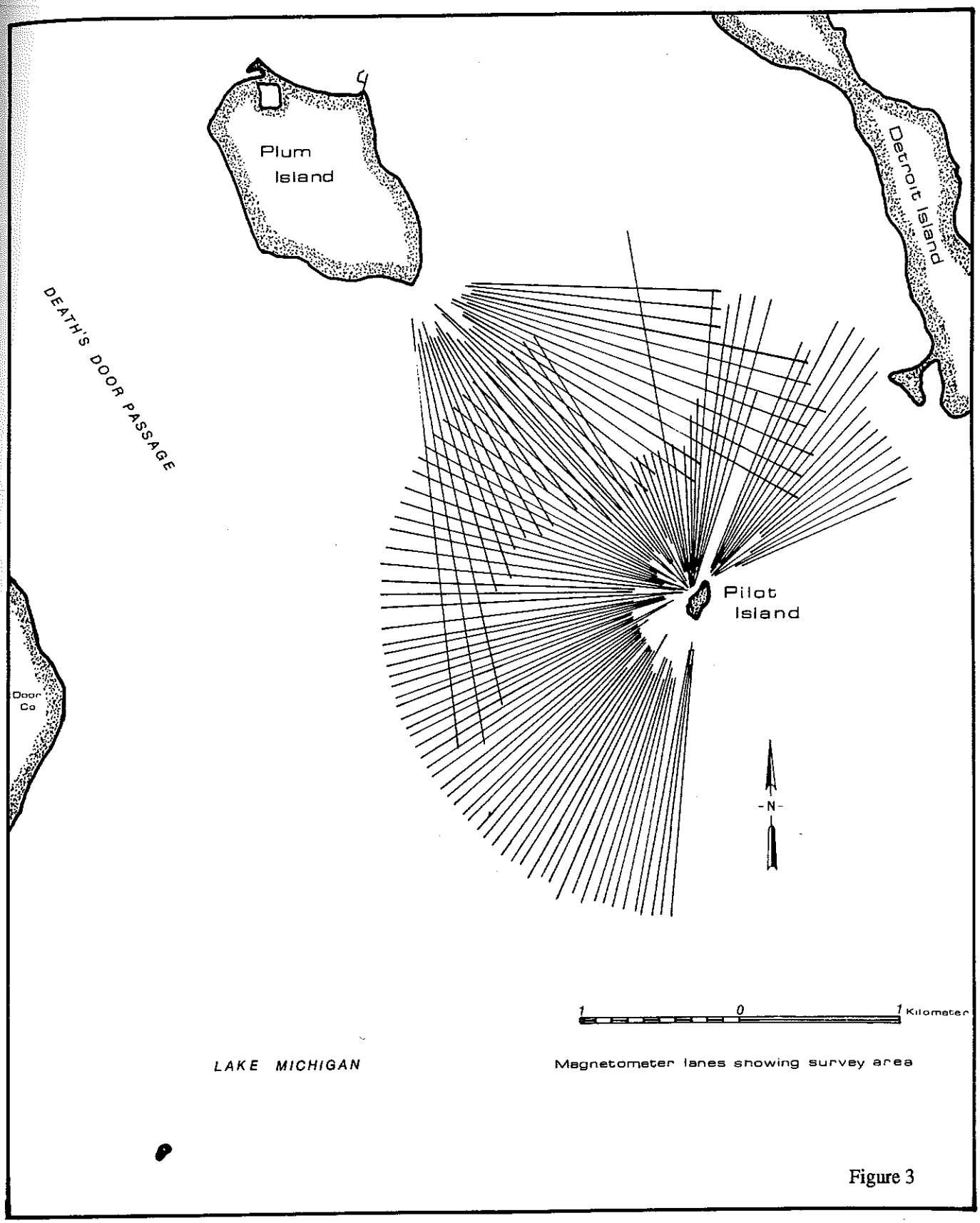

Plum
Island
Detroit Island
DEATH'S DOOR PASSAGE
Pilot
Island
Door
Co
N
1
0
1 Kilometer
LAKE MICHIGAN
Magnetometer lanes showing survey area

Figure 3

Thus, normal lane spacing ensured that the magnetometer would pass within a maximum of 34.92 meters of a target at the end of a transect and 17.46 meters from a target midway through the run. Considering the size of known wrecksites for the area (32 to 42 meters in length or diameter) this spacing was deemed adequate to detect all significant submerged cultural remains within the survey area. Additional perpendicular transects at the extremities of the primary survey lanes were used to fill in any potential gaps caused by the diverging primary survey lanes (this is a problem with using radial lanes instead of parallel lanes). The magnetometer sensor was towed at a distance of twenty-seven meters from the survey craft at a depth of ten feet for shallow water survey (fifteen to sixty foot depth) and at a distance of thirty-seven meters and a depth of approximately twenty feet for deeper survey areas. This increased the sensor's proximity to possible targets on the bottom and removed it an adequate distance from interfering magnetic items (equipment, engines) aboard the survey vessel.

The survey covered approximately 9.42 square kilometers, consisting of 128 survey lanes over approximately 248 linear kilometers. Numerous additional test lanes and repeat lanes were run above this total. The survey included three quadrants to the northeast, northwest, and southwest of Pilot Island, encompassing those areas where submerged cultural resources had already been reported, or those areas where the literature survey seemed to indicate high probability for submerged cultural resources.

Sixty-four magnetic anomalies and anomaly clusters were identified, isolated, and recorded in the three quadrants. The bulk of the high-intensity, long-duration anomalies fanned out from the northwest corner of Pilot Island at a depth of twenty to sixty feet (Figure 4). Additional anomalies were recorded to the southwest and to the south of the island, and a small scatter of low-intensity, short-duration anomalies were recorded on the southeast reef of Plum Island. Field analysis of signatures produced a prioritized list of targets for ground-truthing based on signal duration and intensity. Anomalies of less than ten gammas were placed on low priority for ground-truthing. Some anomalies were recognized by their signatures as magnetic interference, and where repeat runs failed to produce similar anomalies, these readings were rejected.

Ground-truthing consisted of diver inspection of sixteen targets. Significant material received preliminary documentation including measured sketches and photography. Ground-truthing of two additional targets (the Pilot Island Southwest and the Pilot Island South sites) was cancelled due to foul weather on the last day of the project. As these latter targets had previously been reported by sport divers, their preliminary identification has been made and the sites will receive formal evaluation efforts at a future date. A cluster of anomalies relating to the Pilot Island NW site were not ground-truthed, as this site had already been identified and received documentation efforts the previous field season.

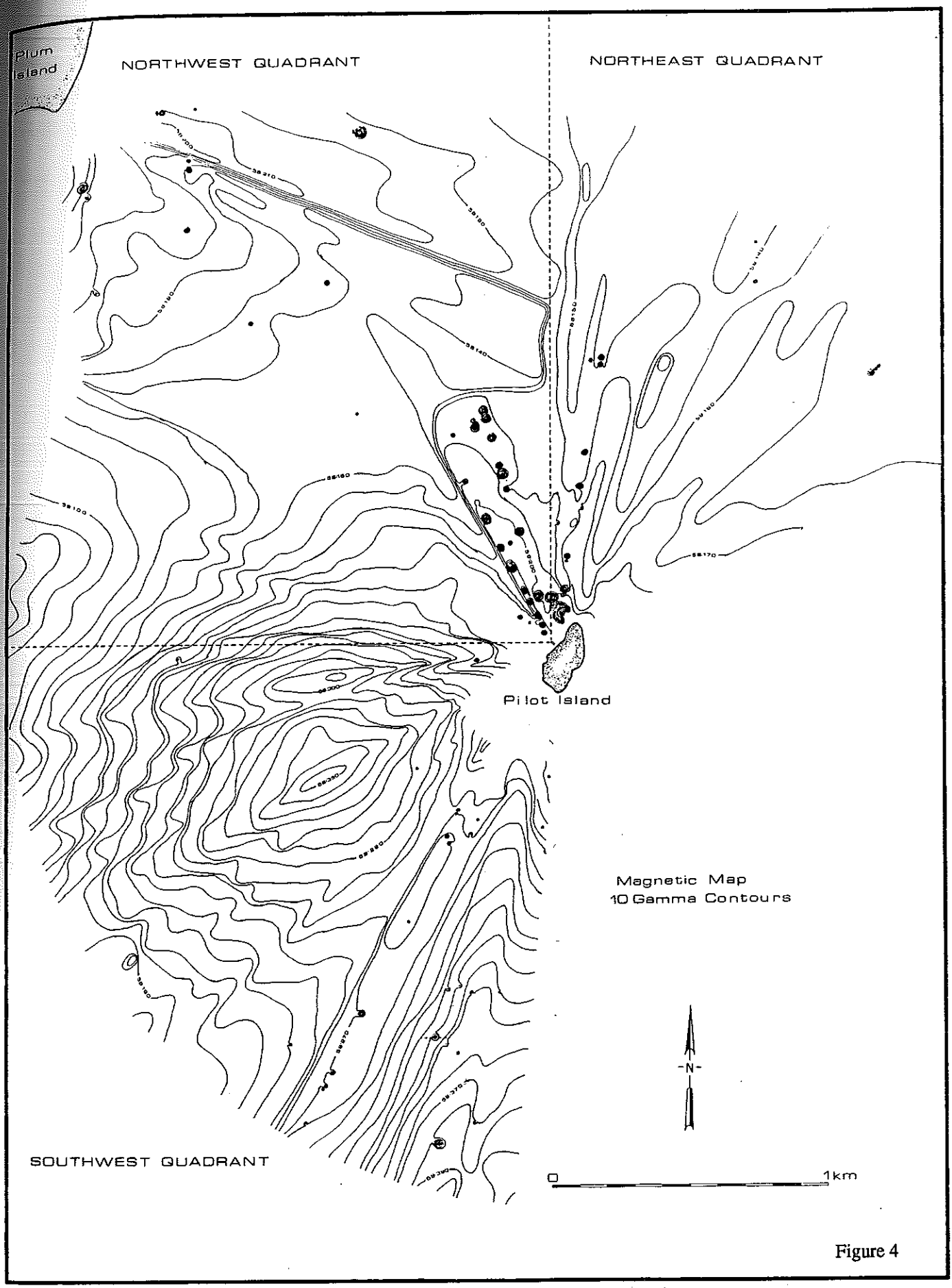

Plum Island
NORTHWEST QUADRANT
NORTHEAST QUADRANT
Pilot Island
SOUTHWEST QUADRANT
Magnetic Map
10 Gamma Contours
-N-
0
1km

Figure 4

As a group, the ground-truthed anomalies consisted of wreckage debris from nineteenth-century vessel losses at Pilot Island and the Plum Island southeast reef, as well as some modern refuse (steel cable and dumped marine batteries). Wreckage consisted of scattered wooden planking, knees, iron drift pins, spikes, a section of hull, a boom, and a possible bulkhead or section of decking. Two of the targets had associated bone fragments (a rib and a longbone fragment) which may be of human origin.

Many of the anomalies were located in the vicinity of PINW, PINW1, and PINW2 sites, indicating that these previous sites are surrounded by a debris scatter of smaller structural fragments. This is consistent with previous observations and diver reports from these sites (Cooper 1989:74). The only other two large hull sections presently known to lie within the survey area include the Pilot Island Southwest site (previously known as the RIVERSIDE) and the Pilot Island South site. This latter site was located by Kevin and Dan Kaniff in the fall of 1988 and has previously been called the "Santa Maria" due to its discovery on Columbus Day (Kaniff 1989, personal communication). It is reported to be the side and half the bow (including a hawsepipe) of a wooden sailing vessel, split down her centerline. This is much like the condition of the PINW 1 and 2 sites. No artifacts were reported in the vicinity of the site and it is not known if the site had been previously discovered (Kaniff 1989, personal communication).

5.0 MAGNETIC MAPPING AND TARGET ANALYSIS

The compilation of detailed magnetic map is the best method now in use to ensure archeological survey accuracy. A magnetic map may cluster seemingly unrelated and insignificant targets, giving them more meaning in the bigger picture.

The Death's Door magnetic survey was divided into four quadrants with Pilot Island at the hub (Figure 4). Three of these quadrants were magnetically surveyed, and are identified by their compass direction from Pilot Island. The anomalies were recorded, isolated, and numbered, with several anomalies often clustered and designated as a single-multi-component signature. Anomaly clusters are usually produced by the same artifact or artifact scatter and were or could be ground truthed by a survey team in a single dive.

The anomalies and target groupings are generally numbered sequentially by transect in a counter-clockwise fashion. With some exceptions, the lower the anomaly identification number the sooner its discovery date for that quadrant. Each quadrant is identified by a two letter abbreviation followed by the anomaly identification number. For example, the third anomaly recorded in the northeast quadrant is designated "NE-3".

Target Analysis Northeast Quadrant (NE-1 through NE-11)

The magnetic contour of the Northeast Quadrant is fairly gradual, proceeding from a peak of 58:200 gammas near Pilot Island down to 58:130 at one kilometers distance (Figure 5).

NE-1

Location Date/Transect/Azimuth: 7-7-89 /10/ 47 degrees
Mini Ranger Location: A 3870 B 1624 CG Tower/LH Porch
Loran C Location: NA
Depth 25-30 feet
Intensity: 55 gammas in 2 monopolar spikes
Duration 24 seconds
Ground-Truthed: No

Analysis: The monopolar nature of this target suggests that it may be created by one or two separate ferrous metal artifacts. The shallowness of the water contributes to the signal intensity as the sensor may have passed directly over the artifact. The target does not extend to the adjacent transects as would be expected for a shipwreck or wreck section.

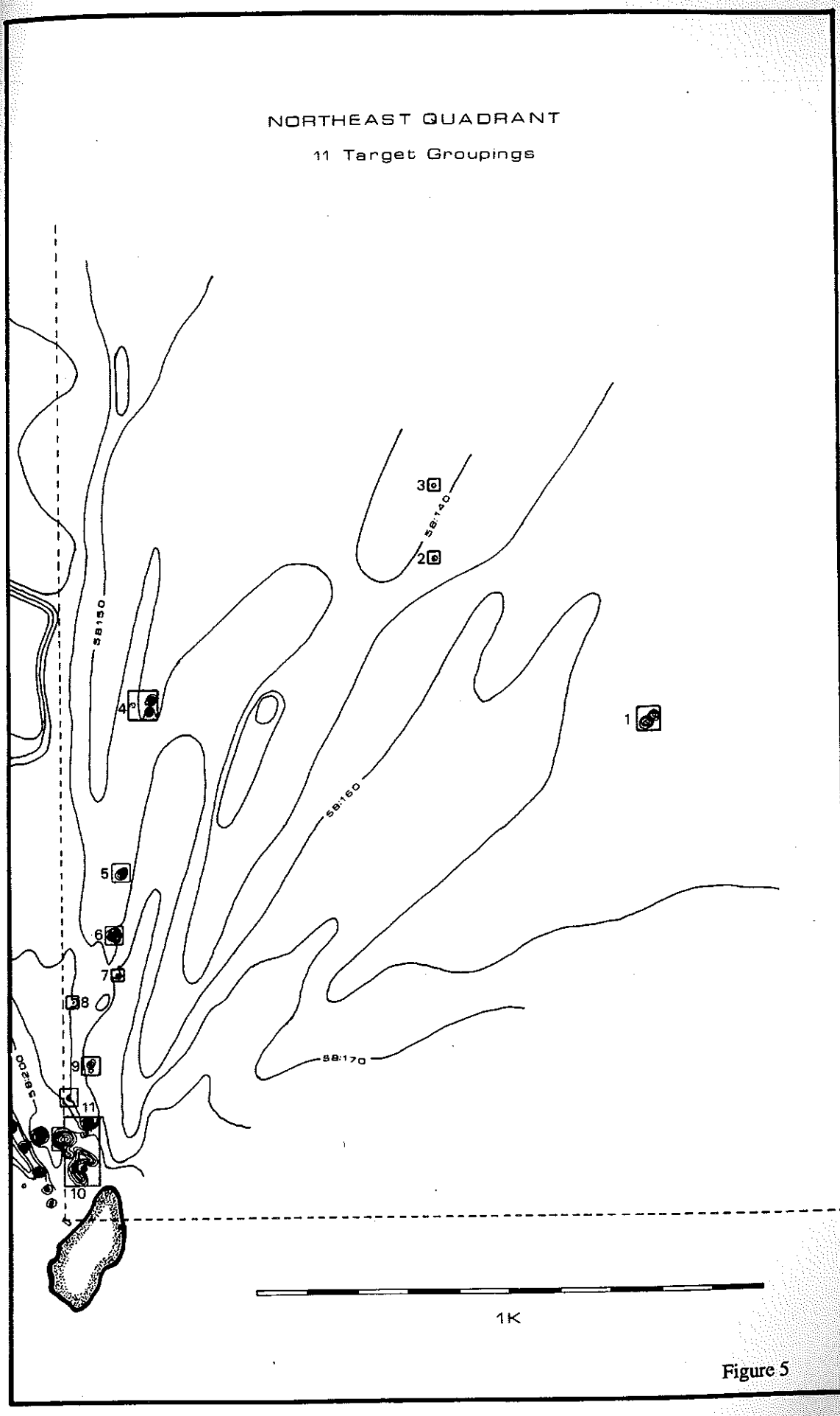

NORTHEAST QUADRANT
11 Target Groupings
3
2
1
4
5
6
7
8
9
10
11
58:140
58:150
58:160
58:170
58:200
1K

Figure 5

NE-2

Location Date/Transect/Azimuth: 7-21-89 / Plum 5 / 104 degrees
Mini Ranger Location: A 1575 B NA
Loran C Location: NA
Depth: 20 feet
Intensity: 10 gammas monopolar
Duration: 4 seconds
Ground-Truthed: No

Analysis: The minimal intensity of this target combined with the shallow water depth make it unlikely that this is a large artifact. Transect 3 of survey work done on 7/7/89 passed within 10 meters of this spot with no registered anomaly.

NE-3

Location Date/Transect/Azimuth: 7-7-89 / 2 / 23 degrees
Mini Ranger Location: A NA B 1700 CG Tower/LH Porch
Loran C Location: NA
Depth: 15-20 feet
Intensity: 10 gammas monopolar
Duration: 4 seconds
Ground-Truthed: No

Analysis: As with NE-2, water depth all but rules this anomaly out as a significant target.

NE-4

Location Date/Transect/Azimuth: 7-6-89 / 1 & 3 / 10 degrees & 10 30' 15"
Mini Ranger Location: A 3081 B 1069 CG Tower/LH SW
Loran C Location: YesDepth: 54 feet
Intensity: 80 gammas multicomponent
Duration: 36 seconds
Ground-Truthed: Yes, 7-12-89
Analysis: Divers located starboard side of vessel 143 feet in length by 18 feet maximum width. Previously located and designated PINW-2, 1987 survey. Possibly wreck of schooner J.E. GILMORE. See Figure 6.

NE-5

Location Date/Transect/Azimuth: 7-6-89 / 1 / 10 degrees 36' 15"
Mini Ranger Location: A NA B 800 CG Tower/LH SW
Loran C Location: YesDepth: 62 feet
Intensity: 35 gammas monopolar
Duration: 6 seconds
Ground-Truthed: Yes, 7/24/89

Analysis: Three strakes of planking edge-fastened, eighteen feet in length. Possibly section of deck clamps or reinforced bilge ceiling.

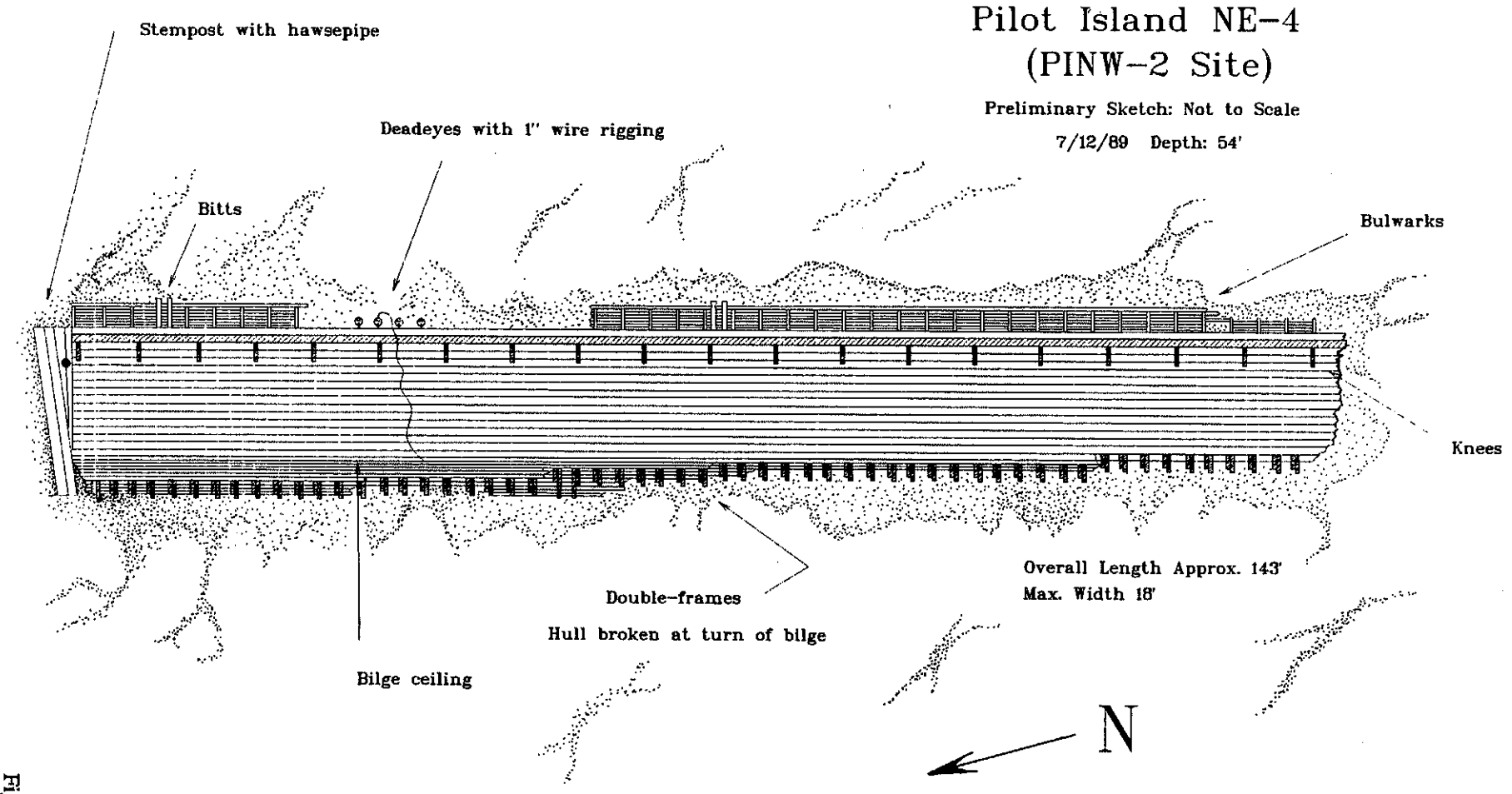

Pilot Island NE-4
(PINW-2 Site)
Preliminary Sketch: Not to Scale
7/12/89 Depth: 54'
Stempost with hawsepipe
Deadeyes with 1" wire rigging
Bitts
Bulwarks
Knees
Overall Length Approx. 143'
Max. Width 18'
Double-frames
Hull broken at turn of bilge
Bilge ceiling
N

Figure 6

NE-6

Location Date/Transect/Azimuth: 7/6/89 / 1 / 10 degrees 36' 15"
Mini Ranger Location: A 3400 B 643 CG Tower/LH SW
Loran C Location: YesDepth: 58 feet
Intensity: 55 gammas monopolar
Duration: 2 seconds
Ground-Truthed: Yes, 7-24-89

Analysis: Divers located scattered wreck debris. Planks, frames (9 inch molded), waterway 14" x 6", 20" hanging knee. Spikes and drift pins were probable anomaly source. Rib fragment (possibly human) found in debris.

NE-7

Location Date/Transect/Azimuth: 7-6-89 / 4 / 16 degrees
Mini Ranger Location: A 3443 B 539 CG Tower/LH SW
Loran C Location: YesDepth: 55 feet
Intensity: 16 gammas monopolar
Duration: 18 seconds
Ground-Truthed: yes, 7-12-89

Analysis: Verified as PINW1 documented in 1987. Possibly wreck of schooner J.E. GILMORE. See Figure 7.

NE-8

Location Date/Transect/ Azimuth: 7-6-89 / 7 / 2 degrees
Mini Ranger Location: A NA B 583 CG Tower/LH SW
Loran C Location: YesDepth: 55 feet
Intensity: 14 gammas monopolar
Duration: 8 seconds
Ground-Truthed: Yes, 7-24-89

Analysis: Scatter of planks, compass timber, one exterior plank from a double framed hull (paired fastening pattern), oak compass timber knee, and compass timber forefoot.

NE-9

Location Date/Transect/Azimuth: 7-6-89 / 1 / 10 degrees 36' 15"
Mini Ranger Location: A 3081 B 409 CG Tower/LH SW
Loran C Location: YesDepth: 53 feet
Intensity: 34 gammas multicomponent
Duration: 6 seconds
Ground-Truthed: Yes, 7-24-89

Analysis: Divers located a wreck section (possibly a foredeck section or chain locker bulkhead) with a boom nearby. See Figure 8.

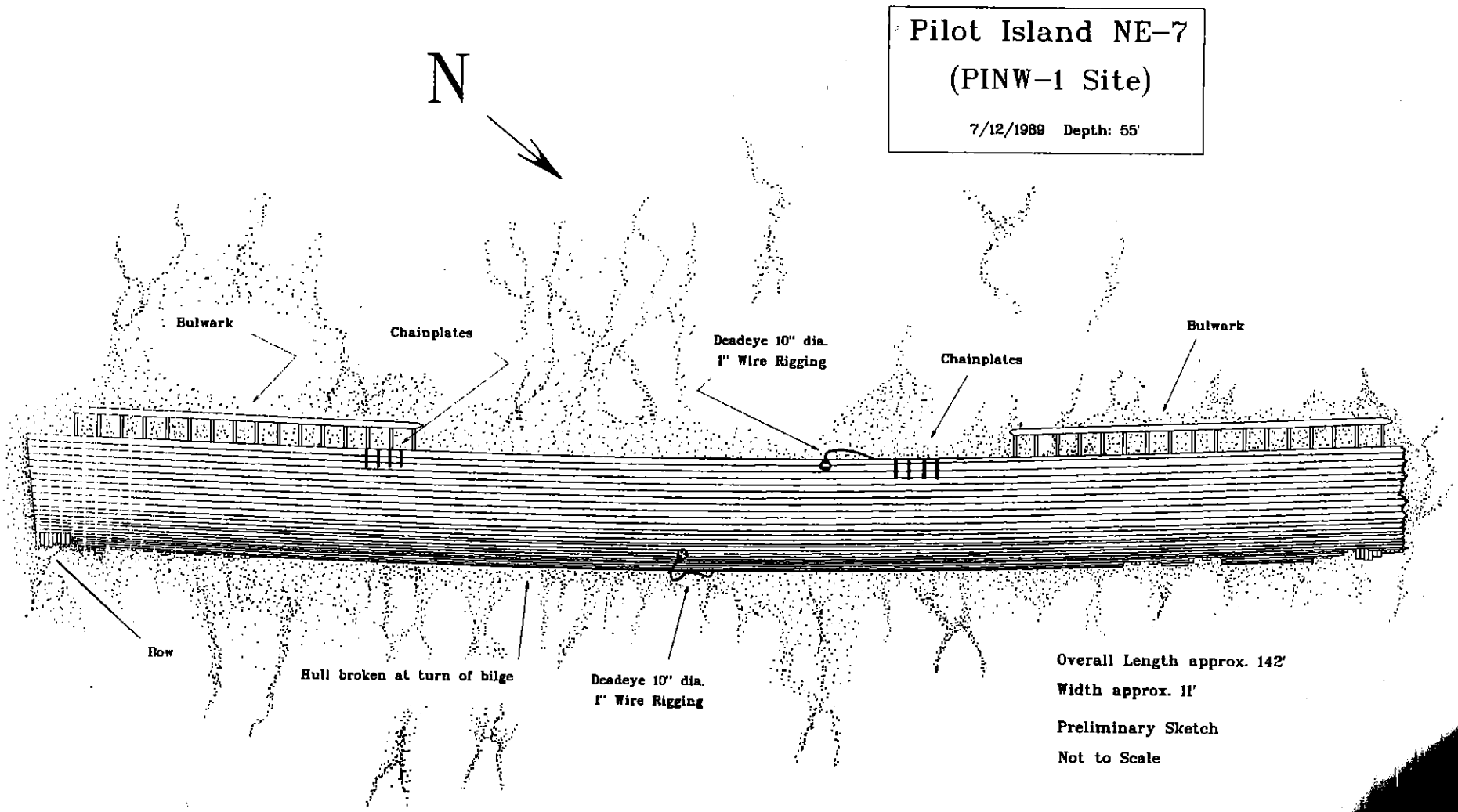

Pilot Island NE-7
(PINW-1 Site)
7/12/1989 Depth: 55'
N
Bulwark
Chainplates
Deadeye 10" dia.
1" Wire Rigging
Chainplates
Bulwark
Bow
Hull broken at turn of bilge
Deadeye 10" dia.
1" Wire Rigging
Overall Length approx. 142'
Width approx. 11'
Preliminary Sketch
Not to Scale

Figure 7

Pilot Island NE-9
7/24/1989
Foredeck or Bulkhead Fragment
Depth: 53'

Planview
Not to Scale

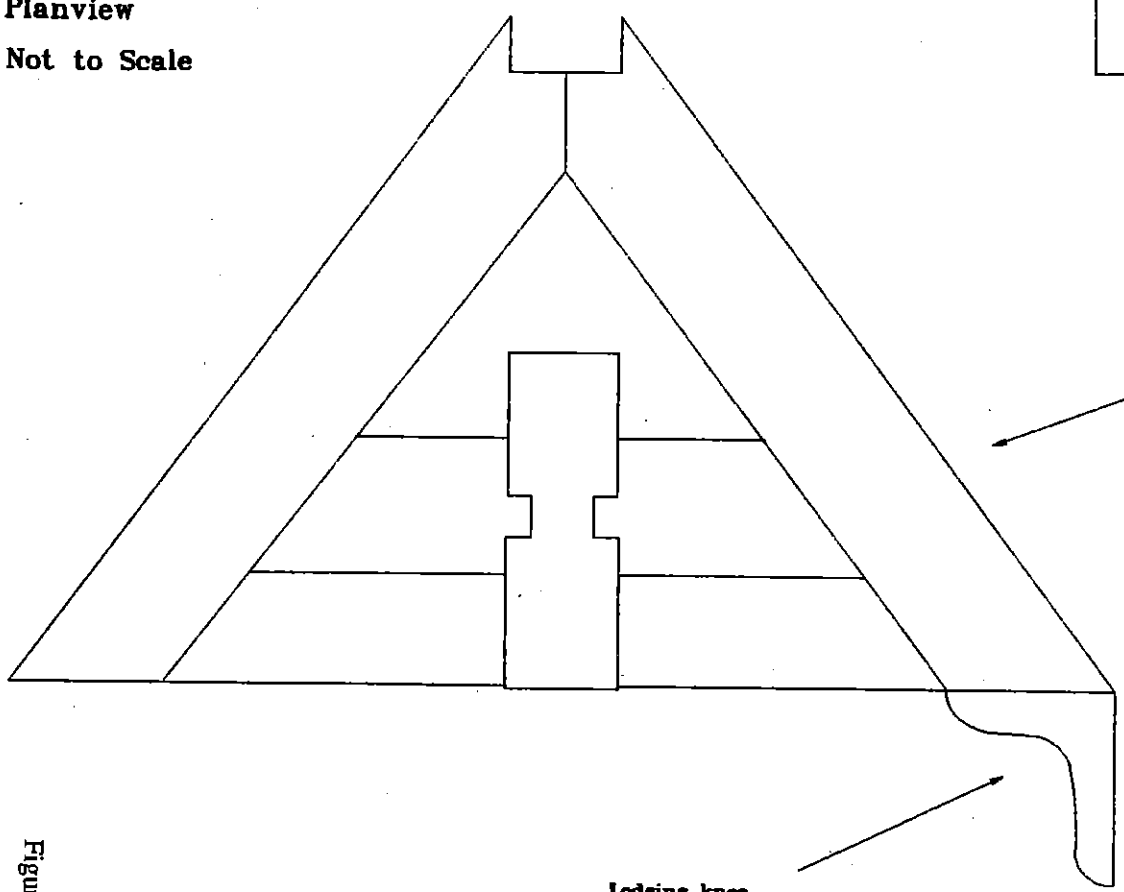


Figure 8

NE-10

Location Date/Transect/Azimuth: 7-6-89 / 1-10 / 10 36' 15" to 353 degrees
Mini Ranger Location: A 3604-3691 B 168-290 CG Tower/LH SW
Loran C Location: NA
Depth: 25-35 feet
Intensity: 80-190 gammas multicomponent
Duration: 40-48 seconds
Ground-Truthed: Yes, 1988

Analysis: PINW site documented in 1988. Major components of at least three different vessels, including schooner A.P. NICHOLS and scow-schooner FOREST. See Figure 9.

NE-11

Location Date/Transect/Azimuth: 7-6-89 / 7 / 2 degrees
Mini Ranger Location: A NA B 323 NA/LH SW
Loran C Location: YesDepth: 48 feet
Intensity: 12 gammas
Duration: 16 seconds
Ground-Truthed: Yes, 7-24-89

Analysis: Wooden hull section fourteen by seventeen feet, double-framed, includes seven cant frame sets. See Figure 10.

Target Analysis Northwest Quadrant (NW-1 through NW-29)

The dominant magnetic feature of the Northwest Quadrant seems to be a rift extending from the northwest to the southeast. Though this feature could be caused by a fault or fracture in the bedrock it is most likely a synthetic anomaly produced by the diurnal atmospheric variation in the magnetometer readings combined with a time differential in the daily survey start. The overall magnetic gradient was fairly gradual with a large area grounding on 58:150 and contours proceeding up to 58:250 gammas to the south (Figure 11).

NW-1

Location Date/Transect/Azimuth: See NE-10
Mini Ranger Location:
Loran C Location:
Depth:
Intensity:
Duration:
Ground-Truthed:

Analysis: See NE-10. PINW extends to NW quadrant.

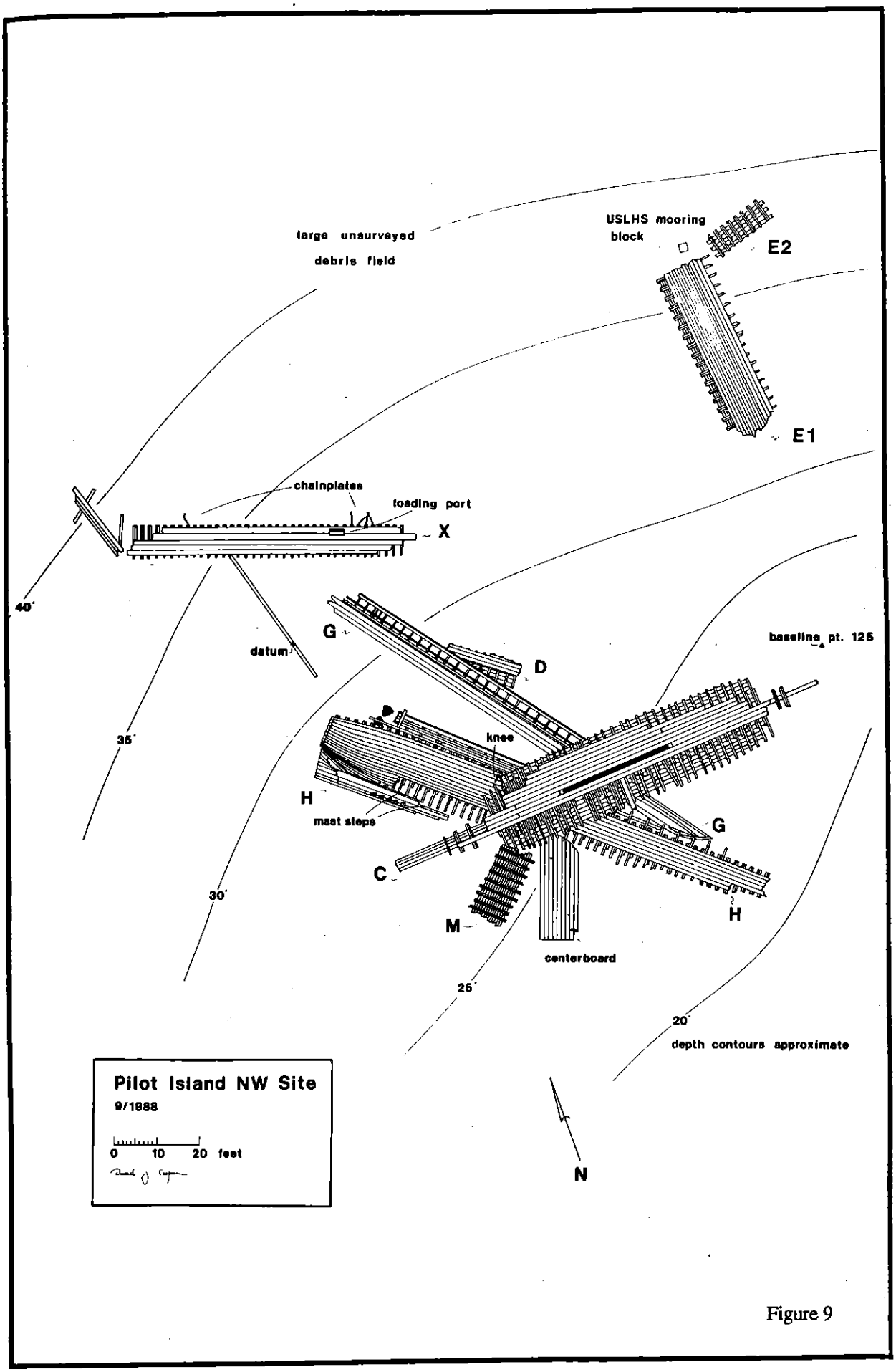

large unsurveyed
debris field
USLHS mooring
block
E2
E1
chainplates
loading port
X
40'
datum
G
D
baseline pt. 125
35'
knee
H
mast steps
G
C
30'
M
H
centerboard
25'
20'
depth contours approximate
Pilot Island NW Site
9/1988
0 10 20 feet
N

Figure 9

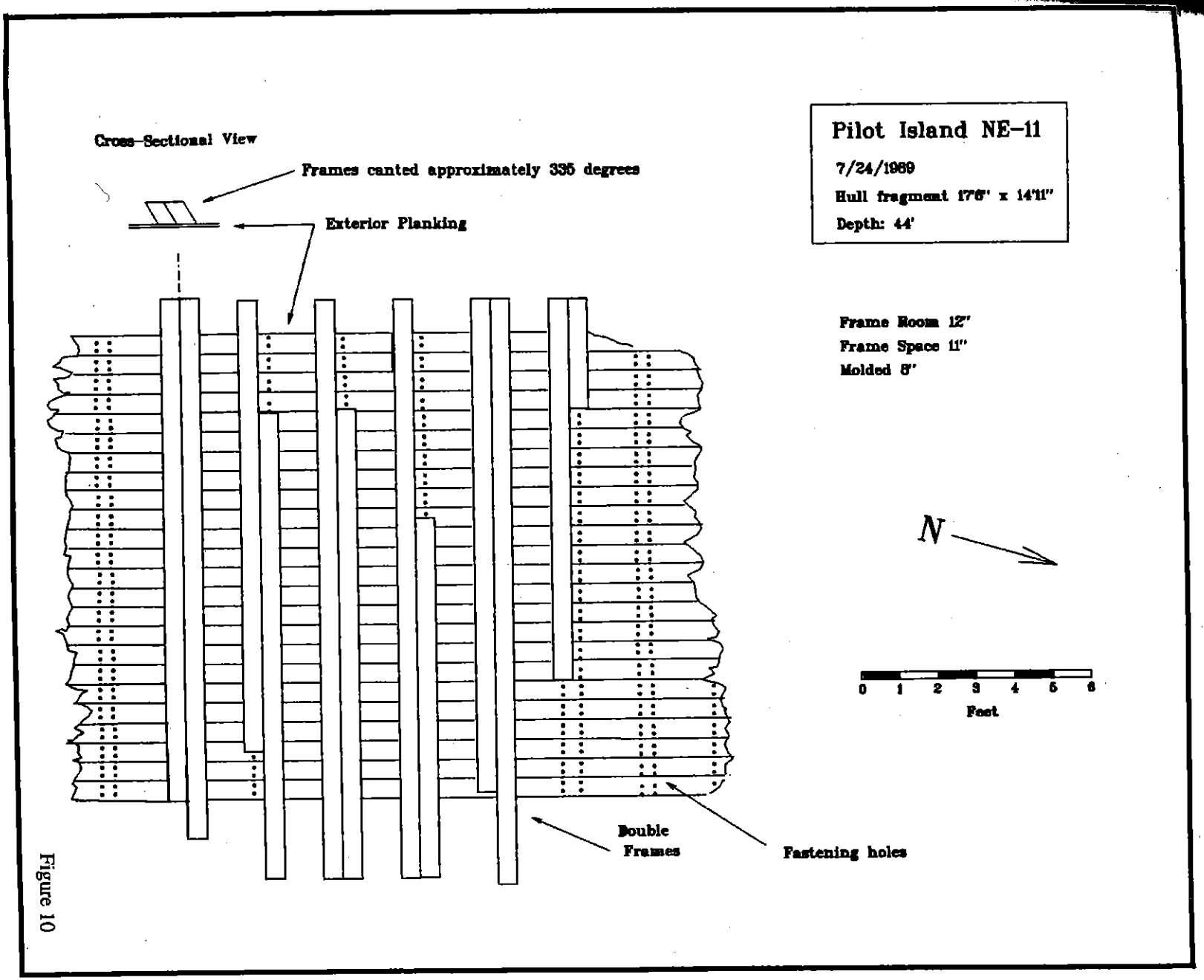

Cross-Sectional View
Frames canted approximately 335 degrees
Exterior Planking
Pilot Island NE-11
7/24/1989
Hull fragment 17'6" x 14'11"
Depth: 44'
Frame Room 12"
Frame Space 11"
Molded 8"
N
0 1 2 3 4 5 6
Feet
Double Frames
Fastening holes

Figure 10

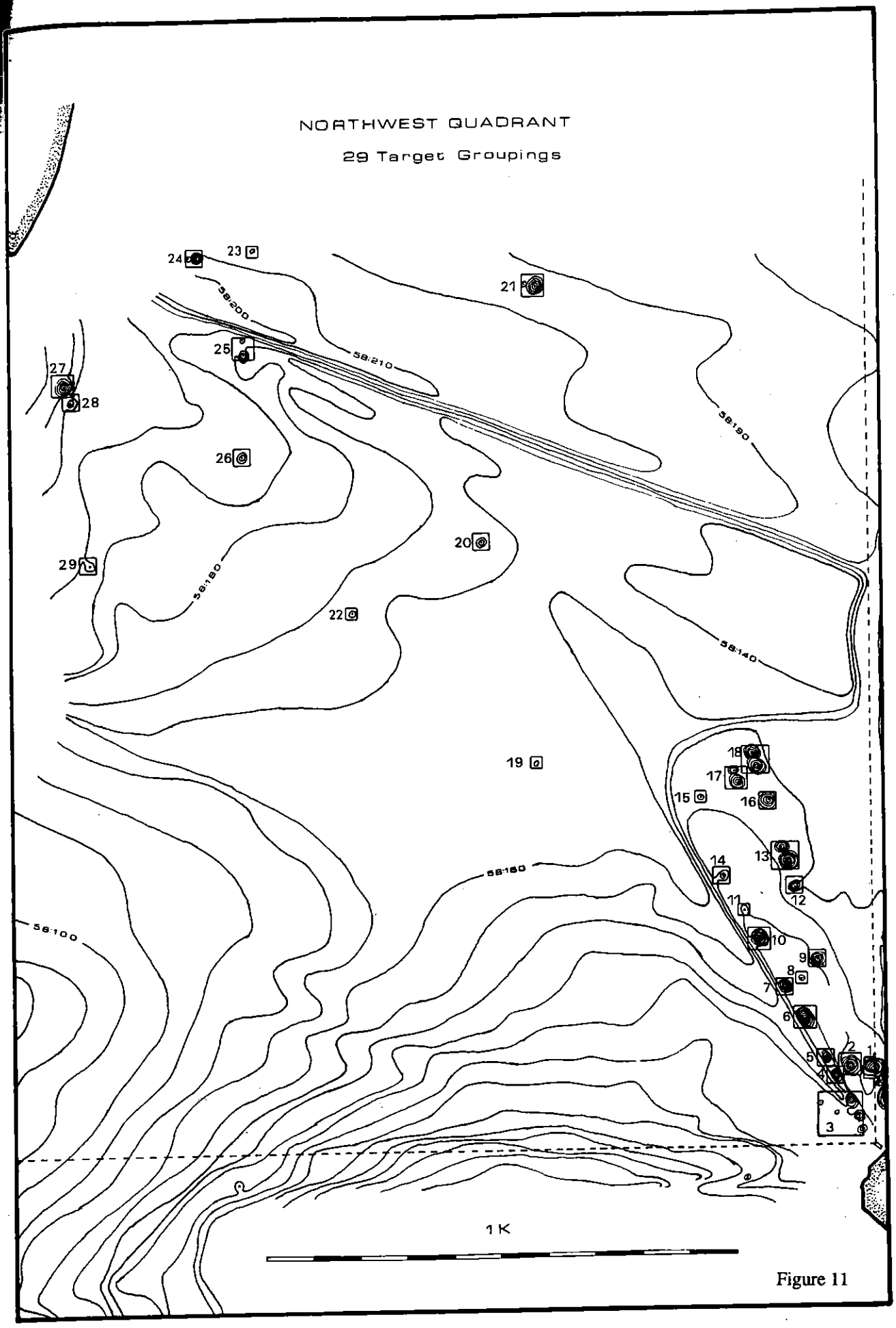

NORTHWEST QUADRANT
29 Target Groupings
24
23
21
25
27
28
26
20
29
22
19
18
17
15
16
14
13
12
11
10
9
8
7
6
5
4
3
2
1
SB:200
SB:210
SB:190
SB:180
SB:140
SB:160
SB:100
1 K

Figure 11

NW-2

Location Date/Transect/Azimuth: 7-6-89 / 13 / 344 degrees
Mini Ranger Location: A 3556 B 334 CG Tower/LH SW
Loran C Location: YesDepth: 47 feet
Intensity: 67 gammas monopolar
Duration: 12 seconds
Ground-Truthed: Yes, 7-24-89

Analysis: Divers located a coil of wire rope and scattered planking.

NW-3

Location Date/Transect/Azimuth: 7-6-89 / 17 / 332 degrees
7-11-89 / 3, 7, 8 / 312 to 327 degrees
Mini Ranger Location: A 2503 B 231 USGS/LH SW (to west edge of cluster)
A 2624 B 140 USGS/LH SW (to center of cluster)
A 2645 B 125 USGS/LH SW (to SE corner of cluster)
Loran C Location: NA
Depth: 30 feet
Intensity: 10-40 gammas multicomponent
Duration: 16-24 seconds
Ground-Truthed: No

Analysis: NW-3 contains at least five separate targets. The signatures closely resemble the debris field associated with the PINW site. NW-3 is most likely, therefore, a continuation of the wreck and fastening scatter associated with PINW site.

NW-4

Location Date/Transect/Azimuth: 7-6-89 / 17 / 332 degrees
Mini Ranger Location: A NA B 253 CG Tower/LH SW
Loran C Location: NA
Depth: 30 feet
Intensity: 40 gammas monopolar spike
Duration: 2 seconds
Ground-Truthed: Yes, 7-11-89 & 7-12-89.

Analysis: The short duration of this signature with other identical signatures on transect 17 suggest that the targets were created by atmospherics. Ground-truthing revealed no artifacts.

NW-5

Location Date/Transect/Azimuth: 7-6-89 / 17 / 332 degrees
Mini Ranger Location: A NA B 295 CG Tower/LH SW
Loran C Location: NA
Depth: 35 feet
Intensity: 40 gamma monopolar spike
Duration: 2 seconds
Ground-Truthed: Yes, 7-11-89 & 7-12-89

Analysis: See NW-4

NW-6

Location Date / Transect / Azimuth: 7-6-89 / 17 / 332 degrees
Mini Ranger Location: A NA B 362 CG Tower/LH SW
Loran C Location: NA
Depth: 40 feet
Intensity: 70 gamma monopolar spike
Duration: 6 seconds
Ground-Truthed: Yes, 7-11-89 & 7-12-89

Analysis: See NW-4

NW-7

Location Date/Transect/Azimuth: 7-6-89 / 17 / 332 degrees
Mini Ranger Location: A NA B 477 CG Tower/LH SW
Loran C Location: NA
Depth: 50 feet
Intensity: 60 gamma monopolar spike
Duration: 4 seconds
Ground-Truthed: Yes, 7-11-89 & 7-12-89

Analysis: See NW-4

NW-8

Location Date/Transect/Azimuth: 7-6-89 / 15 / 338 degrees
Mini Ranger Location: A NA B 477 CG Tower/LH SW
Loran C Location: NA
Depth: 50 feet
Intensity: 19 gamma monopolar
Duration: 8 seconds
Ground-Truthed: No

Analysis: Though a small signature, it is indicative of a target rather than atmospheric interference such as that which plagued transect 17.

NW-9

Location Date/Transect/Azimuth: 7-6-89 / 13 / 344 degrees
Mini Ranger Location: A 3394 B 499 CG Tower/LH SW
Loran C Location: NA
Depth: 40 feet
Intensity: 60 gammas multicomponent
Duration: 10 seconds
Ground-Truthed: Yes, 7-11-89

Analysis: Divers located coal scatter and two wooden futtocks. There was no visual indication of the anomaly source.

NW-10

Location Date/Transect/Azimuth: 7-6-89 / 17 / 332 degrees
Mini Ranger Location: A NA B 595 CG Tower/LH SW
Loran C Location: NA
Depth: 50 feet
Intensity: 70 gamma monopolar spike
Duration: 2 seconds
Ground-Truthed: Yes, 7-11-89 & 7-12-89

Analysis: See NW-4

NW-11

Location Date/Transect/Azimuth: 7-6-89 / 17 / 332 degrees
Mini Ranger Location: A 3050 B 692 CG Tower/LH SW
Loran C Location: NA
Depth: NA
Intensity: 25 gamma monopolar
Duration: 2 seconds
Ground-Truthed: Yes, 7-11-89 & 7-12-89

Analysis: See NW-4

NW-12

Location Date/Transect/Azimuth: 7-6-89 / 13 / 344 degrees
Mini Ranger Location: A 3180 B 705 CG Tower/LH SW
Loran C Location: NA
Depth: 50 feet
Intensity: 25 gamma monopolar
Duration: 4 seconds
Ground-Truthed: No

Analysis: The signature suggests a target of moderate size as it does not extend to adjacent transects.

NW-13

Location Date/Transect/Azimuth: 7-6-89 / 13 / 344 degrees
Mini Ranger Location: A 3052 B 831 CG Tower/LH SW
Loran C Location: NA
Depth: 50 feet
Intensity: 80 gammas
Duration: 8 seconds
Ground-Truthed: No

Analysis: This target actually consists of two anomalies approximately 25 meters apart. The stronger one is inshore towards Pilot Island from the given coordinates.

NW-14

Location Date/Transect/Azimuth: 7-6-89 / 17 / 332 degrees
Mini Ranger Location: A 3070 B 771 CG Tower/LH SW
Loran C Location: NA
Depth: 50 feet
Intensity: 25 gamma monopolar spike
Duration: 2 seconds
Ground-Truthed: Yes, 7-11-89 & 7-12-89

Analysis: See NW-4

NW-15

Location Date/Transect/Azimuth: 7-6-89 / 16 / 335 degrees
Mini Ranger Location: A NA B 823 CG Tower/LH SW
Loran C Location: NA
Depth: Approx. 50 feet
Intensity: 27 gamma multicomponent
Duration: 20 seconds
Ground-Truthed: No

Analysis: The duration and multicomponent nature of this target signature suggest that it is of a significant nature.

NW-16

Location Date/Transect/Azimuth: 7-6-89 / 13 / 344 degrees
Mini Ranger Location: A 2962 B 923 CG Tower/LH SW
Loran C Location: NA
Depth: Approx. 50 feet
Intensity: 60 gamma monopolar
Duration: 2 seconds
Ground-Truthed: No

Analysis: The short duration and spiky nature of this target suggest that it may be an atmospheric aberration.

NW-17

Location Date/Transect/Azimuth: 7-6-89 / 14 / 341 degrees
Mini Ranger Location: A 1977 B 873 USGS/LH SW
Loran C Location: YesDepth: 52 feet
Intensity: 48 gamma multicomponent
Duration: 24 seconds
Ground-Truthed: Yes, 7-26-89

Analysis: Located at least eight Edison Carbonaire 3.7 volt 1000 amp hour electrical batteries. One specimen dated Nov. 21, 1970. Batteries buried to upper surface with approximately seven inches of sand overburden. Also scattered wreck debris including planks, floors, and chocks.

NW-18

Location Date/Transect/Azimuth: 7-6-89 / 13 / 344 degrees
Mini Ranger Location: A 2929 B 955 CG Tower/LH SW
Loran C Location: NA
Depth: Approx. 50 feet
Intensity: 55 gamma multicomponent
Duration: 14 seconds
Ground-Truthed: No

Analysis: The target consists of several distinctive spikes yet the duration suggests that it may be a significant anomaly.

NW-19

Location Date/Transect/Azimuth: 7-11-89 / 5 / 321 degrees
Mini Ranger Location: A 1644 B 1196 USGS/LH SW
Loran C Location: NA
Depth: 40 feet
Intensity: 10 gamma dipolar
Duration: 16 seconds
Ground-Truthed: No

Analysis: Target NW-19 is a gradual dipolar anomaly. The shallow water depth and the fact that the anomaly was not detected in adjacent transects suggest an anomaly source much smaller than a shipwreck.

NW-20

Location Date/Transect/Azimuth: 7-11-89 / 2 / 329 degrees
Mini Ranger Location: A 1168 B 1645 USGS/LH Porch
Loran C Location: NA
Depth: 25 feet
Intensity: 25 gamma dipolar
Duration: 20 seconds
Ground-Truthed: Yes, 7-11-89

Analysis: Divers located 1 meter long iron rod.

NW-21

Location Date/Transect/Azimuth: 7/21/89 / Plum 2 / 95 degrees
Mini Ranger Location: A 1066 B 2106 USGS/LH SW
Loran C Location: YesDepth: 23 feet
Intensity: 110 gamma dipolar
Duration: 12 seconds
Ground-Truthed: Yes, 7-26-89

Analysis: Divers located a piece of 1.75" diameter wire rope, cable-laid, approximately twenty feet in length.

NW-22

Location Date/Transect/Azimuth: 7-11-89 / 6 / 318 degrees
Mini Ranger Location: A 1067 B 1694 USGS/LH Porch
Loran C Location: NA
Depth: Approx. 25 feet
Intensity: 15 gamma monopolar
Duration: 6 seconds
Ground-Truthed: No

Analysis: The short duration and lack of carry over to adjacent transects suggest a small target.

NW-23

Location Date/Transect/Azimuth: 7-21-89 / Plum 1 / 92 degrees
Mini Ranger Location: A 464 B 2473 USGS/LH SW
Loran C Location: NA
Depth: 23 feet
Intensity: 7 gamma multicomponent
Duration: 20 seconds
Ground-Truthed: No

Analysis: Water depth and target intensity suggest a very small artifact.

NW-24

Location Date/Transect/Azimuth: 7-21-89 /Plum 2 / 95 degrees
Mini Ranger Location: A 389 B 2490 USGS/LH SW
Loran C Location: NA
Depth: 20 feet
Intensity: 100 gamma monopolar
Duration: 12 seconds
Ground-Truthed: Yes, 7-31-89

Analysis: The intensity, shallow water, and short duration of this target is suggestive of wire cable, however, divers located nothing in the area.

NW-25

Location Date/Transect/Azimuth: 7-22-89 / Plum 1 & 2 / 113 & 116
Mini Ranger Location: A 520 B 2320 USGS/LH SW A 497 B 2283 USGS/LH SW
Loran C Location: NA
Depth: 24 feet
Intensity: 10-70 gamma monopolar
Duration: 4 seconds
Ground-Truthed: No

Analysis: The shallowness of the water may contribute to the high intensity signature but the short duration suggests a small iron artifact or fastening scatter.

NW-26

Location Date/Transect/Azimuth: 7-22-89 / Plum 8 / 134
Mini Ranger Location: A 638 B 2130 USGS/LH SW
Loran C Location: NA
Depth: 48 feet
Intensity: 25 gamma monopolar
Duration: 2 seconds
Ground-Truthed: No

Analysis: Target duration suggests target smaller than a wreckage section. Transect spacing at this location is narrow with no signal or target carryover to adjacent transects.

NW-27

Location Date/Transect/Azimuth: 7-25-89 / Plum 7 / 161 degrees
Mini Ranger Location: A 279 B 2469 USGS/LH SW
Loran C Location: YesDepth: 18 feet
Intensity: 80 gamma monopolar
Duration: 10 seconds
Ground-Truthed: Yes, 7-31-89

Analysis: The shallowness of the water combined with the short duration of the anomaly indicate it may have been a small iron object that the sensor passed close to. Divers located one chisel-tipped, rosette head, 1/4"-square shank ship spike.

NW-28

Location Date/Transect/Azimuth: 7-25-89 / Plum 7 / 161 degrees
Mini Ranger Location: A 330 B NA USGS/LH SW
Loran C Location: NA
Depth: Approx. 20 feet
Intensity: 55 gamma monopolar
Duration: 2 seconds
Ground-Truthed: No

Analysis: The duration and spiky nature of the anomaly suggest a small iron object similar to NW-27.

NW-29

Location Date/Transect/Azimuth: 7-25-89 / Plum 9 / 173 degrees
Mini Ranger Location: A 676 B 2196 USGS/LH SW
Loran C Location: NA
Depth: 75 feet
Intensity: 10 gamma monopolar
Duration: 2 seconds
Ground-Truthed: No

Analysis: The short duration and spike signature may indicate an atmospheric aberration. The depth of water, however, does not rule out the possibility of a target.

Target Analysis Southwest Quadrant (SW-1 through SW-24)

The magnetic background of the Southwest Quadrant is dominated by three large peaks of 58:310, 58:350, and 58:400 gammas. This in by far the most dynamic gradient of the three quadrants with a magnetic valley due west of Pilot Island of only 58:070 gammas. See Figure 12.

SW-1

Location Date /Transect/Azimuth: 7-12-89 / 12 / 267 degrees
7-25-89 / 9 Plum / 167 degrees
Mini Ranger Location: A NA B 1357 USGS/LH SW
A 2213B 1367 USGS/LH SW
Loran C Location: NA
Depth: 111 feet
Intensity: 22 gamma dipolar 7-12-89
68 gamma monopolar 7-25-89
Duration: 4 to 10 seconds
Ground-Truthed: No

Analysis: This anomaly presented itself on transects extending from both Plum and Pilot islands. Water depth, intensity, and duration indicate it may be associated with significant cultural material.

SW-2

Location Date/Transect/Azimuth: 7-13-89 / 2 / 257 degrees
Mini Ranger Location: A NA B 290 USGS/LH SW
Loran C Location: NA
Depth: Approx. 35-40 feet
Intensity: 22 gamma monopolar
Duration: 10 seconds
Ground-Truthed: No

Analysis: Water depth, intensity, and duration suggest that although this anomaly may represent cultural material it is not on the order of a wreck or wreck section as it does not extend to adjacent transects.

SW-3

Location Date/Transect/Azimuth: 7-14-89 / 6 / 227 degrees
Mini Ranger Location: A 2764 B 570 USGS/LH SW
Loran C Location: NA
Depth: 70-80 feet
Intensity: 20 gamma monopolar
Duration: 6 seconds
Ground-Truthed: No

Analysis: This target is most closely related to the SW site marked by local divers. Subsequent magnetometer passes may have pinpointed the SW site at A 2744 B 717. SW-3 may represent the outer fringes of the wreck section.

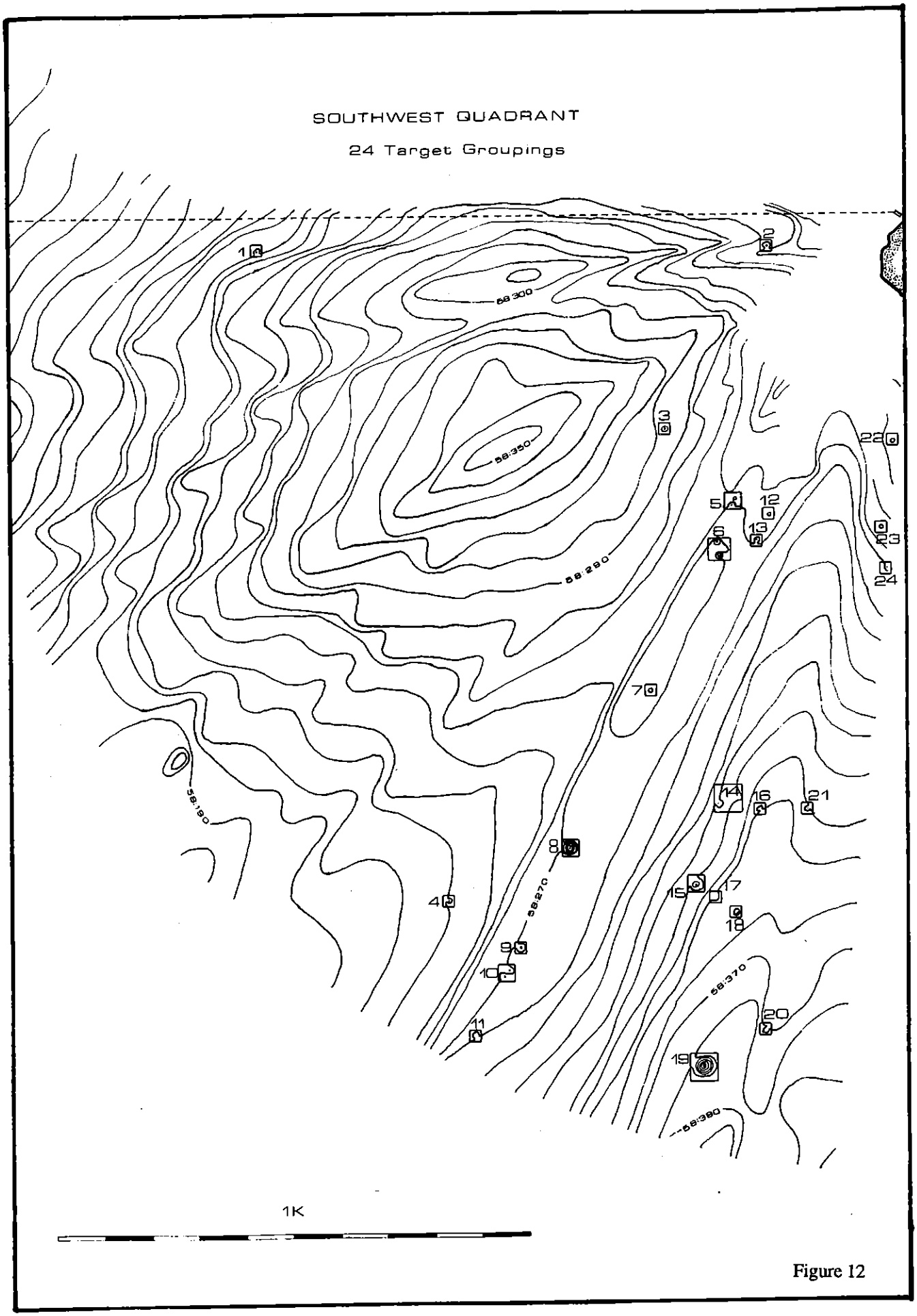

SOUTHWEST QUADRANT
24 Target Groupings
58:300
58:350
58:290
58:190
58:270
58:370
58:380
1K

Figure 12

SW-4

Location Date/Transect/Azimuth: 7-17-89 / 5 / 213 degrees
Mini Ranger Location: A NA B 1732 USGS/LH SW
Loran C Location: NA
Depth: Approx. 100 feet
Intensity: 10 gamma monopolar
Duration: 2 seconds
Ground-Truthed: No

Analysis: All variables considered, this is very weak anomaly and is not carried over to adjacent transects.

SW-5

Location Date/Transect/Azimuth: 7-18-89 / 1 / 211 degrees 12'
Mini Ranger Location: A 3006 B 706 USGS/LH S
Loran C Location: NA
Depth: Approx. 50-60 feet
Intensity: 25 gammas multicomponent
Duration: 8 seconds
Ground-Truthed: No

Analysis: The multicomponent nature and water depth indicate that this may be a significant anomaly.

SW-6

Location Date/Transect/Azimuth7-18-89 / 1 & 2 / 211 degrees 12'
209 degrees 12'
Mini Ranger Location: A NA B 760 USGS/LH S
A 3065B 783
Loran C Location: YesDepth: Approx. 60 feet
Intensity: 15-25 gammas multicomponent
Duration: 4-8 seconds
Ground-Truthed: No

Analysis: The multicomponent nature of this signature taken with the fact that it extends to adjacent transects indicates it may represent significant cultural remains.

SW-7

Location Date/Transect/Azimuth: 7-18-89 / 2 / 209 degrees 12'
Mini Ranger Location: A 3251 B 1095 USGS/LH S
Loran C Location: NA
Depth: Approx. 70-80 feet
Intensity: 10 gamma dipolar
Duration: 6 seconds
Ground-Truthed: No

Analysis: The duration and water depth suggest that this may be a significant anomaly.

SW-8

Location Date/Transect/Azimuth: 7-18-89 / 2 / 209 degrees 12'
Mini Ranger Location: A 3511 B 1487 USGS/LH S
Loran C Location: NA
Depth: Approx. 100 feet
Intensity: 60 gamma dipolar
Duration: 10 seconds
Ground-Truthed: No

Analysis: Duration, intensity and water depth all indicate that this may be a significant target.

SW-9

Location Date/Transect/Azimuth: 7-18-89 / 2 / 209 degrees 12'
Mini Ranger Location: A 3671 B 1713 USGS/LH S
Loran C Location: NA
Depth: Approx 100 feet
Intensity: 20 gamma monopolar
Duration: 6 seconds
Ground-Truthed: No

Analysis: All variables indicate that SW-9 maybe a significant anomaly.

SW-10

Location Date/Transect/Azimuth: 7-18-89 / 2 / 209 degrees 12'
Mini Ranger Location: A 3734 B 1812 USGS/LH S
Loran C Location: NA
Depth: Approx. 100 feet
Intensity: 20 gamma multicomponent
Duration: 10 seconds
Ground-Truthed: No

Analysis: Variables suggest a significant target

SW-11

Location Date/Transect/Azimuth: 7-18-89 / 2 / 209 degrees 12'
Mini Ranger Location: A 3826 B 1907 USGS/LH S
Loran C Location: NA
Depth: Approx. 100 feet
Intensity: 15 gamma monopolar
Duration: 2 seconds
Ground-Truthed: No

Analysis: Considering water depth this may be a significant target.

SW-12

Location Date/Transect/Azimuth: 7-18-89 / 5 / 205 degrees 12'
Mini Ranger Location: A 3103 B 686 USGS/LH S
Loran C Location: NA
Depth: Approx. 35 feet
Intensity: 15 gamma dipolar
Duration: 4 seconds
Ground-Truthed: No

Analysis: Water depth indicates that although this anomaly may represent cultural material it is likely to be smaller than a wreck or wreck section.

SW-13

Location Date/Transect/Azimuth: 7-18-89 / 5 / 205 degrees 12'
Mini Ranger Location: A 3136 B 740 USGS/LH S
Loran C Location: NA
Depth: Approx. 40 feet
Intensity: 10 gamma monopolar
Duration: 4 seconds
Ground-Truthed: No

Analysis: Target SW-13 probably does not represent a large object but its proximity to SW-6 and SW-12 may make it part of an extended debris field.

SW-14
Location Date/Transect/Azimuth 7-18-89 / 5 / 199 degrees 12'
197 degrees 12'
Mini Ranger Location: A 3583B 1260-1270 USGS/LH S
A 3639B 1280 USGS/LH S
Loran C Location: NA
Depth: Approx. 80 feet
Intensity: 10 gamma monopolar
Duration: 2 seconds
Ground-Truthed: No

Analysis: Though this anomaly seems to extend over two transects it is extremely faint.

SW-15

Location Date/Transect/Azimuth: 7-18-89 / 8 / 199 degrees 12'
Mini Ranger Location: A 3713 B 1421 USGS/LH S
Loran C Location: NA
Depth: Approx. 80 feet
Intensity: 33 gamma monopolar
Duration: 8 seconds
Ground-Truthed: No

Analysis: All variables suggest this may be a significant anomaly.

SW-16

Location Date/Transect/Azimuth: 7-18-89 / 10 / 195 degrees 12'
Mini Ranger Location: A 3659 B 1264 USGS/LH S
Loran C Location: NA
Depth: 90 feet
Intensity: 9 gamma monopolar
Duration: 10 seconds
Ground-Truthed: No

Analysis: This is a very faint anomaly though water depth indicates that it may be a significant target.

SW-17

Location Date/Transect/Azimuth: 7-18-89 / 9 / 197 degrees 12'
Mini Ranger Location: A NA B 1475 USGS/LH S
Loran C Location: NA
Depth: Approx. 100 feet
Intensity: 10 gamma monopolar
Duration: 8 seconds
Ground-Truthed: No

Analysis: SW-17 is a faint target but water depth and duration preclude ruling it insignificant. It may also be associated with targets SW-15 or SW-18.

SW-18

Location Date/Transect/Azimuth: 7-18-89 / 10 / 195 degrees 12'
Mini Ranger Location: A NA B 1520 USGS/LH S
Loran C Location: NA
Depth: Approx. 100 feet
Intensity: 16 gamma dipolar
Duration: 6 seconds
Ground-Truthed: No

Analysis: The water depth, intensity, and duration suggest this to be a significant target in close proximity with SW-15 and SW-17.

SW-19

Location Date/Transect/Azimuth: 7-18-89 / 10 / 195 degrees 12'
Mini Ranger Location: A 4116 B 1819 USGS/LH S
Loran C Location: NA
Depth: Approx. 100 feet
Intensity: 58 gamma dipolar
Duration: 2 seconds
Ground-Truthed: No

Analysis: The extremely short duration of this anomaly suggests an atmospheric aberration. The depth and intensity, however, do not rule out cultural material.

SW-20

Location Date/Transect/Azimuth: 7-19-89 / 1 / 191 degrees
Mini Ranger Location: A 4114 B 1737 USGS/LH S
Loran C Location: NA
Depth: Approx. 100 feet
Intensity: 12 gamma multicomponent
Duration: 16 seconds
Ground-Truthed: No

Analysis: Though not an intense reading, SW-20 has a good duration for the water depth and may prove significant.

SW-21

Location Date/Transect/Azimuth: 7-19-89 / 1 / 191 degrees
Mini Ranger Location: A NA B 1270 USGS/LH S
Loran C Location: NA
Depth: Approx 90 feet
Intensity: 15 gamma dipolar
Duration: 10 seconds
Ground-Truthed: No

Analysis: SW-21 does not carry over to adjacent transects but due to water depth may prove a significant anomaly.

SW-22

Location Date/Transect/Azimuth: 7-19-89 / 3 / 187 degrees
Mini Ranger Location: A NA B 460 USGS/LH S
Loran C Location: NA
Depth: Approx. 20 feet
Intensity: 14 gamma dipolar
Duration: 6 seconds
Ground-Truthed: No

Analysis: Water depth and short intensity suggest that SW-22 may be a small metal artifact not large enough or remote enough to be a wreck section.

SW-23

Location Date/Transect/Azimuth: 7-19-89 / 3 / 187 degrees
Mini Ranger Location: A NA B 640 USGS/LH S
Loran C Location: NA
Depth: Approx. 25 feet
Intensity: 10 gamma dipolar
Duration: 4 seconds
Ground-Truthed: No

Analysis: As with SW-22, shallow water depth, low signal intensity, and short duration all but preclude the possibility that this target is a wreck or wreck section.

SW-24

Location Date/Transect/Azimuth: 7-19-89 / 4 / 185 degrees
Mini Ranger Location: A NA B 750 USGS/LH S
Loran C Location: NA
Depth: Approx. 30 feet
Intensity: 8 gamma monopolar
Duration: 4 seconds
Ground-Truthed: No

Analysis: Short duration, water depth, and minimal intensity all but rule SW-24 out as significant wreck debris.

Abbreviations and Terms

CG Tower:	Coast Guard Station Plum Island, old US Life-Saving Service station tower, Mini-Ranger Station
LH Porch	Pilot Island Lighthouse, NW porch, Mini-Ranger Station
LH S:	Pilot Island Lighthouse, south island, Mini-Ranger Station
LH SW:	Pilot Island Lighthouse, SW corner of building, Mini-Ranger Station
Plum:	Theodolite station, Plum Island
USGS:	United States Geological Survey Marker, Mini-Ranger Station
Dipolar:	a magnetic anomaly with both north and south polar orientation.
Monopolar:	a magnetic anomaly with only a north or south polar orientation.
Multicomponent:	a complex magnetic anomaly made up of divergent polar orientations.
NA:	not available

6.0 CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK

A view of the overall magnetic contour map of the Pilot Island vicinity can be misleading (Figure 4). It would appear from this map that most of the cultural material lies to the north and west of Pilot Island. This may not actually prove to be the case. As was mentioned previously, magnetic anomaly intensity is more a matter of sensor proximity to the target rather than the mass of the artifact that produces the anomaly. While the shallow water to the north and northwest of Pilot Island tends to exaggerate anomalies, the northwest target cluster illusion is further enhanced by the many false targets registered on transect 17 of 7-6-89. Ground-truthing demonstrated that most of these particular targets are bogus, apparently produced by atmospheric aberrations.

Though there is indeed a good deal of significant material in the Northwest and Northeast quadrants near Pilot Island, the Southwest quadrant contains many targets which may be equally significant though water depth reduces the signature intensity. Anomaly clusters and single anomalies which are detected on adjacent survey transects are much more indicative of a target's physical size than is anomaly strength in this deeper water.

The scattered, broken vessel remains located in the vicinity of Pilot Island reflect the high-energy environment of the Death's Door Passage, which has greatly affected the remains of stranded vessels. A combination of ice and wave action very quickly disposed of any remains left in shallow water, contributing to the present makeup of such jumbled sites as the Pilot Island Northwest Site (Cooper 1989:60-76) and the large broken hull elements of the Pilot Island NW1, NW2, Southwest and South sites. Much of the lakebed is covered with additional smaller debris in the vicinity of the large wreckage sections.

The concentration on the northwest side of Pilot Island clearly indicates that while the southwest reef was the focal point for much of the historically known wreck activity (Cooper 1989:57-61) this debris was later pushed northwards until it settled into the lee of Pilot Island (that this is the best protected side is reflected in the fact that the old lighthouse dock is on the northwest side of the island). As the south and east faces of Pilot Island are the most exposed to weather from Lake Michigan, heavy lake weather would tend to push wreckage into the lee on the northwest. This deposition pattern is confirmed by the relative dearth of inshore wreckage in the other quadrants of Pilot Island.

Of the eleven vessels reported total losses and believed to never have been salvaged from Pilot Island (Figure 2), current archeological remains account for at least five of these vessels, and potentially more (many of the fragmentary remains cannot be related to any single vessel). While additional analysis of the known wreckage may account for fragments of other vessels, where the major hull fragments have gone is currently unresolved. A similar situation was found at Plum Island southeast reef, where of two major vessel losses reported on the southeast reef, only a few iron hull fastenings could be found. Six additional vessels simply reported as wrecked at Death's Door may also have been lost in the survey area, but have not yet been relocated and identified.

It is possible that these vessels were (1) salvaged historically and the event was not recorded (2) have not survived in the Door's high energy environment other than in fragmentary, almost unrecognizable form, or (3) have been moved by environmental forces away from the islands into deeper water where they may still be preserved.

Plainly, much work remains to be done in completing investigations of the Death's Door Passage. Ground-truthing of the remaining targets needs to be conducted (Figure 13) with priority placed on those whose signature indicates a high probability to yield significant archeological material. Additional remote-sensing survey is warranted for the rest of the Death's Door Passage, particularly the deep waters between the mainland and Plum Island. Additional work in the vicinity of Pilot Island should include remote-sensing in the yet-unsurveyed southeast quadrant (which currently has no reported submerged cultural resources though some may exist) and more follow-up investigations of the low intensity anomalies in the surveyed quadrants.

Figure 13

Ground Truthing Priority List

First Priority	Secondary	Ground-Truthed to Date
NW-3	NE-1	NE-4
NW-8	NE-2	NE-5
NW-13	NE-3	NE-6
NW-15	NW-12	NE-7
NW-18	NW-16	NE-8
SW-1	NW-19	NE-9
SW-3	NW-22	NE-10
SW-5	NW-23	NE-11
SW-6	NW-25	NW-1
SW-7	NW-26	NW-2
SW-8	NW-28	NW-4
SW-9	NW-29	NW-5
SW-10	SW-2	NW-6
SW-11	SW-4	NW-7
SW-13	SW-12	NW-9
SW-14	SW-22	NW-10
SW-15	SW-23	NW-11
SW-16	SW-24	NW-14
SW-17		NW-17
SW-18		NW-20
SW-19		NW-21
SW-20		NW-24
SW-21		NW-27

Both the Pilot Island Southwest and South sites require at least a preliminary level of documentation, and additional documentation work remains to be conducted at PINW, PINW1, and PINW2. While these known sites have highlighted the general lack of structural integrity that most historical shipwreck sites are likely to yield following a stranding in the Door's high energy environment, much valuable archeological data relating to marine architecture and site deposition may be obtained from these and other disarticulated wrecksites.

Project objectives of Phase I identification of concentrations of submerged cultural resources in the project area have largely been completed, with additional ground-truthing and Phase II documentation to follow. Ground-truthing of priority targets in the Southwest quadrant is especially important, and will provide a better idea of the potential for significant remains in this area. The 1989 survey succeeded in locating the most significant inshore cultural remains in the southeast Death's Door Passage with their accompanying debris fields, providing a much better understanding of the distribution of these resources, how these shipwrecks have been affected by the Door's high energy environment, and what type of remains have been preserved to the present day.

7.0 REFERENCES CITED

Arnold, J. Barto III
1976 An Underwater Archeological Magnetometer Survey and Site Test Excavation Project off Padre Island, Texas. Publication No. 3. Texas Antiquities Committee, Austin.

Breiner, Sheldon
1973 Applications Manual for Portable Magnetometers. Geometrics, Sunnyvale, California.

Boyd, Richard
1988 Personal communication.

Cooper, David J.
1987 Evaluation of Field Operations of the Atlantic Alliance for Maritime Heritage Conservation in Door County, Wisconsin, August 10-15, 1987. Unpublished report on file, State Historical Society of Wisconsin, Madison.

Cooper, David J.
1988 Inventory of Vessel Losses in Death's Door, Door County, Wisconsin and Surrounding Waters 1837-1938. State Historical Society of Wisconsin, Madison.

Cooper, David J.
1989 Survey of Submerged Cultural Resources in Northern Door County; 1988 Field Season Report. State Historical Society of Wisconsin, Madison.

Eaton, Conan Bryant
1974 Death's Door; the Pursuit of a Legend. Bayprint, Inc., Sturgeon Bay.

Kaniff, Daniel and Kevin Kaniff
1988 Personal communication.

Kaniff, Daniel
1989 Personal communication.

Shastal, William
1988 Personal communication.

U.S. Lighthouse Board
1896 List of Lights and Fog Signals of the United States on the Northern Lakes and Rivers. Government Printing Office, Washington, D.C.

Van Harpen, Jon
1987 Atlantic Alliance draft report. Ms. on file, State Historical Society of Wisconsin, Madison.

UNDERWATER ARCHEOLOGY PROGRAM
DIVISION OF HISTORIC PRESERVATION
STATE HISTORICAL SOCIETY OF WISCONSIN
816 STATE STREET
MADISON, WI. 53706