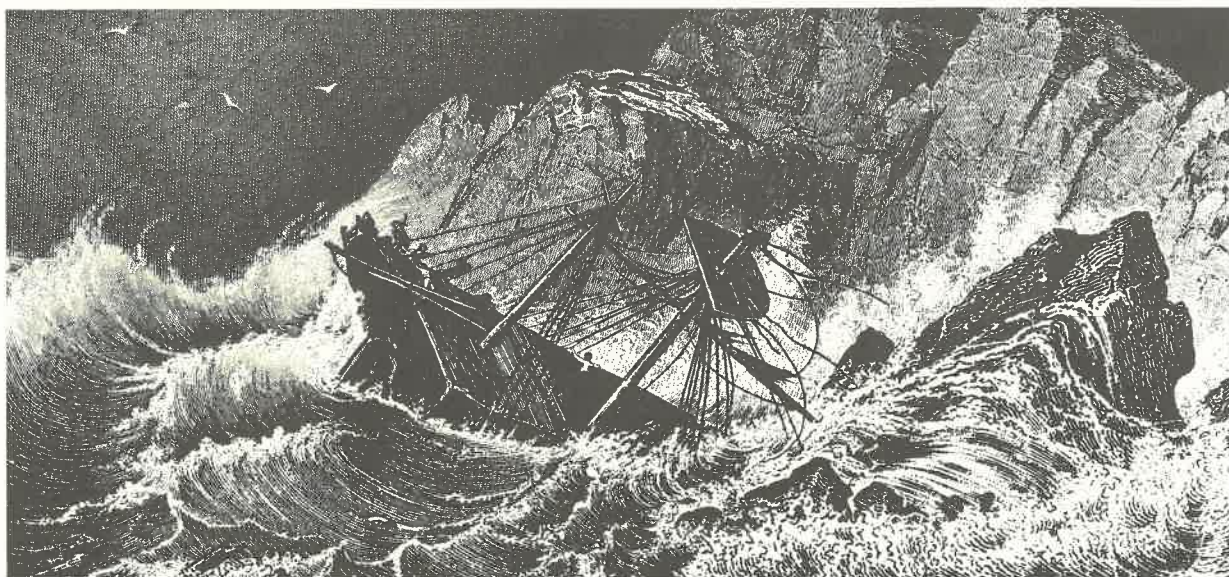


Coastlines

NEW YORK STATE SEA GRANT INSTITUTE
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Lake Ontario's Shipwrecks . . . A Look at the Past

by Robert B. Buerger, Sea Grant Specialist in Oswego

New York's Lake Ontario might well be described as a "graveyard for ships." Storms, sea battles, negligence and amusements have claimed hundreds of vessels to its bottom.

From Ancient Mariners to Jacques Cousteau

With the arrival of world-famous underwater explorer, Jacques Cousteau, and his research vessel, *Calypso*, in eastern Lake Ontario, interest in freshwater wrecks is high. *Calypso's* crew is exploring unknown wrecks for a future television documentary.

Although saltwater sailors may not regard Lake Ontario as perilous, those who have experienced its gales, blizzards, squalls, and thunderstorms know the lake can test the best of a sailor's seamanship. As evidence, an excerpt from a December 1846 issue

of the *Palladium Times*, Oswego's daily newspaper, reads "We were visited by another storm of wind and snow on Wednesday and Thursday of last week. The wind blew a perfect hurricane for upwards of 48 hours. A Canadian vessel went ashore in our harbor on Thursday morning. This is the fourth vessel which has been beached here during the late storm."

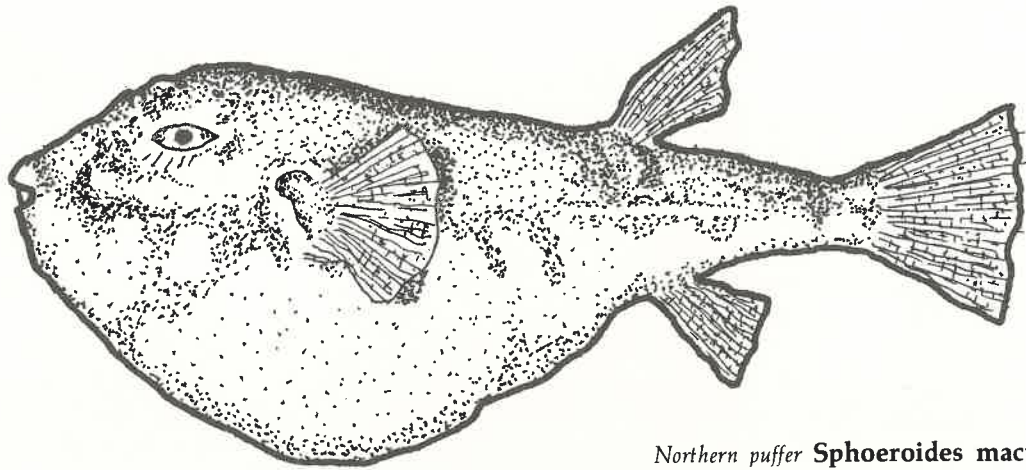
And an 1885 French Canadian chanty advises Ontario's sailors:

"Now all good wood scow sailor
mans,
Take warning by dat storm,
An' go marry one nice French girl,
An live on one beeg farm.

Den de win' can blow lak hurricane,
An' s'pose she blows some more;
You can't get drown on Lak Ontario
So long you stay on shore."

Accounts of shipwrecks describe the tragedy and triumph of the Great Lakes sailing life. In *Old Shipping Days in Oswego*, Leo Finn recalls the August 22nd, 1828 voyage of the *Sophia*, a small 25-ton schooner loaded with corn, from Pultneyville to Oswego. Captain Throop and his crew of two were five miles off Big Sodus Bay when heavy northwest winds turned the lake very rough. One of the crew discovered the *Sophia* was taking on water. Two minutes later, the ship had sunk. Captain Throop was in his cabin at the time and was drawn underwater by the suction of the sinking ship. After struggling to the surface, Throop found himself and his crew completely alone in the stormy lake waters. Clinging to floating boards, they began the long, four-hour swim

Continued on page 8.



Northern puffer *Sphoeroides maculatus*

The Puffer Paradox

by Christopher F. Smith, Sea Grant Specialist in Riverhead

Puffer fish are scaleless members of the family Tetradonotidae, and are distributed through a broad circum-global belt which extends from latitudes 47°N to 47°S. A somewhat innocent and unassuming appearance belies their ability to cause violent and painful death when eaten by man or animal. Indeed, many warnings against promiscuously eating puffer fishes have appeared throughout recorded history, most notably that which appears in the Bible in Deuteronomy 14:9-10: "These ye shall eat of all that are in the waters: all that have fins and scales shall ye eat: And whatsoever hath not fins and scales ye may not eat; it is unclean to you."

Many biblical experts feel that these prohibitions were directed toward preventing human contact with puffer fish since they were the most toxic scaleless fishes known to have existed in the region inhabited by the ancient Israelites.

Modern day scientists have investigated the phenomenon of puffer fish poisoning. This research has primarily occurred in Japan, and reveals some interesting trends. Poisoning is caused by ingesting the flesh, viscera or skin of a toxic puffer. Toxicity is greatest immediately prior to and during the reproductive season of the fish. The skin, liver, ovaries and intestines are the most toxic portions of the fish. The musculature is safer to

eat than other parts of the fish, but it too may be toxic in certain species. Unfortunately, these are not hard, unvarying rules. Toxicity varies seasonally, geographically, and between individuals. One puffer might be deadly poisonous, while its neighbor is perfectly safe to eat.

Death from puffer fish poisoning is caused by failure of the respiratory musculature. The onset and types of symptoms in puffer poisoning vary greatly, depending upon the person and the amount of poison ingested. If death occurs, it usually takes place within the first six hours or within 24 hours at the latest. During this time, respiration becomes shallow and heartbeat faint. One account tells of; a victim who was considered to be dead and was placed on a cart and taken to a crematorium in a nearby town. The victim recovered as he was being removed from the cart and walked away. There is presently no known antidote to puffer poisoning.

In Japan, puffer fish is considered a delicacy and is highly sought after. This is somewhat bizarre since it is common knowledge in Japan that puffers are poisonous. Interviews with these "Kamikasie" gourmets reveal that the favor is not the sole attraction. It is said that partakers experience an exhilarating state of being, consisting of sensations of warmth, flushing of the skin, numb-

ness of tongue and lips, and euphoria. Preparation of puffers for public consumption is a serious affair, requiring a licensed cook. A cook can receive a license only after rigorous training by Japanese government officials. It is disconcerting to note that even the finest puffer cooks occasionally succumb to their own cooking!

Puffer fish were once landed in abundance in the New York commercial fishery. The greatest catch in New York waters was in 1945, when almost 2.5 million pounds were landed. Since that time catches have generally declined to the 1979 landings of just under 2,000 lbs. Several investigators have found certain portions (not the tail muscle that is popularly eaten) of New York puffers to be potentially toxic. Presently, information on the toxicity of N.Y. puffer fish limits any conclusive answers.

Perhaps the best advice on carelessly eating puffer fish is given by an author in 1880: "Although there are many occupations in the world, some people engage in stealing instead of entering one of them. Although there are many women in the world, there are some men who become adulterers instead of marrying the women. Although there are many kinds of foods in the world, some people like to eat poisonous fugu (puffer fish) instead. These three groups of people make up an extremely stupid trio."

Guard Against Inadequate Toe Protection When Planning Shoreline Structures

says Peter Sanko (right), Sea Grant Specialist in Stony Brook, author of this article.



Seawalls, revetments, and bulkheads, when properly designed and constructed, provide secure protection against storm waves for the fastland and facilities behind them. As anyone who's had to build one recently knows, costs range from \$100 to \$300 or more per linear foot. Therefore, it pays to build them right in the first place, so they won't have to be replaced or reconstructed later.

Calculating inadequate toe protection

Failure of a structure before its life expectancy is most frequently caused by inadequate toe protection. When the toe or seaward edge of a structure's base is undercut, the structure fails. Undercutting results from the lowering of sea bottom or beach in front of a structure. This causes scouring away of the earth under the foundation and loss of backfill through a path under the structure. Beach lowering due to long-term erosion and short-term wave effects must be anticipated in the design of shoreline structures.

Beach lowering can be estimated by projecting the offshore profile landward for a distance equal to the erosion rate multiplied by the estimated economic life of the structure. For example, if the erosion rate is one foot per year, and the life of the structure is expected to be 50 years, then the elevation of the sea bottom in front of the structure in 50 years will be equal to the present bottom elevation 50 feet seaward of the structure.

As a general rule, the maximum depth of storm wave scour below the natural bed is about equal to the height of the maximum unbroken wave that can be supported by the original depth of water at the toe of the structure. For safety's sake, it's probably best to calculate on the basis of the wave heights somewhat offshore of the structure and to take into account increased water depths due to storm surge.

Ways to prevent toe failure

Once the amount of bottom lowering is estimated, toe protection can be incorporated into the structural design. Should it prove uneconomic to place the toe of the structure below the depth of maximum scour, several other means of protecting the toe can be used, singly or in combination.

A **blanket of rock** immediately in front of the toe is one way of preventing toe scour. Its feasibility depends upon the availability and cost of rock in the local area. One remedial measure of existing structures threatened with toe failure is to place a rip-rap revetment directly against the structure.

Vertical sheet-pile cutoff walls are sometimes incorporated into the design of new structures to protect the toe from failure. These are simply low sheet pile walls, the toes of which extend below the maximum scour depth. They can also be used to protect the toe of existing seawalls, revetments and bulkheads threatened by failure.

Small groins, under certain circumstances, are used to maintain



An example of undercutting, scouring and loss of backfill due to inadequate toe protection.

beach elevation seaward of a shoreline structure.

For groins to work, sufficient littoral drift and unidirectional longshore transport over a long period of time is required. If natural beaches don't or never did exist, groins will not work unless sand is artificially placed in the groin compartments. Since it is the beach created by the groins that protects the main structure, and not the groins themselves, the decision to use groins should be made cautiously. Also, it's possible for the beach to lower during one or a series of closely spaced storms, thus exposing the main structure to toe scour. Additionally, no matter how few and how small the groins may be, some downdrift erosion will occur.

Caution advised with groins

It's advisable to use groins only when the effects of accelerated downdrift erosion are acceptable. Groins accelerate downdrift erosion in several ways. They act as a barrier to littoral transport, causing starvation of downdrift beaches while the updrift compartments are filling. This effect can be mitigated somewhat by pre-filling the updrift compartments. Depending upon their length, groins deflect varying amounts of sand offshore, some of which may be permanently lost to downdrift beaches if deposited in deep enough water. Keeping the groins short and low helps to maintain sufficient beach elevation and to sustain natural sand bypassing of the groin field.

Often overlooked is the effect groins have on the longshore transport rate. The rate at which sand moves parallel to the shoreline is, in part, determined by the angle of the waves to the shoreline. When waves strike the shoreline at a right angle, only offshore-onshore transport takes place. As this angle decreases, longshore transport rates increase. Within the updrift accretion area of a groin, the shoreline will reorient itself so that it is at a greater angle to the direction of wave approach than before placement of the groin. The longshore transport rate is therefore slowed, and downdrift beach starvation will result. So, the best advice is to use groins as a last resort.

Inadequate toe protection is a common cause of premature structural failure. It should not be compromised for short-term savings unless reconstruction will be less costly than prevention.



Youth Projects

High School Students in East Hampton Conduct Coastal Resource Inventory

by Edward Matthews, Cooperative Extension 4-H Agent for Suffolk County

What does it mean for high school students to be involved in conducting a coastal resource inventory?

- It means youngsters can have a chance in understanding a complex problem facing their community.
- It provides an opportunity for youth to participate in problem-solving and decision making at the local government level.
- It exposes young people to the practical application of academic skills to field work.
- It provides a taste of what it's like to have an important job.

Actually, coastal resource inventories are not new to the young people of New York. In recent years, high school students have carried out inventories for local planning boards, conservation advisory councils and other organizations. These inventories have focused on wetlands, shoreline protection structures, and New York's Coastal Management Plan.

In East Hampton, high school students are conducting an inventory of the changes that take place in the distribution of sand along the beaches of a three-mile stretch. The study area includes East Hampton's town beach, Georgica Beach, and Wainscott Beach which are exposed to the direct attack of ocean waves. The purpose of the

inventory is to document the long-term effects of groins, revetments and bulkheads on the movement of sand in comparison to a stretch of open, unprotected beach.

A truly interdisciplinary approach has been developed for this project. Math, earth science, marine biology, and shop teachers from East Hampton's high school, under the leadership of Anthony Minardi, have been responsible for coordinating the study. Students from the shop class helped the project by making the Jacob stakes used for surveying. Biology and earth science students conducted the field aspects of the study. All of the students, regardless of which class they were enrolled in, collected data at specific beach locations on a monthly basis despite the weather conditions. In addition, many of the students were involved in making critical decisions regarding the inventory.

The raw data collected from the 20 sites along the beach was synthesized by math students who wrote their own computer program. The program describes beach profiles for each of the 20 sites in mathematical form which can also be displayed visually in a cross-sectional diagram on a TV screen. The use of graphics allows the students to superimpose several diagrams on top of one another to visually depict the monthly trends in a given area.

The involvement of high school students in a problem confronting a local community and the application of classroom skills to that problem have been a unique, but successful combination in the East Hampton project. According to Henry Bokuniewicz

wicz of the Marine Science Research Center in Stony Brook who has provided guidance on technical aspects of the project, "The use of high school students in making observations on the beach is a practical and potentially valuable strategy."

Presently, the inventory, which is in its second year, is funded by the East Hampton Beach Preservation Association, a group whose members own oceanfront property. However, without the cooperation and support from Sea Grant, Cooperative Extension's 4-H Program, SUNY's Marine Science Research Center in Stony Brook, the East Hampton School District and the Town of East Hampton, the inventory would not have been possible. But the combined dollars, expertise and time given by these organizations have insured the credibility of the data generated by the students.

Youth Involvement Pays Off in Town of Riverhead

"I want to let people know that a valuable resource is being destroyed right in their own town."

These words were spoken by a high school student who recently participated in a wetland and open space inventory for the Town of Riverhead. The inventory was conducted with the help of Cornell's Resource Information Laboratory, Cooperative Extension's 4-H Program, Sea Grant and the Riverhead Conservation Advisory Council. It marks a new approach to town planning using high



school students, university experts and government officials.

Initiated in 1978, the inventory uses sophisticated aerial photo interpretation, mapping techniques and extensive field data. The purpose of the inventory was to examine and map the town's entire 59 square miles to provide information upon which future land use decisions may be made. The projected time for completion of the inventory was four years.

The idea of using high school students to help carry out parts of the inventory came about in March 1979 as a result of a chance meeting. The meeting took place between Brian McKelvey, the coordinator of the inventory, and Edward Matthews, a Cooperative Extension 4-H agent who also works closely with the Sea Grant Extension Program. Brian was helping to teach a Sea Grant-sponsored course on natural resource inventories at SUNY in Stony Brook and Ed was enrolled in the course. Ed was interested in learning about inventories for the purpose of introducing inventory-taking methods to high school students and teachers in the Town of East Hampton.

The upshot of their meeting was that Brian became interested in using students for his inventory work in Riverhead. Over the next few months, the two continued to discuss these possibilities until it was decided that the involvement of youth was feasible and desirable.

According to Matthews, "Teenage mapmakers have proven their worth by conducting a similar inventory in the Town of Somers in Westchester County. If local youth could be trained to do field work and mapping there,

then why couldn't they also be involved in the Riverhead project?" questioned Matthews.

Recruitment and training of student volunteers was carried out cooperatively by Matthews and McKelvey. Cornell's Resource Information Laboratory was primarily responsible for development of the inventory and seeing that training of the students was appropriate for the work that they would be doing.

In May, George Bartunek, a town resident and junior high school teacher, was hired to serve as coordinator in recruiting and supervising the student volunteers. Through Bartunek, the project was explained to the principal and counselors at Riverhead's high school. By June, Bartunek had a dozen interested students signed up.

Through a mixture of classroom and field experiences, the actual training of students took place during five days at the end of June. According to Matthews, "The students learned how to read maps, identify common plants and trees, use and interpret aerial photographs, deal with the public while working in the field, in addition to basic first aid should it ever be needed while they were working in the field."

Before the students were ready to conduct field work, further work in plant identification and recording methods was carried out. Once their skills could be relied on for accuracy, they were sent to the field with little or no supervision. On their return to the office, they spent countless hours transferring field data to base maps and identifying unknown plants. As a result of their fine work it appears

the inventory project will be completed one year ahead of schedule.

The impact of their involvement in the inventory project has been positive. Under Bartunek's leadership, they organized a 4-H Club called the "Riverhead Resource Researchers." The name of their club was prompted by their inventory work on the history of the Town of Riverhead. This historical inventory was finished in September 1980 and will be on display in the Town of Riverhead.

There were other general benefits gained from the project. The youth learned about their community and its natural environment. Because the students volunteered their services, the community benefitted by not having to contract the work out to a commercial enterprise. But more importantly, the community benefitted by creating a nucleus of young people who can now work toward balanced growth and reduced environmental degradation in their home town.

After her involvement in this project, the same student quoted at the beginning of this article stated, "I feel as I always have. Change can come only through education of those causing the problems, so that they can start solving the problems."

By involving their youth, the Town of Riverhead is on the way towards solving its problems.

Illustrations from left to right: High school students take measurements at one of the 20 sites along a three-mile stretch of beach in the Town of East Hampton; Students from Somers and Riverhead work together in a planning session on inventory-taking methods; Understanding charts and maps is a necessary skill for students to develop in conducting inventories.

Hospitality Training Materials Help Bolster Economy

by Mark Wiley, Specialist in Potsdam

How many times have you gone into a restaurant or store and been so badly treated that you vowed never to return? Once? Twice? Several times?

When this happens, you are the unfortunate victim of one of the tourist industry's deadliest diseases — inhospitality.

Improving hospitality can be the cheapest and easiest way of increasing tourism business in most communities. To help increase awareness of the importance of hospitality, New York Sea Grant has published a hospitality booklet series by Vincent Dee and Alana de Meurers of Jefferson Community College. The booklets are designed for businesses and communities that wish to improve hospitality through inservice training or hospitality training seminars.

The first booklet, entitled **How You Benefit from Tourist Dollars**, explains how important the tourist industry is and how, through the multiplying

effect of tourist dollars, the economy of a community benefits. The other six are written for various personnel groups in the tourist industry specifically information center, hotel/motel, marina, restaurant, retail, service station, and public employees. They outline techniques that make tourists feel more welcomed and contain checklists that help employees become more aware of community attractions.

Used separately, an individual booklet can help a specific entrepreneur. A marina owner, for example, might want to use **How You Benefit from Tourist Dollars** and **How Marine Personnel Can Make Visitors Feel More Welcome and Want to Return** in an orientation for new employees or as a refresher in hospitality techniques for all employees. Or several marine businesses might want

to sponsor a seminar, using these booklets.

Used as a package, the booklets can help an entire community that would like to improve its hospitality. They can be distributed to tourist-related businesses in order to promote improvements by all components.

Or the community, through the Chamber of Commerce, might wish to sponsor a hospitality training seminar and use the materials there. Hospitality programs such as the I Love New York "Make it Happen" program have been successful in Niagara Falls, the 1000 Islands, and in Leatherstocking Country. These programs



generally stress the importance of the tourist economy to the community, and how hospitality techniques can improve the return rate of visitors to the area. Use of the checklist can help in identifying attractions available in the area, and making employees aware of their existence. These seminars have been effective in improving the image of a community and emphasizing the importance of hospitality in that process.

Hospitality booklet sets are available at \$1.35 per set or \$.25 per booklet. Bulk rates are also available upon request. All checks should be made payable to Cornell University. For more information about the booklets and about planning a hospitality training seminar, contact Stephen Brown at our new location, 338 Dunn Hall, on the State University Potsdam campus.

New Publications

Several new publications are now available to Coastlines' subscribers. To order them, see **I Want More**.

• **Marketing Alternatives for Fishermen.** Markets and market channels for seafood landed by American fishermen are as varied and diverse as the products which flow through them. From small, one-boat operations to highly industrialized fleets, there is a wide range of conditions and problems. Traditionally, however, most fishermen know little about what happens to the fish beyond the dockside or point of first sale. To some extent, how well fishermen fare as the total fishing/seafood sector of the economy grows and expands depends on the way they are organized to market their product. Published by Sea Grant in Texas, **Marketing Alternatives for Fishermen**, is intended for leaders at all levels of the seafood industry, marine advisory personnel and public policymakers in related state and federal agencies.

• **Location of Foreign Fishing Vessels Harvesting Squid in the Mid-Atlantic Region of the United States: 1970-1976.** In recent years, there has been considerable discussion about the potential for the development of a squid fishery in the Mid-Atlantic. However, knowing where to locate commercial quantities of squid has been a major obstacle. To assist Mid-Atlantic fishermen locate potentially productive areas, the Virginia Institute of Marine Science has published the monthly distribution of the foreign squid fleet between 1970-76.

• **Guidelines for Selecting a Marine Contractor.** If you are like most people who live or own a business on the water, chances are you will require marine contracting services at one time or another. The importance of choosing an experienced contractor with expertise in the type of project being proposed is the subject of this publication. A handy glossary of common terms and a short reference are included.

• **Lake Ontario Fishing Boom: Will New York Be Ready?** Reprinted with permission, this article from the **Great Lakes Fisherman** magazine describes the efforts of Wil Kennedy, chairman of the Lake Ontario Access Committee, to improve access along Lake Ontario in preparation for its developing fishery. Historical background plus a map showing public access in the lake is highlighted.

Update

New Satellite Office in Clayton

Communities in the northeastern corner of Lake Ontario have long had a close association with the lake. A route of early explorers, a site of confrontation in the War of 1812, these Jefferson County communities remain tied to the lake through their tourism enterprises. Communities such as Henderson Harbor, Sacketts Harbor, Dexter, Chaumont, and Cape Vincent also happen to lie mid-point between our Potsdam and Oswego offices making it difficult for residents there to visit a Sea Grant Specialist and vice versa. Recognizing

this difficulty, we have opened a satellite office on a trial basis in St. Mary's Parish School, Clayton. The office is located on Mary Street and its phone is (315) 686-2238. Specialists Buerger, Brown and Wiley will spend two days a week working from that office through November. If successful, the new office will become a permanent fixture.

Fredonia Office Opens Again

Chris Hagerman of the newly functioning Sea Grant office in Fredonia,

wants local residents to know that her office is literally bursting with publications, just waiting for distribution to the right person. Subjects fall under the categories marine industries, coastal protection, floods, coastal zone management, marine foods, recreation and general Great Lakes information.

To find out whether any of these publications are suitable for your needs, call or write Chris at our Fredonia location. Better yet, stop by. Chris would like to meet you and learn of your concerns.

I Want More!

Additional information is available from New York Sea Grant. Please check the publications which interest you and send to your nearest Sea Grant Extension Office. For the following publications, make checks payable to Cornell University:

- _____ **Beach Use and User Constraints in the New York City Coastal Region**, Sea Grant Report Series, C. A. Heatwole and N. C. West, 1980, 74 pp. \$1.50.
- _____ **Beach Use and Water Quality in New York City**, Sea Grant Report Series, C. A. Heatwole and N. C. West, 1980, 21 pp., \$1.50.
- _____ **Guidelines for Selecting a Marine Contractor**, B. Doyle, 1980, 4 pp., 15 cents.
- _____ **Lake Ontario Fishing Boom: Will New York Be Ready?** Reprint from **Great Lakes Fisherman**, S. Willson, 1980, 3 pp., 25 cents.
- _____ **Location of Foreign Fishing Vessels Harvesting Squid in the Mid-Atlantic Region of the United States: 1970-76**. J. Zaborski, 1980, 17 pp., \$1.00.
- _____ **Marketing Alternatives for Fishermen**, J. P. Nichols, et. al., 1980, 46 pp., \$2.00.
- _____ **Mass transit and Beach Access in New York City**, Sea Grant Reprint Series, C. A. Heatwole and N. C. West, 1980, 8 pp. \$1.00.
- _____ **The Potential Cost of Deep Ocean Mining Environmental Regulation**, J. E. Flipse, 1980, 50 pp., \$2.00.
- _____ **The Roles of Research and Extension Education in The Developing Lake Ontario Salmonid Fishery**, Sea Grant Reprint Series, S. P. Schuman et. al., 1979, 3 pp., \$1.00.
- _____ **Views on Sea Grant Advisory Service Work**, B. T. Wilkins, 1980, 61 pp., \$1.00.

If you would like to be notified of additional publications by New York Sea Grant, please check the appropriate category and send to the Albany Sea Grant office. Be sure to include your name and address.

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_____ Oceanography, Limnology, Geology

_____ Aquaculture, Fisheries, Seafood
_____ Using Our Coastal Zone

Lake Ontario's Shipwrecks,

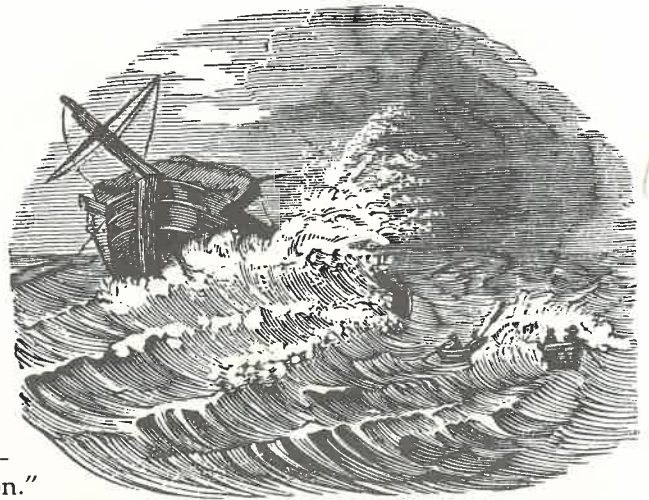
continued from page 1

to shore, but the feat was so strenuous, both crew men drowned. Upon reaching shore, Captain Throop, the lone survivor, could barely stand. Somehow, he managed to walk five miles barefooted for help at the nearest farm. After resting a day, he walked home.

Not all wrecks were the result of brave captains and crews being overpowered by violent Great Lake storms. In **Great Lakes Shipwrecks and Survivals**, William Ratigan gives an account of the demise of the double topsail schooner, Michigan. According to Ratigan, the Niagara Falls held much of the same attraction for world travelers in the early 1900s as it does today. Local promoters and entrepreneurs looked for unusual ways to profit from the falls. A handbill of the times read: "The huge pirate ship, Michigan, with a cargo of ferocious animals, will pass over the Falls of Niagara on the 8th of September, 1827. Plenty of refreshments

and comfortable quarters are available and entertainment is promised for all who may visit the Falls on this remarkable occasion, guaranteed for its novelty and the remarkable spectacle which it will present to be unequalled in the annals of infernal navigation."

On the prescribed day with the banks of the Niagara River filled with exuberant spectators, the Michigan began her final voyage, sailing from Buffalo down the Niagara River to the white water of the Niagara River. Before going over the falls, the captain and crew abandoned ship. Left on board to wander the decks before meeting their fate were the Michigan's "ferocious" cargoes: wild dogs, cats, hawks, a camel, an elk, geese, a swan and a bear. No survivors were reported after the violent wreck of



the Michigan on the rocks below.

Throughout the Great Lakes there are over 6,000 documented wrecks scattered across the bottom. The history of these ships provides exciting adventures, amusing anecdotes and dramatic tragedies. But more importantly, an understanding of what has occurred in the past provides the basis for a better understanding of the Great Lakes today.

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