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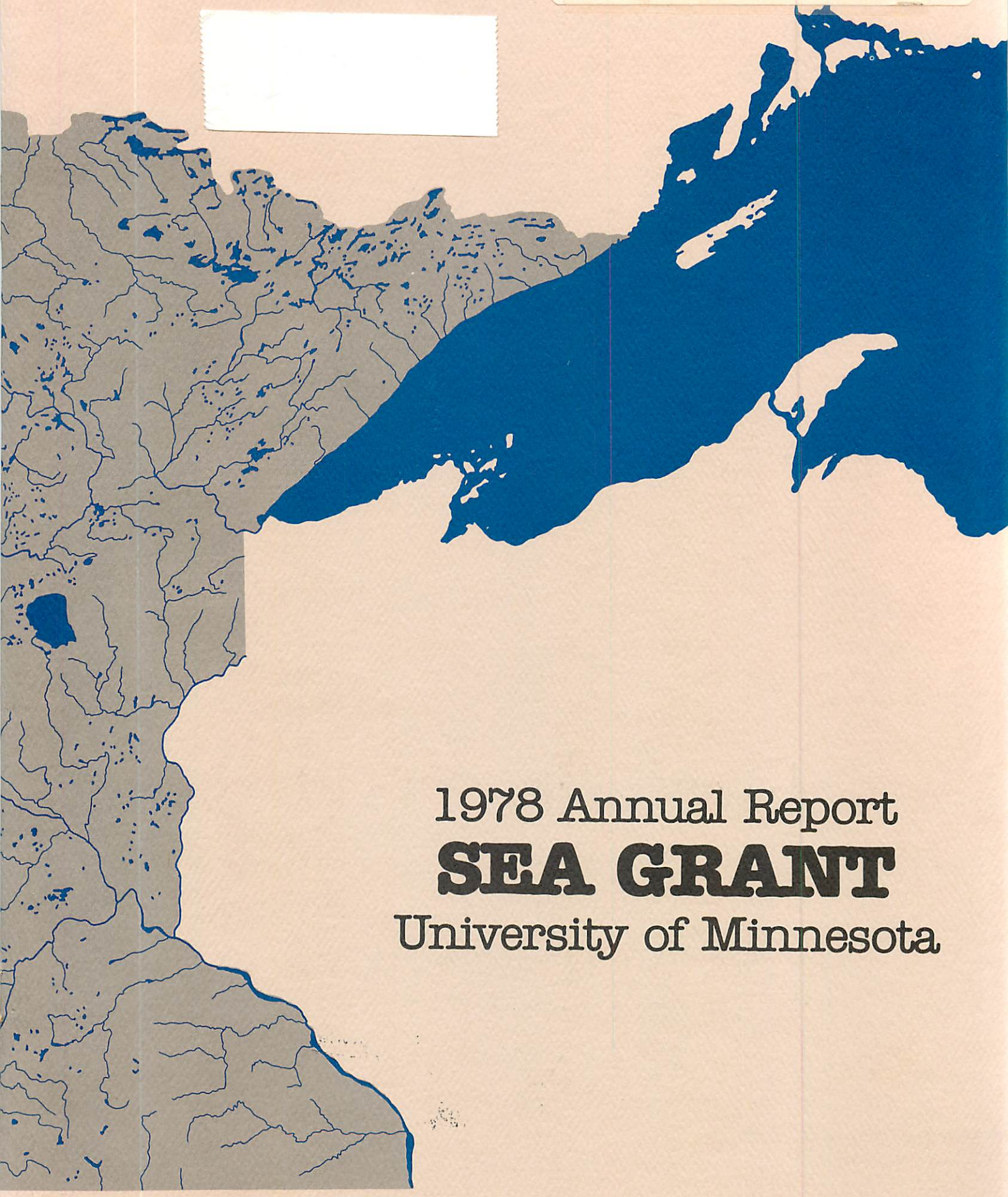

1978 Annual Report

SEA GRANT

University of Minnesota

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For centuries, the spheres of influence of mankind and Lake Superior were only weakly connected. Now the interactions mount, often with unknown effects. Minnesota Sea Grant, a partnership between the University of Minnesota and the state and federal governments, is a program to explore carefully what these interactions mean for both man and the lake.

The diversity of Sea Grant research projects only begins to suggest the complexity of Lake Superior, a great body of water more resembling an inland sea than a freshwater lake. New answers inevitably raise new questions. For this reason, the first stated objective of the national Sea Grant Program, understanding, is rightfully placed.

Warren Ibele
Chairman, Sea Grant Council
University of Minnesota

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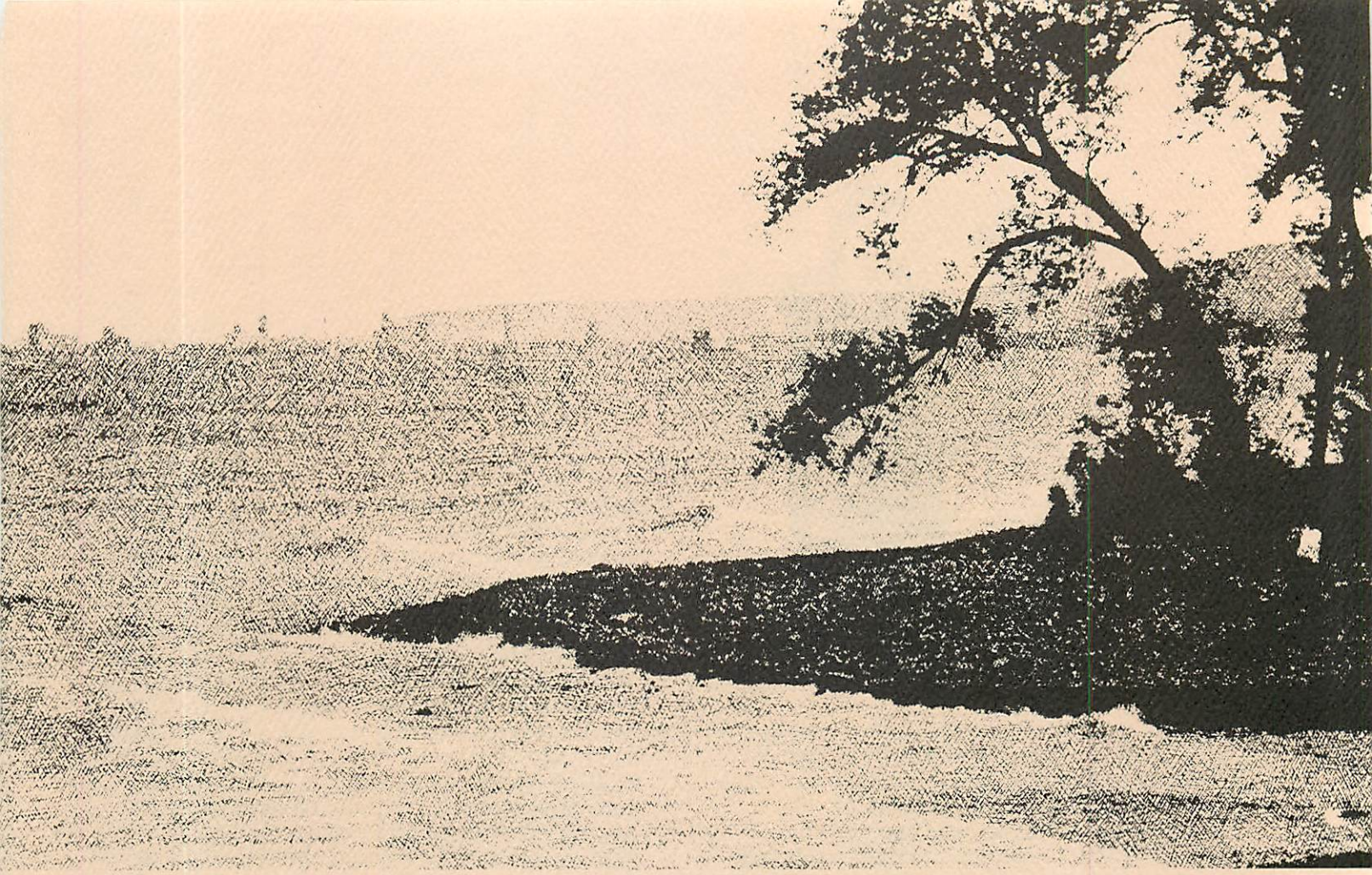


A New Advocate for Lake Superior

Not many people live along Minnesota's coastline, the roughly 150 miles between Duluth and the Canadian border 40 miles northeast of Grand Marais. But during the summer months, most Minnesotans have driven the long curve of the North Shore and, even in winter, they feel the profound, cold presence of Lake Superior, our inland sea.

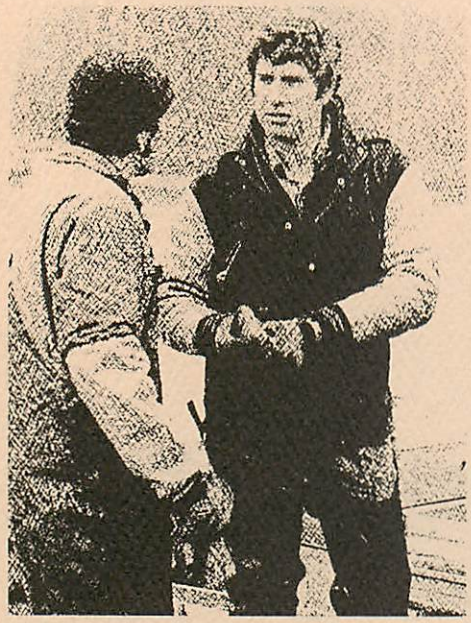
The lake transcends definition by state and national boundaries. Its 440 trillion cubic feet of water represent 10 percent of the entire world's supply of available freshwater. Its location, however, in the sparsely populated woodlands of southern Canada and the northern United States makes it a resource without a sizable constituency.

Lake Superior and its surroundings, nevertheless, present a natural environment whose elements interact in ways so subtle and complex as to baffle even the most fastidious observer. And more intense human involvement in the Superior region complicates the picture still further. Understanding this web of interactions, then, is the necessary first step in protecting the lake's magnificent endowment; and Minnesota Sea Grant accepts this role as its special charge.

Sea Grant is a national program to expand our knowledge of marine resources, including the oceans, the continental shelf along our coasts, and the Great Lakes. Oceanographer Athelstan Spilhaus, while dean of the University of Minnesota's Institute of Technology, conceived the Sea Grant idea, and coined the term, in 1963. That year, at a fisheries conference held in Minneapolis, Spilhaus called on Americans to do for their seas "what wise men had done for the better cultivation of the land a century ago."

Spilhaus's appeal to the success of the Morrill Act of 1862, which had created Land Grant colleges across the nation, won Congressional enactment of Sea Grant in 1966. Since late 1970, Sea Grant has been administered by the National Oceanic and Atmospheric Administration, an agency of the Department of Commerce. As the enabling legislation provided, the Program sponsors research "to accelerate national development of marine resources, including their conservation, proper management, and maximum social and economic utilization."

National Sea Grant funds two-thirds of sponsored Sea Grant programs with federal



dollars. The participating institutions, usually colleges and universities, provide, in money or equipment and facilities, the remaining one-third of the cost of their Sea Grant programs.

The Sea Grant charter was amended by Congress in 1976, broadening further its access and applicability. The new law created fellowships to aid students in marine research. With an eye to the full dimensions of environmental problems and opportunities, the 1976 legislation also authorized funding for research projects aimed at problems of national scope. And, finally, the new act gave Sea Grant a role in helping developing countries with their marine resources.

Here in Minnesota, Sea Grant developed in direct response to local needs. With the decline of commercial fishing on Lake Superior, the few who remained in the industry were looking for ways to improve the lake's flagging productivity. And in a state that boasts the highest per capita boat ownership in America, many Minnesotans were eager to cultivate and to conserve opportunities for recreational uses of the lake.

In December 1974, having left his post at the New York Sea Grant Institute's Lake Ontario program, Dale Baker arrived in Duluth to assume leadership of the first stage of Minnesota's Sea Grant Program. In an effort to enrich it with public experience and support, Baker gathered an Advisory Council from the ranks of Minnesotans actively interested in the lake's future. Serving three-year terms, members of the Council include a trio from each of the three Minnesota counties on the Superior shoreline. These members represent a variety of marine interests, including school systems, local governments, environmental groups, and the tourism and fishing industries. The Advisory Council contributed ideas and insights for the fledgling Minnesota program, originally organized as the Marine Advisory Service.

Known today as Sea Grant Extension, the Marine Advisory Service embarked on its career with efforts on two fronts. In hopes of bolstering the commercial fishing industry, the Advisory Service test-marketed frozen fish products made from Lake Superior sucker, an infrequently retailed variety. As an adjunct to the Coastal Zone Management Program, Baker also led the Advisory Service in establishing its role as a reference resource for land- and water-use issues in the western Lake Superior area.

Over the past several years, Sea Grant Extension has expanded the range of its public services considerably. With the continuing assistance of the Advisory Council, a staff of Sea Grant Extension agents — those "county agents in hip boots" Athelstan Spilhaus envisioned — keeps in touch with the day-to-day problems of Lake Superior and its users.

This contact, of course, enables the agents to make a major contribution to University scholars eager to get a feel for the lake before initiating a research project. And Sea Grant Extension also reaches out to the general public directly. It now provides, for example, information for people, such as boat dealers and marina owners, in the marine recreation industry. For Minnesota sports enthusiasts, Sea Grant Extension also maintains programs for education in boating and marine safety.

But research is at the core of any mature Sea Grant Program. Minnesota Sea Grant started to plan for research at a January 1976 meeting in Duluth. Representatives from Program headquarters in Washington discussed research opportunities with interested University faculty. Following further planning by Warren Ibele, Dean of the Graduate School and chairman of Minnesota's Sea Grant Council, and Robert Heller, Provost of the Duluth campus, a committee developed a framework for Sea Grant research at the University of Minnesota.

To execute the University's Sea Grant intentions, Dean Ibele then appointed the noted fisheries expert Lloyd Smith, Jr., to the post of Acting Director of Minnesota Sea Grant. A past president of the American Fisheries Society, Smith won wide respect for his pioneering studies of population changes, from 1930 to 1975, in the fish of Red Lake in northwestern Minnesota. He was also a leader in water-pollution research, having studied the impact of waste materials in waters near paper mills on the Rainy River in northern Minnesota.

With Smith at the helm, the Minnesota program rapidly won federal support with a grant for research in November 1977. As Ned Ostenso, Director of the National Sea Grant Program, said, " . . . we believe that under Dr. Smith's leadership [the Minnesota] Sea Grant Program has quickly gained strength to the point where it is presently accepted as an equal among the Great Lakes network of programs."

Called on to assume the permanent directorship of Minnesota Sea Grant, however, Smith unexpectedly died in June 1978, leaving a sure sense of direction for others to follow.

"The Minnesota Sea Grant Program points toward a special concern for Lake Superior," explains Dean Ibele. Despite its immensity, Lake Superior is an exceptionally fragile ecosystem. Better understood as a small ocean than as a large lake, Lake Superior is so deep and so cold that its waters support relatively few living organisms. Precisely because of this peculiarity, however, the lake is less able to protect itself from harmful intrusions. Whereas the flora and fauna common to most large bodies of water can purify alien elements, Lake Superior has little such immunological defense.

Despite the lake's remoteness from major metropolitan centers, our industrial society's recent encroachments, carried afar on wind and water, have, in fact, seriously threatened Superior's millennial equilibrium. Since the lake is this state's only marine resource, and a great one, Minnesota Sea Grant has a heavy obligation to understand and maintain it.

Fortunately, this program does not shoulder its responsibility alone. At Wisconsin and Michigan, for example, Sea Grant researchers have significantly enriched our scientific appreciation of Lake Superior. And, since its formation in 1977, the Great Lakes Sea Grant Network, a consortium of the Sea Grant Programs of Great Lakes states, has fostered cooperative returns on this costly work.

The Network, then, can amplify the contributions of Minnesota Sea Grant researchers. Questions of environmental pollution, to cite one instance, are not limited to Lake Superior. But as organic chemists Robert Carlson and Ronald Caple, both from the University's Duluth campus, have discovered, their port city offered an interesting opportunity for basic research.

With Sea Grant funding, Carlson and Caple have studied the potential harm to people arising from the effects of coal dust from the huge heaps of coal, awaiting shipment across the Great Lakes, on the docks of Duluth. Will potentially harmful compounds, released by the coal dust, enter the food chain of Lake Superior fish? And will people who eat these fish get a concentrated dose of these sometimes carcinogenic chemicals? With the stresses of our energy situation, and with renewed emphasis on coal, surely this research will have widespread applicability.

Similarly far-reaching in its implications, the research of animal physiologist Edmund Graham addresses the possibility of increasing our harvest from the seas and lakes. With Sea Grant support, Graham is working toward long-term storage of the reproductive cells of Lake Superior fish. A cryobiologist, he freezes fish sperm and eggs to extend the period of their fertility. But the process is not simply mechanical; rather, it demands a new and fundamental understanding of the basic biological process of reproduction. Should Graham succeed, however, his conclusions may bridge the scientific and the practical spheres.

With fish reproduction responsive to man's needs rather than the delicate natural cycle, people in a hungry world may better meet their growing nutritional requirements.

Fisheries biologist Ira Adelman, with Sea Grant help, also studies Lake Superior fish. His research investigates the lake's mysterious smelt population. Why do there seem to be so many smelt some years, and so few the next? What factors influence the apparent growth and decline of the smelt population? Since the task of measuring the population of even this single species is so remarkably difficult, Adelman's results can yield data, eventually, for modelling a more generalized picture of the life in Lake Superior. In fact, in neat counterpoint, Sea Grant at the University of Michigan has worked on such a mathematical model of the Great Lakes system. In concert, then, Sea Grant researchers, such as Adelman, can achieve ends far beyond the immediate aims of their individual projects.

Sea Grant research extends itself, moreover, beyond the realm of natural science. On the Duluth campus, University economists Raymond Raab and Donald Steinnes have studied the social costs of Minnesota's annual madness, the springtime smelt run.

For the thousands of fishermen the run attracts, of course, smelting is fun and provides good food virtually for free. But the local communities in the Duluth area, where the smelt run upstream to spawn, are burdened by additional police and clean-up expenditures.

Raab and Steinnes have tried to measure the value of smelt fishing to the participating anglers. Armed with these figures, the economists may then recommend new ways of distributing the costs — by licensing smelt fishing, for example — to those who profit from the sport.

Besides its contributions to science, Sea Grant research also yields educational benefits appropriate to a university. At the University of Minnesota, for example, graduate student David Erdahl's work with cryobiologist Edmund Graham resulted in publication of the significant findings in Erdahl's Master's thesis. Too, graduate students who participate in Sea Grant research projects receive an apprenticeship which is the best possible training. Furthermore, Sea Grant researchers continually hone their scientific and scholarly abilities against the real problems they tackle. And their students are the primary beneficiaries of this constant sharpening.

Minnesota Sea Grant, then, touches a wide spectrum of audiences. The boating public, marine industries, students, and scientists all participate in the Program's dividends. Minnesotans stand to gain most from Sea Grant's success, however, in the years to come.

In the hierarchy of the national Sea Grant Program, Minnesota's program today is a "coherent project." The University, in other words, demonstrates capabilities in some areas of marine affairs and has begun research appropriate to the Sea Grant enterprise.

In the near future, Minnesota would like to achieve the status of "institutional support," which indicates a university's broad competence in and commitment to Sea Grant objectives. Ultimately, the University of Minnesota aspires to recognition as a Sea Grant College. This exclusive designation marks an institution as a leader in competent, integrated, and dedicated marine research.

A Week on the Water

A new staff position has enabled Minnesota Sea Grant Extension to expand marine education activities. Extension Agent Bruce Munson's assignment is to help schools add Lake Superior-related materials to their classes and to extend informal education on the nation's inland seas to the general public.

One new project is known as "A Week on the Water." In cooperation with the 4-H Program, Minnesota Sea Grant laid the groundwork for a summer activities program for underprivileged young people in Duluth. More than 50 children, ages eight to twelve, learned about collecting data for water research, visited the Environmental Protection Agency laboratory, and saw first-hand how people in the port area earn their livings. Some of the older participants tried kayaking on the lake, and everyone toured the harbor aboard an excursion boat.

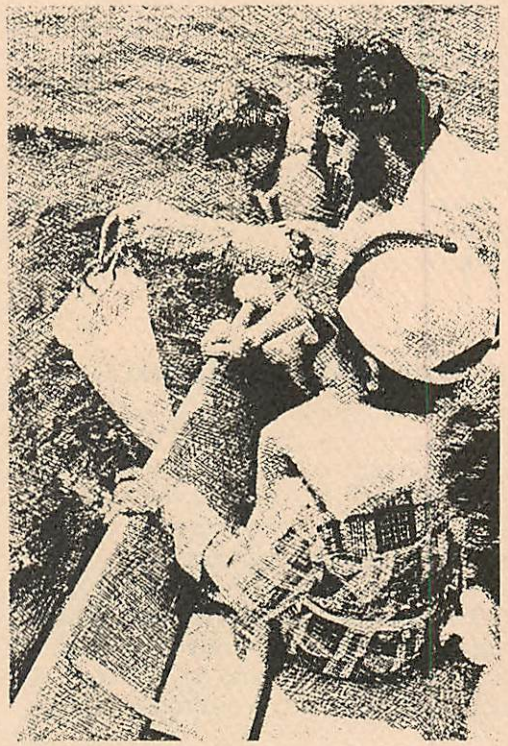
Working the State Fair

The University of Minnesota's 1978 State Fair exhibit, "Minnesota's Water — Our Fair Share," emphasized the institution's role in preserving and utilizing one of the state's prime resources. Part of the display was prepared by Minnesota Sea Grant and featured a four-foot animated fiberglass fish called Lawrence the Talking Lake Trout. Lawrence's short speech, uttered countless times, began with an explanation of his home, Lake Superior, and concluded with an interview by Twin Cities radio and television stations on his new career in marine education.

Also, a special issue of the Minnesota Department of Natural Resources magazine, The Minnesota Volunteer, was distributed at the University exhibit. It featured seven articles on Lake Superior written by University faculty members, including Sea Grant investigators.

Marine Industry Conference of Minnesota

Cosponsored by the North Central Marine Association and Minnesota Sea Grant Extension, this workshop has become an annual event. It provides a way for marina operators and marine dealers to keep current on industry trends, improve management practices, and meet informally with others from around the state.



The 1978 conference focused on areas of interest identified by participants the previous year. Included were practical sessions on merchandising, floor planning, and inventory control. Also, a presentation from the 1977 workshop, dealing with insurance for the marine dealer, was repeated by popular request. (That earlier session had led to a cover story in Marine Business magazine and brought the editor, Paul Kellum, to Minnesota as this year's keynote speaker.)

The Western Lake Superior Boating Survey

Information generated by this Minnesota Sea Grant survey is being put to work. Harbor development groups in Two Harbors and Silver Bay have heard presentations on the demand for boating facilities and the economic impacts of marina development. U.S. Economic Development Administration staff have used survey data to evaluate the Barker's Island Marina proposal for Superior, Wisconsin. And the U.S. Army Corps of Engineers has estimated that information from the survey saved their "harbors-of-refuge" study program about $20,000.

A Living from the Lake

Research Assistant Barbara Sommer, working with the Northeast Minnesota Historical Center and the Minnesota Fish Producers Association, undertook an oral history project on North Shore commercial fishing. Veteran fishermen, their families, and fish dealers were interviewed about how the industry developed, how fishing is done, how fish are sold, and why commercial fishing on the lake has declined.

Interviews were tape-recorded, transcribed, and catalogued with photographs in the Historical Center's archives. Later, they became the basis for an audiovisual presentation by Minnesota Sea Grant called "A Living from the Lake."

Superior Recreation Report

In an effort to blend educational and recreational information, Extension Agent James Murray brought a summer program three times a week to Duluth residents over KDAL radio. About 40,000 listeners were provided historical and scientific background on recreational sites and activities related to Lake Superior. Station manager John Russell reports that the program was among their best-received public service features. He plans to continue the program each year during the summer tourist season.

Aquaculture in Minnesota?

Minnesota Sea Grant sponsored three conferences about raising high-value food fish, such as yellow perch and walleye, in closed artificial systems. The first was a general meeting for fishery managers and researchers held at St. Paul in March. Harold Calbert, a Sea Grant investigator from the University of Wisconsin Sea Grant program, was the featured speaker. For raising perch, he has developed aquaculture systems said to work particularly well on converted dairy farms.

In June, two workshops were held in Northern Minnesota, and attended by more than 100 people interested in raising fish for the marketplace. Richard Soderberg of Wisconsin Sea Grant described the problems and prospects of raising perch and walleye in the climate the two states share.

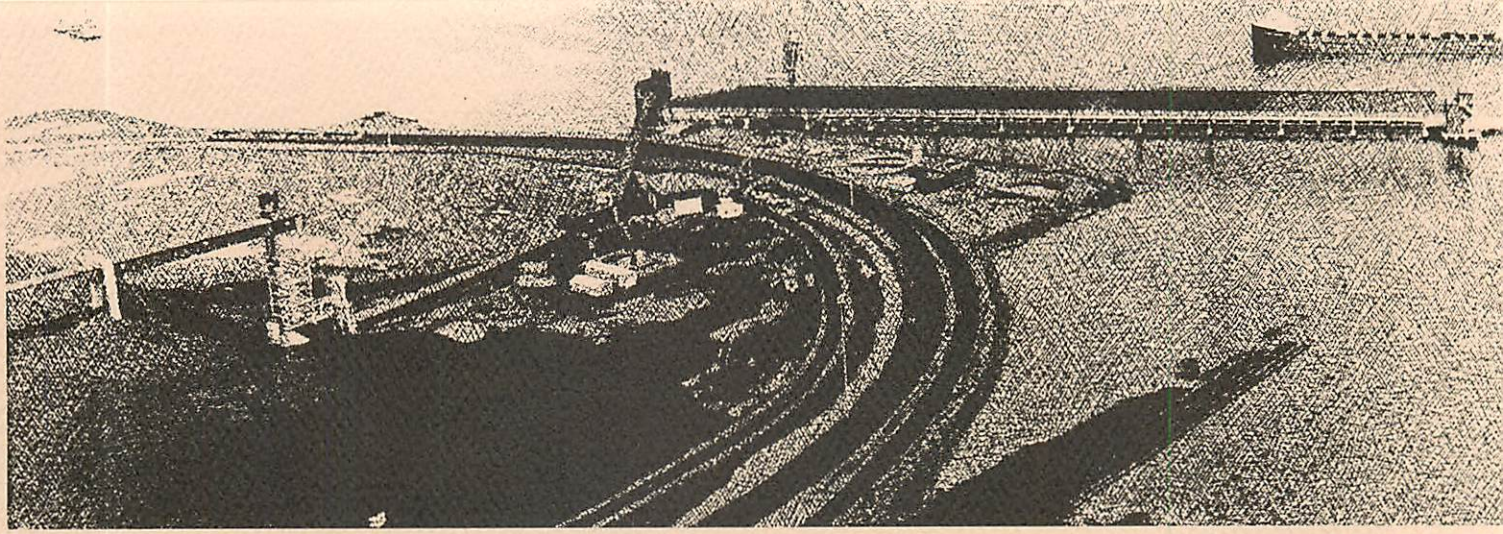
A Great Lakes Perspective on Boating

At the suggestion of the Boating Industries Association and several boating organizations, Great Lakes area Sea Grant programs jointly have developed a regional conference on research and extension needs related to recreational boating. Investigators and extension staff from the five Sea Grant states meet to discuss integration of their work to serve better both the boat owner and the industry which supplies marine goods and services. Minnesota Sea Grant Extension coordinated the 1978 meeting held in Chicago.

The Seiche, Newsletter for Minnesota Sea Grant

After its first six issues, readership of this quarterly newsletter — produced cooperatively with the Lake Superior Basin Studies Center — has doubled to about 1,100. Results of a recent survey show that The Seiche is regarded as a useful source of information about Lake Superior-related activities.

According to the survey, over half the subscribers file their copies for reference; each copy has an estimated readership of about four people, reaching an audience of about 4,200. Although the newsletter is geared to local issues, subscribers are spread over 40 states and four other countries.



Do Twin Ports coal piles affect the harbor ecology?

For decades the freighters steaming out of Duluth-Superior harbor have carried cargoes of timber, wheat, iron ore, and taconite to eastern cities. Now, with our nation's energy problems, western coal has joined this list — awaiting passage in huge piles on Twin Ports docks. While certainly a boost to the port's shipping industry, the coal presents a threat to the harbor's water quality: swirling coal dust is blown into the water and, during rains, particle-laden streams trickle off the docks.

Sea Grant research by chemists Robert Carlson and Ronald Caple is examining whether the stored coal is polluting the harbor, and possibly damaging an already weakened fishery. Carlson and Caple chose to study a class of organic compounds called polynuclear aromatic hydrocarbons (PAH), known cancer-causing materials found in western coal. If these compounds are indeed transferred to the harbor water from the storage piles, the chemists hope to learn whether fish accumulate these materials in their tissues, the way compounds such as DDT are accumulated.

The two researchers are applying their scientific skills as chemists to a public problem. As Carlson explains, "In our previous work, we developed fundamental tools to examine a wide range of organic compounds — tools useful to anyone doing this kind of work. For Sea Grant, we're looking at a local problem — that coal pile, and its effect on the amounts of PAH in the harbor, lake, and fish."

From early studies the researchers discovered that PAH isn't carried by run-off water into the harbor, but instead is transferred by water evaporation. Says Carlson, "When you've got an 800,000 ton pile of coal, strange things can happen. That huge hill is 20 percent water, and as it heats up from both the pressure of its weight and sunlight, some of the water is evaporated, taking the PAH with it."

In addition, the chemists found that each particle of coal dust takes up PAH, and upon being blown into the water, transports the compound into the fish's world. Not only can the particles carry PAH into the water, but once there they can collect other organic compounds dangerous to fish.

Surprisingly, this characteristic of coal particles could perform the role of a harbor-water filter. Researchers working with particulates and their effects on pesticides and PCBs have argued that these materials tend to settle to the lake sediment, taking themselves and compounds attached to them out of the water. But Carlson and Caple's experiments question whether this is also true of coal particles.

For one thing, coal particles seem to lose their ability to "hang on" to the organic materials, eventually releasing them into the water. And even if they retain the materials, Carlson observes, "Some of our studies suggest that the particles — if they are churned off the lake bottom through wave action, storms, dredging, high water, or stream flow — come in contact with fish and become imbedded in their gills, ending up in the gut, and finally transmitting the organic compounds into the fish tissue."

An environmental activist in the late sixties, Carlson found he was unable to back up his concerns with facts. Turning to that craft which he does best, chemistry, he has since tried to find those facts for others. In this case, local government agencies involved with water quality questions are anxiously waiting for the results of this Sea Grant work. If it turns out that coal piles do harm fish, the project should help improve the site selection and design of future coal storage facilities around the Duluth-Superior harbor.

Future work will, therefore, be directed toward detecting whether fish accumulate PAH found on these coal particles. "It's a major problem," admits Carlson, "and I'm not sure how far we're going to get. But we're going to give it a good shot."

Can we produce more fish by freezing reproductive cells?

When winter wanes, the farmer buys seed from his local dealer. Once his fields are ready, he sows them. Barring unforeseen problems, the farmer fully expects that, sometime in the next several months, he will have a crop to harvest. Animal physiologist Edmund Graham looks forward to the day when fish can be farmed in similar fashion.

From time immemorial, of course, people have taken fish, without great concern for their replenishment, from streams, lakes, and seas. In recent years, however, several factors, including environmental pollution and overfishing, have made the yield of fish from our waters less reliable. And this precisely when we most need a wealth of high-quality protein to feed the world's growing population.

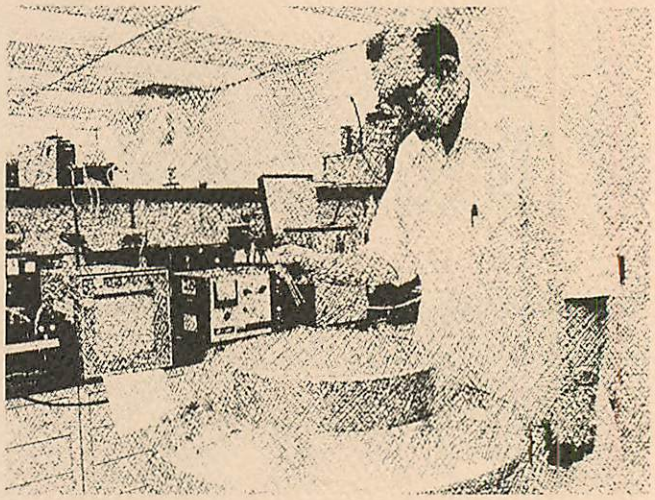
Graham wants to apply the techniques of cryobiology, or freezing living cells, to the economical reproduction of fish. With Sea Grant help, he is studying several Lake Superior species.

As Graham explains, the basic principle in storing live cells is to arrest the processes of aging and degeneration. "When living cells are cooled, there is a slowing down," he says, "of the biochemical processes involved in respiration, metabolism, and all other interactions between the cells and their environment."

For 28 years, Graham has experimented with cryobiological preservation of many species of animal cells, including human spermatozoa. His experience has shown that it should be possible to preserve fish gametes — the eggs and sperm — indefinitely. Then, when it becomes desirable to recall the stored genetic material to action — to make use, in other words, of the frozen sperm and eggs for reproduction — the gametes can be thawed. After careful thawing to the proper temperature, the gametes will resume their full activity as living cells.

As Graham points out, the gametes will function properly only provided they have not been damaged during freezing and thawing. Graham's research focuses, therefore, on improving ways to protect the gametes, and to freeze and thaw them more safely. Although Graham has done considerable work with a variety of freshwater fish sperm, only recently has his attention turned to the technical difficulties of preserving the fertilized fish eggs.

Interestingly enough, Graham's project arose not merely out of an attempt to emulate nature but from a desire to improve on the precarious and unpredictable natural reproductive cycle of fish. Some freshwater



species, for example, may lose an entire year's reproduction when male and female fish reach their sexual maturity at different times. Also, the different spawning seasons of various species make crossbreeding very difficult without some sort of gamete preservation.

If Graham reaches his goals, Minnesotans could establish year-round hatchery breeding of fish, an entire new industry. With effective crossbreeding, new fish, more resistant to disease and environmental change, could be developed to stock our lakes both to feed more people and to make sport fishing more enjoyable.

More research is necessary; so Graham, with colleagues at his laboratory on the St. Paul campus, continues searching for the best conditions for long-term storage of fish gametes. While they study the inevitable welter of data, including especially the chemistry of sperm and eggs, they keep their sights on the ultimate objective — successful preservation of fish eggs and sperm, until they are recalled, stored frozen at -196 degrees Celsius.

Who should finance the fisherman's fun?

Each spring millions of small, silvery smelt make their well-known spawning run up North Shore streams, while thousands of fishermen try to scoop them out with nets and buckets. The three-week event has always placed a burden on local governments which must pay for increased law enforcement, toilet facilities, damage to private property, and the post-run garbage clean-up.

Economists Donald Steinnes and Raymond Raab have attempted to clarify the financial issues in the continuing debate over recreational smelting in the Duluth-North Shore region. In their Sea Grant funded project, Steinnes and Raab have provided local governments with an accurate assessment of the total costs and benefits of the sport to area communities and residents.

Over the years, local citizens have tolerated these costs on the assumption that the smelters were mainly outsiders who compensated for their nuisance by buying goods and services in the area. Then, a University sociology class, after surveying smelters, concluded that the sportsmen spent an average of only ten dollars in the Duluth region. Steinnes recalls, "That figure provided the ammunition for property owners who were already stirred up enough to want smelting banned. Now they could justify their claim that the event had no value to the community."

The same student study reported, however, that over half of the smelters lived in the Duluth area. This suggested to Steinnes and Raab that the recreational benefits of smelting to local residents might offset the public costs of the sport. So they set out on the difficult task of estimating the recreational value of smelting.

The researchers used a theory of recreational economics called "consumer surplus of benefits"; applied to the smelt run, the theory says that the enjoyment a sportsman receives from smelting is not really paid for. To estimate what a smelter would pay to fish, they interviewed non-local smelters to learn the distance they traveled to get to the streams, and the costs they incurred en route. A major assumption of the theory is that the farther away a potential smelter is from the streams, the less willing he is to accept the costs of getting there. By analysing such data, they estimated an average recreational dollar value for smelting.

Taking this figure, they applied it to Duluth smelters, who lack any significant traveling expenses. By multiplying the value by the number of smelting days (defined as one person smelting for one day), they concluded that Duluth smelters valued their activity to the tune of $150,000.

Steinnes and Raab also found that the total administrative cost of smelting to the area came to less than $20,000, suggesting that, indeed, smelting is beneficial to the Duluth-North Shore region. By placing a dollar figure on the recreational value of the sport, this elusive benefit is more easily compared with relatively concrete costs such as stream clean-up and traffic control.

Of course, within the region, smelters generally receive the benefits while non-smelters suffer the costs. "We'll be satisfied if we can demonstrate that these recreational benefits exist," explains Steinnes. "The method of transferring those benefits to the people incurring the costs is up to government agencies."

Can we take a census of Lake Superior's smelt?

When the smelt run draws fishermen to the North Shore each spring, problems arise that demand solution. So social scientists join with local people and governments to search for answers. In all the commotion of the annual run, however, the smelt themselves — and the questions they pose for angler and scientist alike — may be overlooked.

Why, for example, do smelt seem every so often to die off in large numbers, for no apparent reason? And, more generally, what are the factors influencing their reproduction and population patterns in Lake Superior? With Sea Grant support, University fisheries biologist Ira Adelman wants to find out.

Adelman says that, although the custom of smelting seems time-honored, smelt are in fact a fairly recent arrival to the Great Lakes. In 1912, conservationists stocked Crystal Lake in northern Michigan with smelt eggs. Through rivers and streams, the fish then migrated into the Great Lakes. They seem to have reached western Lake Superior only in the late 1940s.

Today smelt constitute a substantial portion of Lake Superior's entire yield to commercial and recreational fishermen. To a large extent, too, smelt seem to have displaced other small species as part of the diet of Lake Superior's larger fish, such as the northern pike and lake trout.

For both the prosperity of the fishermen and the equilibrium of the lake's vital food chain, then, Adelman's research may prove significant. To begin to understand smelt better, during spawning season Adelman wades into North Shore streams to collect samples of the species. He then returns to his laboratory on the University's St. Paul campus where he and his graduate students probe the fish for clues.

The biologists examine the smelt and their eggs assiduously. They count the eggs, for example, to get some idea of what the reproductive capacity of a female smelt is. Then they measure the fish, keeping an inventory of their size for comparison with smelt taken from different places and at different times. As Adelman notes, he has benefited from the cooperation of commercial fishermen who give the scientist specimens from their catches in Lake Superior.

With the help of a microscope, Adelman also studies fish scales. "A scale's somewhat analogous to rings on a tree," he says, and scales can provide information about the smelt's age and its earlier stages of growth. These data can then be used for comparisons with past information and serve as a base line for future testing.

To formulate a better sense of the smelt population over time, Adelman and his assistants have tried to assemble information on the fish's heredity. Graduate student Don Schreiner, for example, studied protein systems in various smelt tissues while attempting to assemble its genetic profile.

Over three years of study, Adelman hopes to piece together a new picture of the Lake Superior smelt population. "Since the fish stock has really been in a state of turmoil in the Great Lakes," as Adelman explains, his results should update and complement what science already knows. Then, perhaps, a mathematical model of the lake's fish life, to help improve smelt management, might be possible.

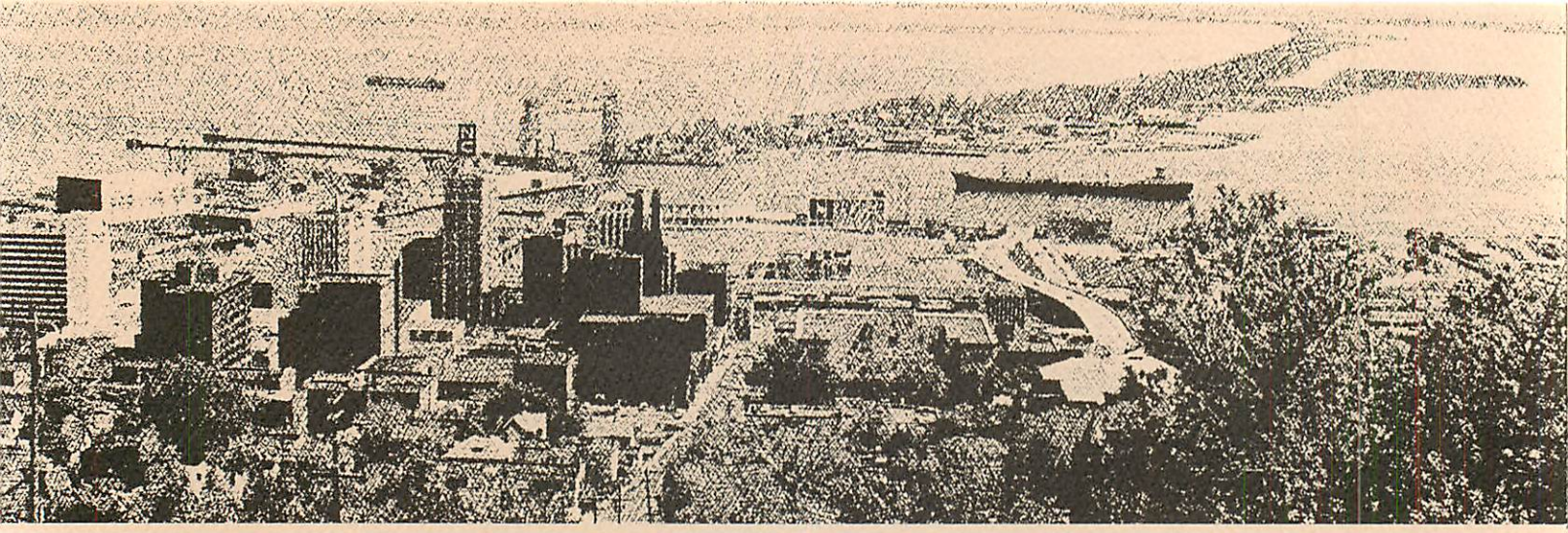
Fiscal Year 1978 Budget / $383,368

For the 1978 fiscal year, 54% of the University of Minnesota Sea Grant Program budget was funded by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, and 46% by the University of Minnesota.

	NOAA SUPPORT	UNIVERSITY SUPPORT
Research	$83,065	$67,190
Program Management	$16,719	$45,094
Extension	$109,100	$62,200
	$208,884	$174,484

Research Projects

TITLE	INVESTIGATOR(S)	SUPPORT SOURCES NOAA	UNIVERSITY	STATUS
Preservation of gametes of freshwater fish.	Edmund Graham Animal Science	$19,830	$28,387	continuing
Evaluation of the effects of coal storage areas on commercial and sport fishing in Lake Superior.	Robert Carlson Ronald Caple Chemistry	$22,073	$17,333	continuing
Population characteristics of Western Lake Superior smelt and the nature and causes of post-spawning mortality.	Ira Adelman Entomology, Fisheries, and Wildlife	$22,380	$11,593	continuing
Economics of smelting as a recreational activity.	Raymond Raab Donald Steinnes Economics	$18,782	$9,877	completed



Minnesota Sea Grant Committees

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Information Available

To obtain the materials listed, all except the Research Report free of charge, contact either the Sea Grant Program Duluth office (109 Washburn Hall, University of Minnesota, Duluth, MN 55812; 218/726-8106) or the St. Paul office (130 Hodson Hall, University of Minnesota, St. Paul, MN 55108; 612/373-1708).

GENERAL PUBLICATIONS

The Edge of the Arrowhead
A 60-page booklet which describes the Minnesota coast of Lake Superior.

Lake Superior Soup
A compendium of resources and services related to Minnesota's Lake Superior coast. Volume I covers public agencies, Volume II private groups.

RESEARCH REPORT

Western Lake Superior Recreational Boating Needs and Patterns
A detailed report of a boating survey completed in 1976. $2.

SUPERIOR ADVISORY NOTES

A fact sheet series, thus far consisting of the following:

1. Who Catches Smelt?
2. Harbors of Refuge — A What, Why, and How
3. Recreational Boating on Western Lake Superior — A Survey
4. Smelt — Dip Net to Dish
5. Marine Industry Conference of Minnesota — Highlights
6. What to Do About Head-Aches — A Primer on Marine Sanitation Devices in Minnesota
7. Superior Boating Safety
8. An Introduction to Sailing on Western Lake Superior

THE SEICHE

A quarterly newsletter published in cooperation with the Lake Superior Basin Studies Center, providing information about the Minnesota coast of Lake Superior.

AUDIOVISUAL PROGRAMS

A Living from the Lake
A history of commercial fishing on Minnesota's North Shore. 20 minutes.

Extension Agents in Hip Boots
A description of the Sea Grant Extension Program. 11 minutes.

Sea Grant in Minnesota
A summary of the role and activities of the Sea Grant Program, focusing on Lake Superior-related research. 12 minutes.

The Minnesota Coast
An overview of the state's Lake Superior coastal area. 12 minutes.

A report on the University of Minnesota Sea Grant Program
for the period October 1, 1977 to September 30, 1978,
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