



SEA GRANT PROGRAM

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UNIVERSITY OF MINNESOTA

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Sea Grant at Minnesota

Contents

A Vintage Year	1
The Benefits: In Human Terms	2
1981: A Year of Dramatic Growth	3
Working with the Tourism and Recreation Industry	4
Studying How People Respond to the Cold	6
Researching Life within the Lake	8
Aquaculture: A Growing Area	11
Finding Contamination in a Pristine Lake	14
American Indian Students Explore Marine Science	15
A Marine Environment Curriculum	16
A Superior Experience	17
Budget Summary, Research Projects, Staff, Committees	18
New Publications Available	inside cover

Cover photo by Bruce Borich

Minnesota's Sea Grant Program developed as a response to the needs of residents, industries, tourists, and business people that use Lake Superior and its Minnesota shoreline. The Program began as the Marine Advisory Service, an extension division formed in 1974 by Continuing Education and Extension at the University of Minnesota. Under national Office of Sea Grant guidelines, it became a "coherent" Sea Grant program in 1977 when it added a director and a small research program to complement and expand upon its extension services. As the research effort matured, Minnesota Sea Grant was promoted to institute status in 1981.

Minnesota seems an unlikely place for a program named Sea Grant, but, in fact, it is not. Scientists have documented what early explorers only sensed—that Lake Superior and the other Great Lakes are more like oceans than lakes. As an early Duluth newspaper put it, they are "unsalted seas." Consequently, when the U.S. Congress passed the enabling legislation for Sea Grant, the Great Lakes were included as a focus for research and education.

Today, Sea Grant researchers are based at both the Twin Cities and Duluth campuses of the University of Minnesota. The administrative office is located on campus in St. Paul; the extension office is

on the Duluth campus. The overall Minnesota Sea Grant Program is under the jurisdiction of the University's Graduate School and its dean, Warren E. Ibele. It receives support and cooperation from Continuing Education and Extension, the Agricultural Extension Service, and the Agricultural Experiment Station, and from the Minnesota Legislature.

Minnesota Sea Grant is part of a national network of Sea Grant programs funded and administered through the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce. Sea Grant is designed as a comprehensive effort to help people understand and manage coastal resources throughout the United States. Like the Land Grant System, after which it was patterned, Sea Grant serves as a base from which to conduct research, extend the results to the general citizenry, and train future generations.

Sea Grant is unique in that, although it emphasizes research, it requires that its projects have tangible community benefits, and many suggestions for projects come from the people who live and work on the lake. The interplay between extension and research is essential; once research is under way, Sea Grant extension makes certain that results are communicated to those who need to know about them.

A Vintage Year

In retrospect, 1980-81 was a vintage year for Minnesota Sea Grant. It began with a 42 percent increase in funding—the result of a site visit by national Sea Grant representatives in May 1980. In February 1981 we fought along with other programs for our lives. By July we had received credit from the national office for our considerable progress in marine research, education, extension, and program management. At the end of the year some of our most trusted colleagues, those who made Sea Grant function in



**Warren E. Ibele, Dean, Graduate School
(photo: Graduate School Research
Development Center)**

Minnesota, announced career changes that will remove them from our family.

Sea Grant *is* a family. Warren E. Ibele, dean of the University of Minnesota Graduate School, has presided over our development from the time research studies and graduate training were added to the original extension program founded by Continuing Education and Extension (CEE); that development enabled us to become a “coherent” program in 1977. As he leaves the deanship, we salute his careful guidance—Minnesota Sea Grant is



**Gordon D. Rose, Assistant Director,
Agricultural Extension Service (photo:
Agricultural Extension Service)**

one of his achievements. Gordon D. Rose, director of the Natural Resources Program in the Agricultural Extension Service, has co-presided with CEE over the Sea Grant Extension Program since its inception in 1974; he will be returning to his home department, Agricultural and Applied Economics. The effectiveness of extension efforts on behalf of the people of the Lake Superior shore is in large part due to his guidance.

The struggle to keep the National Sea Grant College Program alive has caused all of us to reexamine our goals in research and education. The Program was evaluated as having had a significant impact on marine business nationwide; the cooperation of the user community was most evident—and, likewise, appreciated—and cooperation within the national network increased visibly. Consequently, Congress again funded the Program for 1981. Since then, cost/benefit considerations have become routine in planning future applied research efforts.

Our new status as an institute reflects the University of Minnesota's capabilities to serve the state and nation through applied research directed toward marine industries. Our immediate goal is increased service through controlled growth.

A handwritten signature in dark ink that reads "Don McNaught". The signature is written in a cursive, slightly slanted style.

**Donald C. McNaught
Director**

The Benefits: In Human Terms

In 1980, Charles Landmesser worked as a Sea Grant trainee for Thomas Johnson, associate professor of geology at the University of Minnesota. He conducted research aboard a ship, used sophisticated equipment, and learned highly technical and complicated geological techniques from a respected professional. As a result of his work, Landmesser secured an oil exploration job in 1981 with Atlantic Richfield Petroleum Company in Alaska. Johnson believes the training of graduate students is a major benefit of Sea Grant research efforts.

In 1980, Lea Fairbanks had opportunities few undergraduates ever experience. As part of a new Minnesota Sea Grant program that funds American Indian undergraduates in the marine sciences, Fairbanks received tuition and a small stipend. She conducted experiments in the Hypothermia Laboratory on the Duluth campus under the supervision of Sea Grant researchers Robert Pozos and Lorentz Wittmers. Perhaps most important, though, was the encouragement she received from her advisers, her mentors, and Sea Grant-

American Indian Program liaison Robert Diver. Today, Fairbanks is one of the few American Indian students from Minnesota to have been admitted to medical school.

Other beneficiaries of Minnesota Sea Grant programs include fishermen and hatchery specialists who incorporate research results into their day-to-day work. For example, in early fall of 1981, Sea Grant Extension agent Jeff Gunderson organized demonstrations of how fishermen could find their prey with scanning sonar equipment. Also, research on new techniques for extending the life of fish sperm and eggs is giving fish breeders more flexibility and more success. Development of methods for raising bait leeches to salable size is infusing new life into an already lucrative business.

Consumers learn how to handle, buy, preserve, and prepare fish through the new Sea Grant Extension publication *Fixin' Fish*. The new *Guide to Lake Superior Launch Ramps*, published by the Great Lakes Sea Grant Network, helps boaters find appropriate launching sites in Minnesota, Wisconsin, and Michigan.

Sea Grant water safety researchers teamed up with an offshore drilling company that wanted to teach water safety techniques to its employees. In the Hypothermia Laboratory, researchers continued tests of personal flotation devices such as life preservers and body suits. Water safety research led to greater understanding of cardiopulmonary resuscitation techniques: the accepted methods do not work in all hypothermic situations, and new ways of reviving victims of the cold are needed.

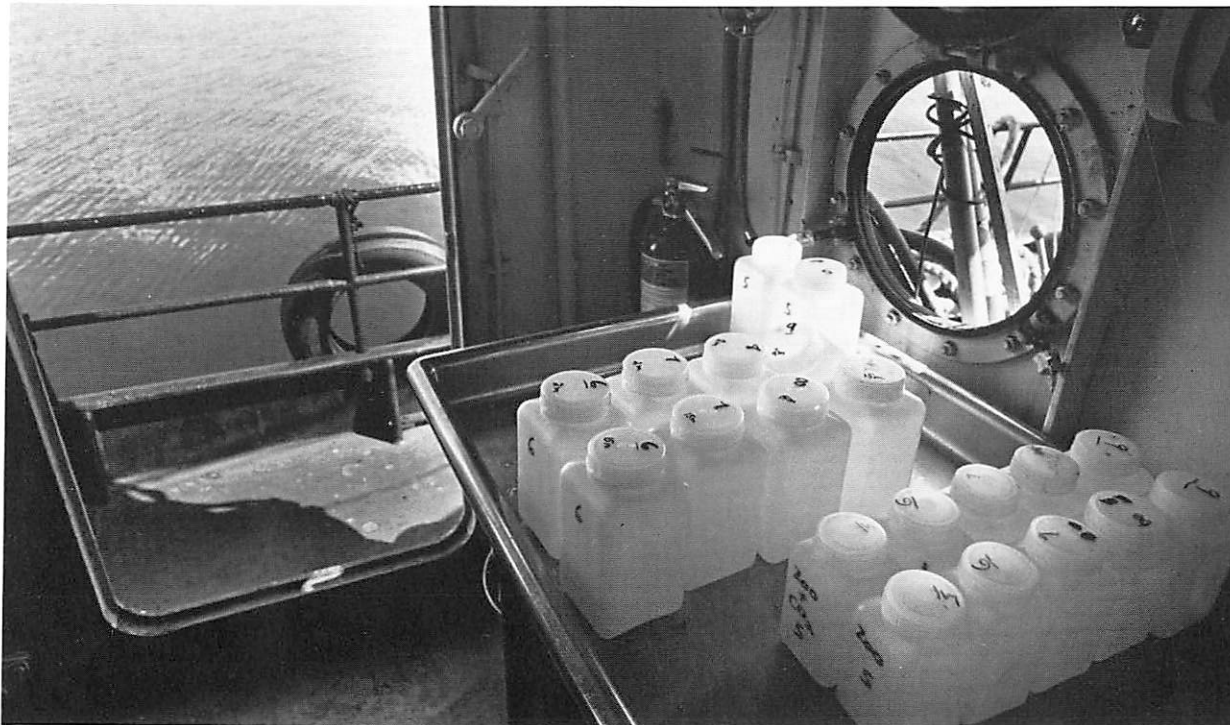


photo by Bruce Borich

1981: A Year of Dramatic Growth

In 1981, Minnesota Sea Grant funding from the federal government increased from approximately \$360,000 to \$500,000, allowing for expansion in all of the Program's research areas as well as in its extension division. State support continued to provide a sizable portion of the Program's financial base.

Along with growth came increased selectivity: forty-six research proposals came to Minnesota Sea Grant for 1980-81 funding, and only fourteen were chosen.

Donald C. McNaught, in his first full year as Minnesota Sea Grant Program director, worked closely with research subprogram coordinators in developing each area of the interdisciplinary program. In 1981, growth was most marked in the areas of tourism and recreation, water safety, and marine education. Research relating to fisheries and coastal and environmental processes also expanded, as did extension programs.

The management office increased its communications effort, with a half-time writer/editor to ensure that research projects and their results were communicated through established professional journals, trade magazines, and the popular press.

By May 1981, when the national Sea Grant evaluation team came, Minnesota Sea Grant Program's progress was visible, and—team members acknowledged—impressive. When they left the Twin

Cities, the team's national office members indicated that Minnesota Sea Grant could expect institutional status in funding year

1981-82 in recognition of the Program's maturity and the University of Minnesota's support for its objectives.



photo by Bruce Borich

Working with the Tourism and Recreation Industry

Cars, vans, and recreational vehicles pour from Duluth to Grand Portage each year. Tourists by the thousands drive through the area from May to November, attracted by Lake Superior—the largest freshwater body in the Western world—and the surrounding wilderness.

Although tourism and recreation provide a major economic base for the North Shore area, the economic return from tourism could be substantially

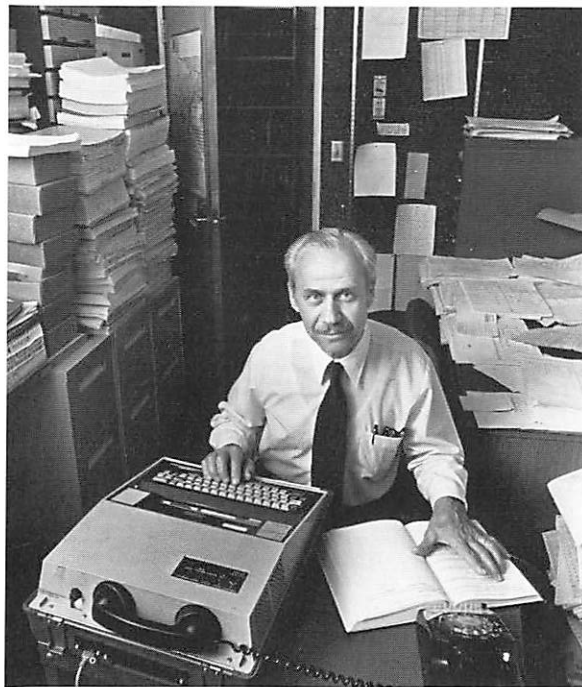
improved, according to preliminary results from the first year of Sea Grant-funded research conducted by Uel Blank, professor of agricultural and applied economics; Timothy B. Knopp, associate professor of forest resources; and graduate student trainee Sally Stanbrough.

Most North Shore tourists come as sightseers, and although they are also consumers, the amount of goods and services they purchase is not as large as it might be if they were more aware of what the area has to offer. The study will provide information on who visits the area, where tourists spend their money, and what they want from a vacation.

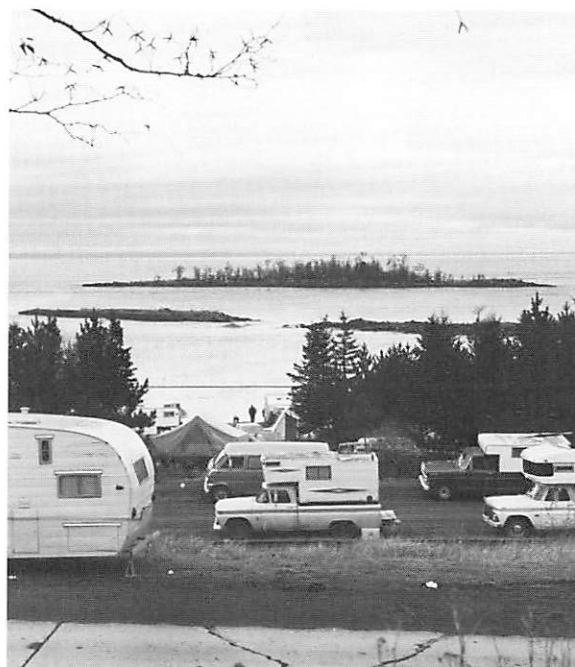
The research team began surveying during the summer of 1981 and will

continue through 1982. From June to September 1981, 284,000 tourist vehicles came to the North Shore.

Surveying has included interviewing tourists at gas stations, stopping traffic on the highway (with Department of Transportation assistance), classifying traffic at three major exit points from the North Shore Drive, and utilizing information from Statistics Canada and Minnesota Highway Department automatic traffic counters. Sea Grant Extension agent Tom Mack has helped coordinate surveying at the Lester River exit point in Duluth and has stayed in close contact with the researchers throughout the development and implementation of the project.



Dr. Uel Blank (photo by Bruce Borich)
(photos at right: Minnesota Department of Natural Resources)



To supplement survey information, the researchers intend to interview resort owners and get estimates of retail spending in North Shore townships from the state Department of Revenue.

After the first few months of surveying, Blank and his team found that a lot of people visit the North Shore with little prior information, that they just want to see the area. Because information about activities is often not readily available, tourists don't stay as long or spend as much money as they might, he said. "Most come from within 500 miles and keep moving most of the time."

Corresponding Through a New Extension Publication

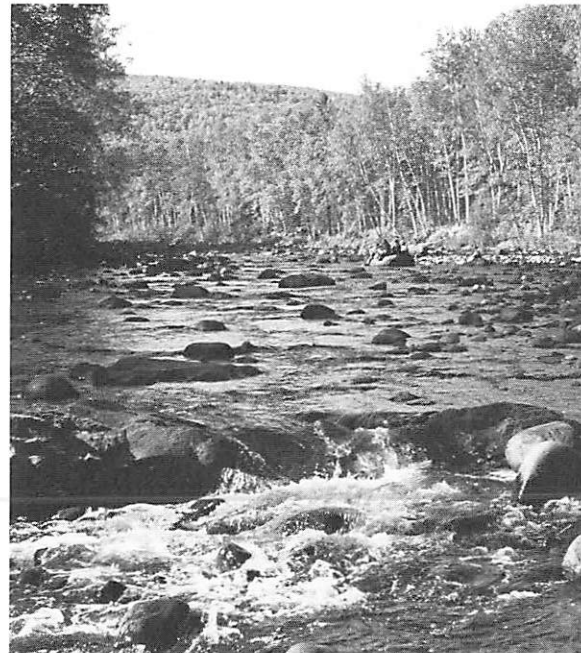
To inform the tourism industry, the media, and government agencies about issues affecting the North Shore, Tom Mack started an informal newsletter, *North Shore Correspondence*, in 1981.

In the three issues of *Correspondence* that came out in its first year, topics included harbors of refuge on the North Shore, Sea Grant research on boaters, and the Knife River sewage problem.

Results of a telephone survey of owners of sixty-seven lodging facilities on the North Shore were published in the fall 1981 issue. Mack discovered that the typical resort is small, consisting of quiet rooms or cabins on the lake, and offers limited recreational opportunities. Because of the abundance of public access to the lake shore, streams, wooded trails, and

parks, lodging owners do not see the need to create separate, private recreational facilities.

Almost 70 percent of those interviewed told Mack that less than half of their income is derived from the lodging business; close to 70 percent operate their business only during the summer. Many respondents indicated that they are in the business for other than financial reasons. Approximately 28 percent told him that they intend to sell their facility or that they have owned it for less than five years. Mack said that one reason for the high rate of turnover is that the typical lodging business is not profitable.



(photo: Minnesota Department of Economic Development)

Extension Offers Seminar On Marine Management

Marina owners and boat sales businesses benefited from a practical day-long workshop offered by Sea Grant Extension in March 1981. The "North Country Marine Management Seminar" covered such essential topics as insurance, financial management, working with bankers, and salesmanship.

Participants learned how banks make loans both to consumers and to business owners upgrading their inventories. They learned how to sell the boating experience along with the boat. They worked on hypothetical problems demonstrating how a year-end balance sheet can be used as a tool for financial planning. And they learned about workman's compensation, liability coverage, and purchasing insurance to cover inventory. Two thirds of those who attended the seminar said they would use the information to make decisions or improvements in their businesses.

Studying How People Respond to the Cold

Hypothermia, a lowering of internal body temperature, is a cause for concern in the maritime industry—particularly as the Great Lakes' commercial shipping season is extended into the colder months. It's also of concern to cross-country skiers, snowshoers, snowmobilers, ice fishermen, and anyone else who works or plays in the cold.

At the Hypothermia Laboratory on the Duluth campus, Minnesota Sea Grant funding has enabled physiology faculty members Robert Pozos, Lorentz Wittmers, and Lois Heller to quantify the human body's response to the cold.

Pozos began Sea Grant-funded research in 1978. Now Sea Grant is funding three hypothermia-related projects, each directly relevant to industries concerned about safety on the Great Lakes.

Hypothermia is considered a major contributor to as many as one third of the drownings associated with increasing use of the oceans and Great Lakes for recreation and transportation.

Interest in the subject and in the Duluth researchers' work has grown dramatically since the Hypothermia Laboratory opened its doors. In the summer of 1981, an international conference on hypothermia brought participants from as far away as Great Britain to the campus. Pozos, Wittmers, Heller, and Sea Grant Extension agent Tom Mack have been invited to speak to groups as diverse as the local 4-H and the Undersea Medical Society, which met in Athens.

One 4-H member, inspired by Mack's

talk to her group, did a project on hypothermia that won a blue ribbon at her county fair and a red ribbon at the 1981 Minnesota State Fair.

Industry approached the researchers to test life preservers and full-body suits and to teach offshore drilling workers about water safety under adverse conditions. Pozos analyzed the designs of personal flotation devices for the physically handicapped.



Dr. Robert Pozos monitors Sea Grant Extension agent Tom Mack in the immersion tank. (photo: Duluth Herald & News-Tribune)

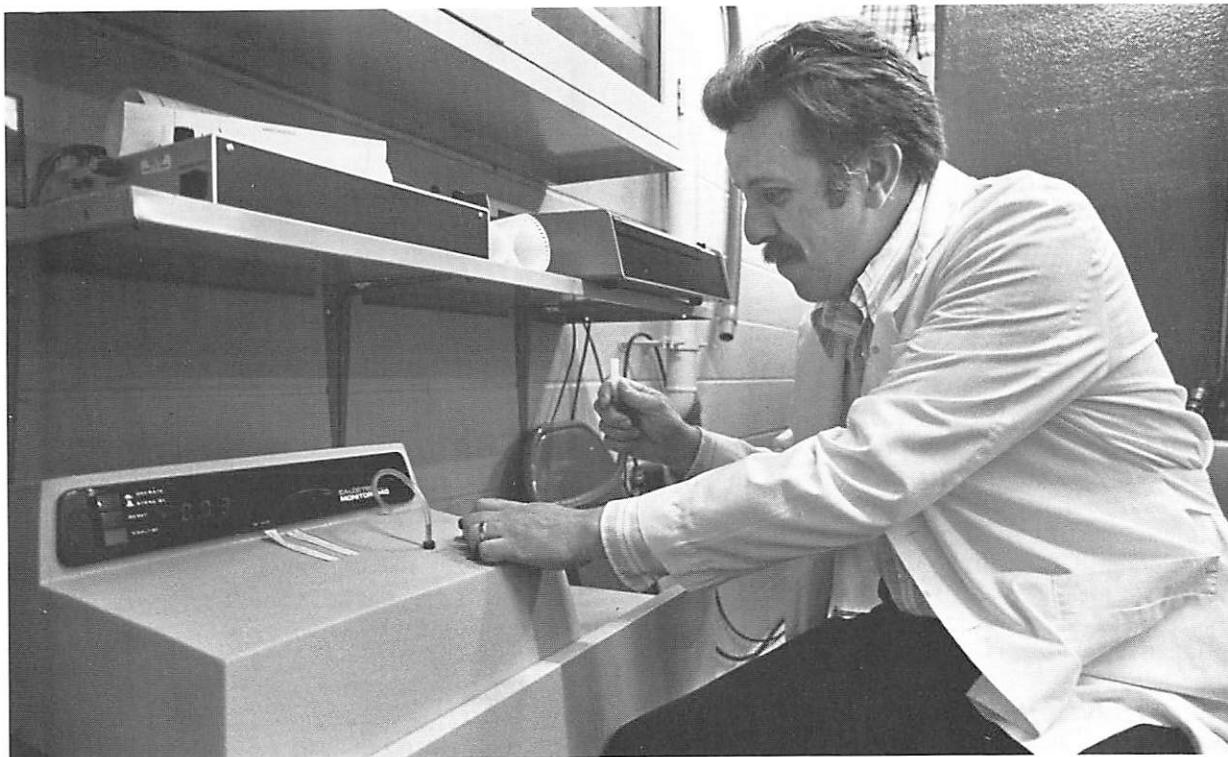
Hypothermia: Research Results

Chronic hypothermia, typically caused by prolonged exposure to cold air, frequently occurs when an individual is also wet from perspiration, rain, or deck-side spray. Victims are drained of energy reserves and become physically uncoordinated and mentally foggy. They may even lose consciousness and die.

Acute hypothermia, which often leads to death, occurs when a person is immersed in very cold water. Since Lake Superior's waters average thirty-nine degrees Fahrenheit, immersion in the lake is not only uncomfortable but also dangerous. Hypothermia is the leading cause of death among those who survive boating and shipping accidents.

Although hypothermia has long been recognized as an important factor in cold-related deaths, seldom has it been studied thoroughly in an extensive facility designed specifically for hypothermia research.

The Hypothermia Laboratory, described by *Duluth News-Tribune* outdoor writer Sam Cook as "a cross between an intensive care unit and a health spa," includes an immersion tank, a treadmill, an environmental chamber, digital monitors, a spirometer for measuring lung capacity, and other data-gathering equipment. Anyone who signs up to go through the experimental regimen undergoes extensive physical testing before being immersed in cold water or



Dr. Lorentz Wittmers (photo by Bruce Borich)

exposed to cold air. Physicians are always nearby during testing.

The temperature regulation system of the body is very complex and depends on a large number of variables such as body size, amount of fat, and fatigue.

In his first three years of Sea Grant funding, Pozos determined that shivering is not always a whole-body response. He also found that not everyone shivers—a fact that has significant implications for

manufacturers of wet suits that utilize shivering to raise body heat to a safe level. Use of alcohol, he and his colleagues have determined, greatly alters the body's response to cold. Although it suppresses the ability to shiver, alcohol also makes a person more relaxed and therefore less likely to move around and lose body heat.

Wittmers is analyzing the responses of different age groups to cold, to cold plus

alcohol, and to total-body versus facial immersion in cold water. He is studying the dive reflex, also called the oxygen conserving reflex, which enables some mammals to survive while submerged in water. When the reflex is triggered, the blood supply is diverted from body parts such as the muscles, the gastrointestinal tract, and the skin to the core systems of the heart and brain. The dive reflex, however, may also lead to fatal cardiac arrhythmia, or irregular heartbeat, which then results in drowning.

Heller's Sea Grant-funded study examines hypothermia-induced ventricular fibrillation, a fatal cardiac arrhythmia in which the normal synchrony of heartbeat and pulse beat is interrupted, and blood flow to the rest of the body ceases. It is a common cause of death in persons being rewarmed from a hypothermic state.

Pozos's, Wittmers's, and Heller's research also may lead to the development of more effective methods of cardiopulmonary resuscitation for hypothermia victims. And, in addition to health and safety considerations, the researchers are studying how hypothermia affects the performance and judgment levels of people who work in the cold.

Fixin' Fish



Fish made the news this year.

A new Minnesota Sea Grant book, *Fixin' Fish*—a guide to handling, buying, preserving, and preparing fish—stimulated interest not only across Minnesota, but also in other areas of the country; news articles and feature stories appeared as far away as California. Extension agent Jeff Gunderson created a mini-series for Duluth television based on the book.

The book's first chapter discusses the nutritional and economic reasons for eating fish. The major portion of the book tells how to keep fish fresh, as well as how to cook and preserve fish. Canning, smoking, salting, and pickling techniques are detailed, along with scoring, flaking, grinding, and more. Illustrations show the reader how to fillet, dress, skin, and scale a fish.

More than 2,500 copies of the book have been distributed. Gunderson compiled the publication; Nancy Berini, Sea Grant Extension communicator, edited it; and Leanne Alexander-Witzig illustrated the book.

Researching Life within the Lake

Every animal living in Lake Superior depends on the growth of algae for its existence. Temperature and the availability of nutrients and light determine the growth rate of the various species of algae. This growth, in turn, determines the quality and quantity of food available to the fish fry and microscopic zooplankton that feed on the algae. Zooplankton constitute the major food source for most of the lake's fish.

G. David Tilman, associate professor of ecology and behavioral biology, and Richard Kiesling, Sea Grant graduate student trainee, are analyzing how nutrients, light, and temperature affect algal growth. Beginning in the summer of 1980 and continuing into 1981, they collected samples at twelve sites along a northeast transection from Duluth Harbor to thirty miles from shore. Each field trip resulted in three to six weeks of laboratory work, isolating the major species of algae and manipulating the samples under various light and temperature regimes.

Tilman and Kiesling also analyzed the impact on the algal populations of chemicals deposited in the lake by man. Tilman likened this input to fertilization of a field; as more nutrients are made available to the lake's algal populations, greater productivity can result. This enrichment may or may not be harmful, depending on which species dominate after nutrients are added.

To aid in determining the effects of enrichment, the researchers have been looking at the ratios of phosphate to nitrate and phosphate to silicate. Their



Field assistant Kris Kiesling takes a sample.

work so far suggests that it is important to keep phosphorus in balance with nitrogen and silicon.

Water temperature, the researchers have found, is of secondary importance. Diatoms, the most desirable algae for zooplankton and fish fry, are most abundant at lower temperatures, a finding that will help anyone interested in aquaculture work in the region.

In the next years of the project, Tilman anticipates the development of a predictive model of how light, temperature, and the infusion of phosphorus, nitrogen, and silicon affect algal growth. Aquaculturalists who implement the research findings will thus be able to avoid rearing the undesirable blue-green algae and raise the edible green algae or diatoms instead.



Kris and Richard Kiesling work aboard a research vessel on Lake Superior. (photos by Bruce Borich)

Studying Superior's Sucker

While suckers are not a primary target species for Great Lakes commercial fisheries, a decline in their numbers might adversely affect the industry. Trout and whitefish are a large component of the commercial harvest and they, along with suckers, are a source of food for the sea lamprey; an imbalance in the sucker population would pose a threat to these alternative forms of prey.

George Spangler, associate professor of entomology, fisheries, and wildlife, and graduate student Sherry Middlemis are examining the size and age composition of spawning runs in several Lake Superior tributaries in order to estimate the suckers' sustainable yield. According to Spangler, the capacity of the lake to produce either the common sucker or the northern (longnose) sucker is not known.

In addition, Spangler thinks there is room for marketing and processing research. Although suckers are edible, they have bones in their musculature and therefore require special processing. If the meat is canned, the bones soften and can be eaten. Mincing also results in an acceptable product. The fish, he says, could easily supplement existing fisheries on a regular basis.

The researchers are electrofishing and trapnetting adult suckers as they come into Lake Superior's tributaries to spawn. They also are netting sucker fry, ten to twenty days after hatching, as they move downstream.

The biologists separate the species

by biochemical and morphological characteristics. Age is particularly difficult to determine. Unlike with other fish, the annular rings on the suckers' scales are not a reliable indicator of age. Spangler and Middlemis have found that the most accurate way to determine age is to take a single ray from a fin, slice it, then look at the pattern of bone growth.



photo by Allen Glenn

Once the researchers have described the population structure of spawning stocks (e.g., their age, size, sex ratios, genetic discreteness) and the factors that might influence year-class strength, they plan to estimate the yields of each species under a variety of growth and mortality conditions. They will then develop computer simulation models to test management strategies designed to optimize yields.

A Boost to Fisheries

Sea Grant Extension fisheries agent Jeff Gunderson worked with both commercial and recreational fishermen in 1981 and continued his efforts to promote underutilized fish such as burbot.

Gunderson organized demonstrations of scanning sonar equipment all along the North Shore and continued to test the monofilament trapnet. Both sonar and trapnet offer new ways of finding and capturing fish commercially, and sonar would also be useful to recreational fishermen, scuba divers, and underwater salvage operators.

Throughout the year, Gunderson demonstrated proper fish handling techniques to groups of recreational fishermen and discussed issues such as the safety of consuming parasitized fish. Also, with Wisconsin Sea Grant Extension staff, he produced a five-day course for commercial fishermen in fishery biology.

Aquaculture: A Growing Area

Aquaculture—agriculture under water—is an expanding area in the Minnesota Sea Grant Program. In 1981, three research projects were supported in the fields of cryopreservation of fish sperm and eggs, smoltification of chinook salmon, and rearing and managing of bait leeches.

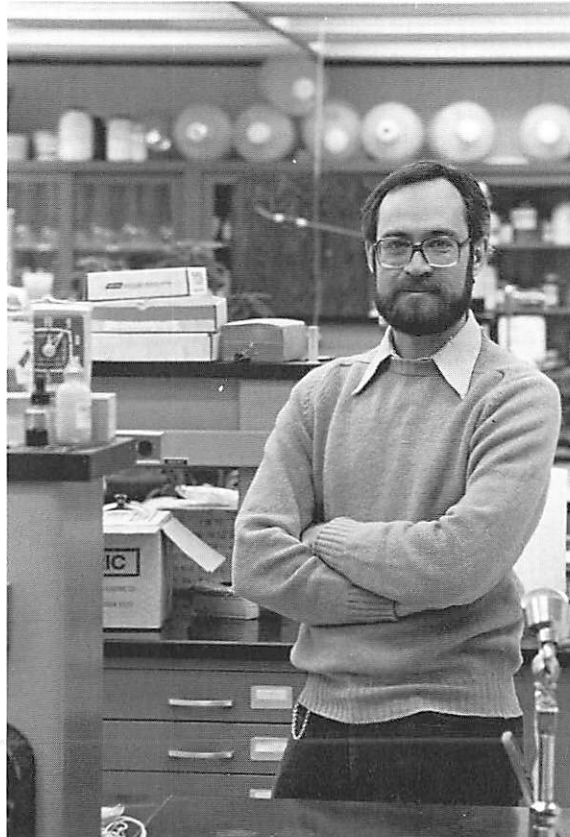
Also in 1981, Minnesota Sea Grant added an Extension specialist in fish breeding and genetics. Douglas Tave, the new specialist, holds a joint appointment with the Department of Entomology, Fisheries, and Wildlife as an assistant professor. He is working with people who are raising bait fish, he is conducting research, and he is teaching courses and directing graduate students in their research.

Tave is the first specialist hired in Minnesota to meet the diverse needs of bait farmers, fisheries-related businesses, government agencies, and the academic community. His job is to create a program in which research goes hand in hand with training new experts in the field and with extending the results to those who can apply it to their work.

According to Tave, the Minnesota bait fish industry is one of the largest in the country, yet there is very little research going on. The area is wide open for new ideas. Genetic manipulation, for example, could increase a crop's economic value.

As the bait fish industry grows, Tave

sees the possibility of Minnesota's exporting to other states in large quantities at premium prices, but it will be a long-term process in which the fish culturing techniques will gain gradual acceptance through demonstration projects.



Douglas Tave, Extension Specialist
(photo by Dave Hansen)

Learning About Leeches

Jeff Denny grew up on a resort in northern Minnesota. Each spring and summer, he helped his father find enough bait to sell to their customers, recreational fishermen who especially wanted to catch walleye. Their bait of choice, the leech *Nepheleopsis obscura*, was plentiful in the spring, but became harder to find and keep alive as the season progressed.

Denny, a graduate student, is now working on a Sea Grant project that may give a big boost to bait dealers and resort owners like his father. In its second year of funding, the project is examining the effects of the unplanned harvesting of bait leeches and is culturing leeches in semi-controlled environments such as ponds and in controlled laboratory settings.

Denny and Hollie Collins and Linda Holmstrand, faculty members in the biology department on the Duluth campus, have been able to keep leeches alive in controlled environments, have achieved leech reproduction in the lab, have stimulated reproduction out of the natural phase, and have raised the animals to marketable and jumbo sizes. As bait dealers learn these techniques, they will be able to minimize their losses, Collins said.

Interest in the project has been widespread, with inquiries coming from as far away as California and Kentucky.

In 1981, Sea Grant Extension published



Bait leeches (photo by Bruce Borich)

Bait Leech: Its Nature and Nurture to spread the word about the researchers' progress. Illustrated with photographs, the publication describes leech feeding, spawning, growth, habitat, and culture. It also gives tips to the fisherman trapping leeches, discusses care of leeches at home and on fishing trips, and talks about the ecological importance of the animal.

The leech is of growing economic importance to Minnesota. Each spring, bait dealers harvest as many leeches as possible from Minnesota's ponds and lakes. The annual harvest nets approximately sixty-five tons and brings in millions of dollars. When leeches are sold by the dozen, a pound can cost as much as \$40.

The Minnesota Sea Grant project will provide the kind of information necessary to avoid overharvesting the bait leech while increasing the understanding of its life cycle and nurture, information that should prove useful to bait dealers.

Understanding How Salmon Smolt

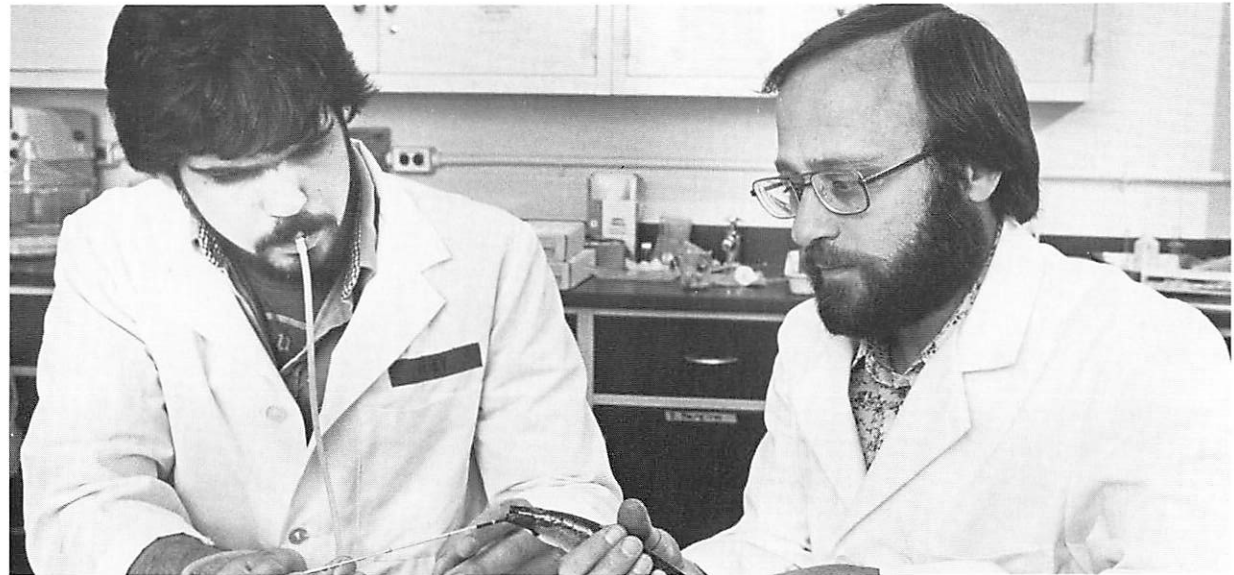
Smoltification is the time in a salmon's life when it is ready to move from freshwater to salt water. In the absence of salt water, a smolting salmon will move from the stream where it was released into a lake such as Lake Superior.

If the salmon is released into salt water before it smolts, it may die. In freshwater, imprinting (recognition of the home stream) may not take place if the fish is released too precipitously from the hatchery. Also, since a fish may not migrate to the lake before it smolts, it may remain in the stream, where it

competes with other fish species.

Ira Adelman, associate professor of entomology, fisheries, and wildlife, and Don Pereira, Sea Grant graduate student trainee, began investigating physiological indicators of chinook salmon smoltification in 1981.

Pereira came to Minnesota specifically to work on the smoltification project. At the University of Vermont, where he received his bachelor's degree, Pereira had worked for a fisheries biologist and had prepared a special seminar on smoltification for an ichthyology class. When he saw the project advertisement for a trainee, he applied immediately for the job and for graduate school at the University of Minnesota. Now a master's degree candidate, Pereira intends to work

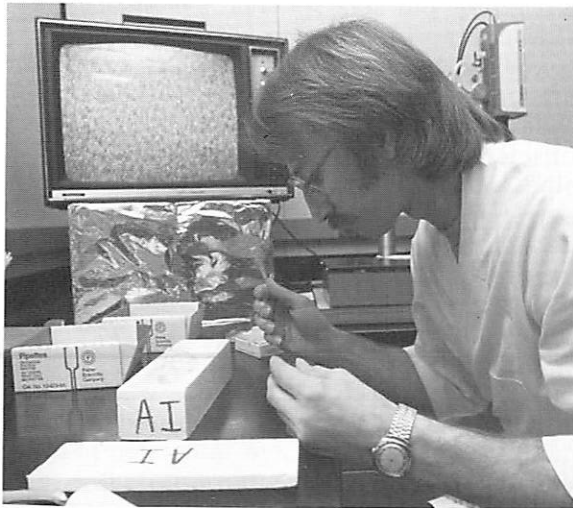


Don Pereira, graduate student, works with principal investigator Ira Adelman. (photo by Bruce Borich)

on a Ph.D. in fisheries.

Among the smoltification indicators being studied are the rate of protein synthesis and the sodium content of the blood. After a year of research, Adelman says that their information supports a recent finding of Pacific Coast researchers that the salmon's peak smoltification periods occur in conjunction with the new moon, particularly at the vernal and autumnal equinoxes.

If the researchers can establish indicators that are reliable and economical to apply, their information will be of tremendous value to hatcheries that need to know when to release the fish. They also are examining methods of manipulating environmental factors such as temperature and light to speed up the smoltification process and thus shorten the fishes' stay in the hatchery.



David Erdahl, Research Associate, Cryopreservation Project (photo by Dave Hansen)

Fish Breeding for All Seasons

During its three years of Sea Grant funding, the Minnesota project on the cryopreservation, or freezing, of fish sperm and eggs has produced significant results.

Edmund Graham, professor of animal physiology, and graduate student trainees David Erdahl and Alan Erdahl have studied the physical and chemical characteristics of fish semen in order to develop dilution and storage methods for preserving fish sperm. The researchers have created two methods for storing sperm—one keeps them viable for several days, the other for years.

Fish sperm that had been frozen for as long as two years, when thawed and united with fresh eggs, resulted in fertility rates ranging from 60 to 90 percent, depending on the species of fish. The researchers believe that the frozen sperm could have remained viable for many more years.

As the project matured, interest grew within hatcheries, the commercial fishing industry, the Minnesota Department of Natural Resources, and other universities. In response to a brief questionnaire sent to commercial aquaculturists by the researchers, commercial fishermen and trout ranchers offered not only their ideas and support, but also the use of their facilities. Researchers across the country requested hundreds of reprints of journal articles on the project from the Sea Grant office.

The research on extending the life of sperm with diluents and cryoprotective



Dr. Edmund Graham discusses principles of cryopreservation with a seminar participant. (photo by Dave Hansen)

agents is ready for application. The researchers presented a seminar on their techniques to private and public hatcheries in early 1982, and they simultaneously published a semi-technical paper through the Minnesota Sea Grant office.

The researchers now see the need to concentrate on the female's role in spawning and on fertilization mechanisms such as the length of time gametes (mature sperm or eggs) are viable upon release into water. They will be focusing on attempts to preserve fertilized eggs.

Among the important applications of their work are these: preservation of sperm and eggs will allow gamete union, even when parent fish do not ripen at the same time; the maintenance of a bank of viable fish gametes will allow year-round use of hatchery personnel and facilities; as the procedure is refined, the number and quality of gametes available will increase; and cross-breeding experiments will become possible with breeds of fish that ripen at different times of the year.

Finding Contamination in a Pristine Lake

Microcontaminants do not always change the appearance, smell, or taste of water, yet they affect every part of the surrounding ecosystem. Five parts of polychlorinated biphenyl (PCB) to a trillion parts of water may concentrate in fish at fifteen parts per million. Such contamination endangers the health of some animal species—including humans—and the survival of others.

To make matters more complex, the nature of the microcontaminant problem is constantly changing. "We now know that the PCB and DDT problem of the 1970s is evolving into the dioxin, PAH [polycyclic aromatic hydrocarbon], and PCB problem of the 1980s," says Steven J. Eisenreich, associate professor of civil and mineral engineering. He has been studying the movement of microcontaminants within Lake Superior since 1979 with funding from Sea Grant and the Environmental Protection Agency.

Eisenreich is creating a dynamic model to predict the fate of organic pollutants within large lakes, verifying and calibrating the model by using PCB as a tracer. The model evaluates the fate of polluting chemicals within the system, predicting how the system as a whole and its individual components such as sediment, water, and plant and animal life might respond to a variety of environmental conditions and to various methods of pollution control.

Finding microcontaminants in a huge body of water such as Lake Superior is a painstaking, time-consuming, tedious procedure. It takes a sample of from

twenty to forty liters of lake water to extract a minute amount of PCB. The process must be carried out with meticulous care—filtering, removal of the microcontaminants by adsorption, extraction with solvents, removal of extraneous materials, and final analysis through gas chromatography with electron capture detection.

During the first two years of his Sea Grant-funded research, Eisenreich determined that atmospheric deposition accounts for more than 85 percent of the microcontaminants that come into Lake Superior—a finding that has been utilized by the International Joint Commission (a United States-Canadian agency that oversees bodies of water bounded by the two countries) in its report assessing airborne contaminants in the Great Lakes Basin ecosystem.

Eisenreich says that his data show that the atmospheric concentration and



Sea Grant coastal and environmental processes researchers aboard a research vessel (photo by Nancy Berini)

distribution of microcontaminants—the atmospheric “burden”—seem to be decreasing and, therefore, water concentrations also should be diminishing. Yet microcontaminants borne by the air from both short and long distances continue to reach the lake. Because microcontaminants are hydrophobic, they favor attachment to particles, and sedimentation thereby removes a large portion of microcontaminants from bodies of water.

In a lake such as Lake Erie, which experiences significant erosion along its shores and has a surfeit of algae and zooplankton, there are a large number of particles to which microcontaminants can attach themselves.

In Lake Superior, which is unusually clear of particles, contamination is more pronounced. Without sedimentation as a major particle removal system, microcontaminants stay within the lake longer, concentrating in the biota. Other removal processes—tributary outflow, biodegradation, volatility—are not sufficient to reduce the concentration of microcontaminants while the input remains at elevated levels. It is ironic that Lake Superior, termed the most pristine of the Great Lakes, should be in trouble precisely because of its purity.

Perhaps, through research such as Eisenreich's, knowledge of the life histories of microcontaminants will lead to effective methods of control. As the magnitude of the problem is determined, regulation of microcontaminants will probably become a significant issue to those who draw upon the Great Lakes for food and water.

American Indian Students Explore Marine Science

When Mike Swan came from the White Earth Reservation to elementary school in Ponsford, Minnesota, thirty American Indian students were beginning school there. By the time he was in seventh grade, enrollment had dropped to sixteen; by twelfth grade, only four remained.

The number of American Indian students who make it to college is minuscule, and only a small fraction of them study the sciences. Ruth Myers and Robert Diver, both American Indians, counsel other American Indian students on the University's Duluth campus, encouraging them to excel in their college

careers and to study the sciences.

Myers believes that science—not just pure research, but also areas such as nutrition, energy, and water quality—teaches survival and that all students need a good science background.

Swan is one of two undergraduate students to receive support from Minnesota Sea Grant in 1981 through a new program called American Indians in Marine Sciences (AIMS). Swan is working with the Sea Grant bait leech project, analyzing lake bottoms to determine the ideal environment for growing the leeches.

He is slightly older than most of the other students in his civil engineering, business, and Indian studies classes. As with many American Indian students, he was not encouraged to go to college by his family, friends, or high school counselors; so, instead, he went to work for the telephone company after graduating from Park Rapids High School.

Now twenty-six years old, Swan is not only a dedicated student, but also has served as president of Anishinabe, the campus Indian club, and as student representative to the American Indian Advisory Board. He plans to transfer to the Twin Cities campus, finish his degree in civil engineering, and then possibly work on the reservation. As a civil engineer with a minor in business, he would be able to work in city planning and engineering, start a small business, or in other ways improve the overall economic and environmental resources of his reservation.

Lea Fairbanks, the other first-year AIMS student, is now in medical school after working intensively with Sea Grant hypothermia researcher Lorentz Wittmers, associate professor of physiology.

As AIMS students, Swan and Fairbanks visit laboratories on the Twin Cities and Duluth campuses and participate in research projects under the guidance of Sea Grant principal investigators in Duluth.

AIMS intends to support a total of eight Indian students in the marine sciences over a period of several years. Ideally, those students will form a cadre of experts in areas such as water



Robert Diver talks with AIMS student Mike Swan. (photo: School of Medicine, University of Minnesota, Duluth)

A Marine Environment Curriculum

resources, hatchery management, recreation and tourism, and water pollution control. Diver thinks the program will produce not only marine science experts, but also role models for youth in the Indian community.

Bruce Munson, Sea Grant Extension agent, says that American Indian tribes have management or treaty rights to the use of nearly all major bodies of water in the state, and as they're exercising these rights more and more, they want trained people to help insure wise use of the resource.

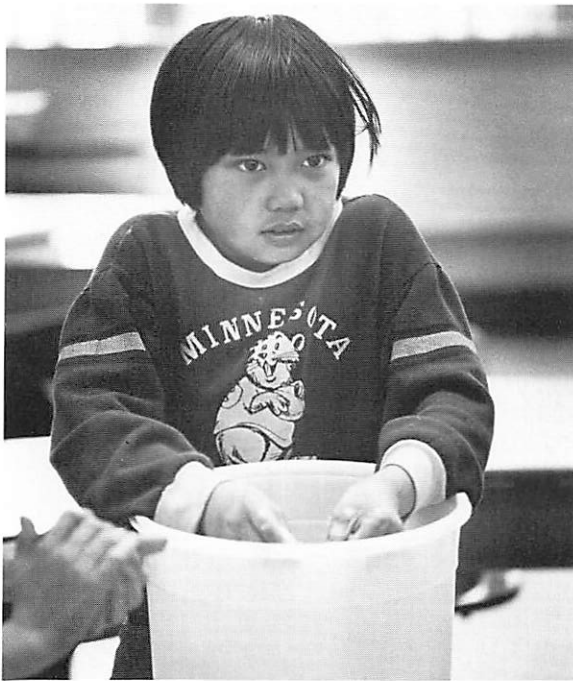


photo by Bruce Borich

"This is the funnest science we have ever had!" wrote an elementary student who participated in a trial test of curriculum materials developed with Minnesota Sea Grant funding. Along with elementary students in thirty other classrooms, he learned about water, weather, the geology of lake bottoms, and ecosystems through the unifying theme of acid precipitation.

Department of Curriculum and Instruction faculty members Eugene Gennaro, Roger Johnson, and Allen Glenn and graduate student trainees Steve Rakow and Linda Scott developed the four curriculum guides in 1980-81. They plan to revise the materials and put them into an attractive and convenient format.

The packets describe activities for concepts that have had little more than discussion in the elementary grades. Children of varying ability levels are grouped together to work cooperatively on each project. Linda Scott prepared a separate booklet for teachers on the cooperative goal structure.

Scott, a Ph.D. candidate, teaches methods of elementary science instruction to undergraduate education students at the University. She was an elementary classroom teacher and a science resource teacher for the Moundview school district before entering graduate school.

Rakow, also a Ph.D. student, has a background combining teaching and biochemical research in aquatic toxicology. As an undergraduate, Rakow did an intensive study of a reservoir created out of a stream. He came to Minnesota to do graduate work in

freshwater biology and along the way became interested in teaching and curriculum development.

The research team is also developing an excursion packet for families and classes going on field trips to the North Shore.

Lacustrine Lessons

Bruce Munson, Sea Grant marine education agent, and Nancy Berini, Extension communicator, began a newsletter, *Lacustrine Lessons*, to provide ideas for classroom activities in kindergarten through grade twelve. The publication first appeared in fall 1980 and continued bimonthly throughout the school year. By the fifth issue, its circulation had almost tripled as teachers throughout the state requested to be on the mailing list.

Topics covered in the 1980-81 issues included ice safety, testing for water pollution, hypothermia, determining the effects of acid rain, driftwood art, and sampling for aquatic organisms. Educators and scientists check the materials for accuracy before they are printed. The editors of *Lacustrine Lessons* are inviting contributions for its second year of publication.

A Superior Experience: Sea Grant-Sponsored Camps



Sea Camp '81 (photo: Lake County News Chronicle)

Sea Grant Extension continued in 1981 to cosponsor two summer camps for Minnesota youth. "A Superior Experience," a one-week residential camp for 4-H junior leaders, brought teens from across Minnesota to Duluth to learn about the value of Lake Superior to the state. "Sea Camp" is a series of week-long day camps held along the coast for elementary-age children. Bruce Munson, Sea Grant marine education agent, coordinated and organized the camps.

Sixty-four 4-H members from twenty-five Minnesota counties came to the College of St. Scholastica in Duluth for "A

Superior Experience." Aged fourteen to nineteen, they learned about the natural history of the area and about Lake Superior as a recreational, commercial fishing, transportation, and tourism resource. They visited grain elevators, a coal terminal, and a research vessel. When they went home, they presented to their clubs what they had learned.

Grand Portage, Silver Bay, Two Harbors, and the Duluth area were sites for the 1981 "Sea Camp," attended by 353 children, most of them from low-income families. The camp was cosponsored by 4-H and private donor Julia Marshall, who

was named an honorary Sea Camper and lifelong "caretaker of the lake" by the young campers.

Water quality was the focus for the camp's activities, which included a beach walk and a pollution experiment. On the walk, the children looked at how the rocks had been worn smooth by the waves and built a sand castle to illustrate how erosion works. Of several "pollution jars" containing water samples, one was obviously polluted; to find out if the others were, the children used their senses and a scientific test. One sample felt polluted (it had syrup in it). One smelled polluted. One tasted polluted. And a pH test determined the acidity of another. In addition to learning activities, the children had picnics, hiked, and swam.



Fiscal Year 1981 Budget Summary

For the 1980-81 fiscal year, 64 percent of the Minnesota Sea Grant Program was funded by the national Office of Sea Grant (NOAA, Department of Commerce: grant #NA80AA-D-00114), 12 percent by the Minnesota State Legislature, 23.5 percent by University of Minnesota matching dollars, and 0.5 percent by private contribution.

	NOAA Office of Sea Grant	Pass- Through Funds	State Legislative Special	University Match
Research	\$181,016		\$21,329	\$93,265
Education	85,263	3,000*		
Extension	171,716		26,564	71,827**
Program Management	<u>62,005</u>	<u> </u>	<u>46,724</u>	<u>20,499***</u>
Total	\$500,000	\$3,000	\$94,617	\$185,591

*Contribution of Julia Marshall, Duluth, in support of Sea Camp

**Includes salary support from the Agricultural Extension Service, Continuing Education and Extension, and the Agricultural Experiment Station

***Includes contributions of the Graduate School

Research Projects

Title	Investigator(s)	NOAA Sea Grant Funds	Legislative & University Match	Status
Estimation of Yield Potential of Suckers (Catostomidae) from Minnesota Tributaries to Lake Superior	George Spangler	\$5,000	\$16,983	Ongoing (year 1)
The Relationship of Growth Rate Changes to Smoltification of Chinook Salmon	Ira Adelman	13,304	3,996	Ongoing (year 1)
Nutrients, Productivity and Algal Dominance in Lake Superior: A Mechanistic Approach to an Oligotrophic Food Web	G. David Tilman	5,648	15,094	Ongoing (year 1)

Bait Leech, <i>Nepheleopsis obscura</i> , Culture and Management	Hollie Collins Linda Holmstrand	16,515	8,593	Ongoing (year 2)
Gamete Preservation and Reproductive Potential in Fish	Edmund Graham Jonathan Wheaton	11,199	8,967	Completed
Microcontaminant-Air, Water, Sediment, Biota Interactions in Lake Superior	Steven Eisenreich	24,550	5,250	Ongoing (year 2)
Sedimentation in Duluth-Superior Harbor	Thomas Johnson David Darby	8,752	6,499	Completed
A Market Segmentation Study of North Shore Tourism	Uel Blank Timothy Knopp	20,316	9,558	Ongoing (year 1)
Alcohol, Shiver, Skin and Body Temperature Metabolism During Cold Water Immersion	Robert Pozos	12,674	8,175	Completed
Diving Reflex-The Effect of Alcohol on Cardiovascular Adjustments to Cold and Water Stress	Lorentz Wittmers	13,323	6,083	Ongoing (year 1)
Hypothermia-Induced Ventricular Fibrillation in Normal and Hypertrophied Hearts	Lois Heller	14,937	6,048	Ongoing (year 1)
A Multidisciplinary Approach to the Study of a Regional Marine Environment with Implications for Community and Family Living	Eugene Gennaro Roger Johnson	5,966	14,546	Ongoing (year 1)
Program to Increase Yield in Minnesota Bait Fish Ponds	Douglas Tave	11,921		Developmental
Development of Aquaculture		9,911		Developmental
Ship time to Support Research	Donald C. McNaught	7,000		Ongoing

Minnesota Sea Grant Staff, 1980-81

Donald C. McNaught, Director
Dale Baker, Extension Director
Bruce Munson, Marine Education
Thomas Mack, Marine Recreation
Jeffrey Gunderson, Fisheries
Douglas Tave, Aquaculture Specialist
Nancy Berini, Public Information
(Extension)
Roberta Berner, Public Information
(Management Program)
Judith Goetzke and Judith Zomerfelt,
Secretaries
Sandra Glantz and Gail Stroup, Accounts
Assistants

Minnesota Sea Grant Committees 1980-81

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William F. Hueg, Jr.	Deputy Vice President and Dean, Institute of Agriculture
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Kenneth Keller	Vice President, Academic Affairs

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Lenore Johnson	County Commissioner, Lake County
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Richard Sauer	Director, Agricultural Experiment Station
Thomas Scott	Director, Center for Urban and Regional Affairs
Stanley Sivertson	Sivertson Bros. Fisheries
Roger Staehle	Dean, Institute of Technology

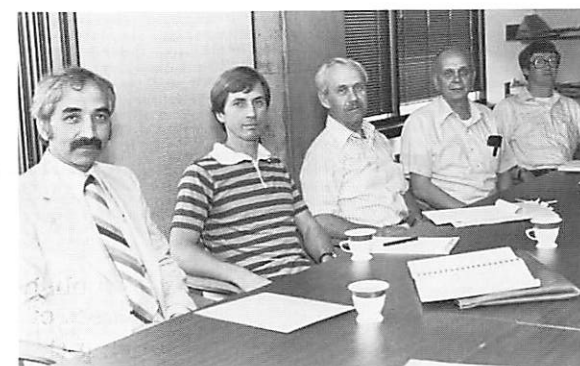
Extension Advisory Council

Eugene Bergman	Past President, Lake Superior Steelhead Association
Edwin Drill	Owner, Knife River Marina
Tom Eckel	Commercial Fisherman
Blaine Fenstad	Member, Board of Directors of the North Shore Association
Janet Green	Member, Duluth Township Planning Board
Virginia Hills	Member, N.E. Minnesota Environmental and Economic Council
Lenore Johnson (<i>ex-officio</i>)	County Commissioner, Lake County
Carl Odmark	Owner, Cascade Lodge
Kenneth Olson	County Commissioner
Andrea Peterson	School Teacher, Grand Portage
Bruce Simons	Director, Spirit Mountain
Stanley Sivertson	Owner, Sivertson Bros. Fisheries
Dick Thorngren	Reserve Mining



Left to right: Donald C. McNaught, Sea Grant Institute Director; Dale Baker, Sea Grant Extension Director (photo by Sue Silvis)

Research Subprogram Coordinators



Left to right: Dr. Robert Pozos, water safety; Dr. Thomas Johnson, coastal and environmental processes; Dr. Uel Blank, recreation and tourism; Dr. Eugene Gennaro, marine education; Dr. George Spangler, fisheries (photo by Sue Silvis)

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New Publications Available

General Publications

- Fixin' Fish** (a guide to handling, buying, preserving, and preparing fish) \$1.00
A Boater's Guide to Lake Superior Launch Ramps \$1.00
Edge of the Arrowhead (updated edition: discusses geological and cultural background of the Lake Superior region, along with current concerns) \$2.00
Parasites: Are the Fish Good Enough to Eat? \$.50

Superior Advisory Notes

- Bait Leech: Its Nature and Nurture**
Brochures to Boost Business
Smooth Sailing Through Coastal Permits

Reprint Series

- Sediment Redistribution by Waves in Lakes, Reservoirs and Embayments**
Histological Effects and Bioaccumulation Potential of Coal Particulate-Bound Phenanthrene in the Fathead Minnow *Pimephales Promelas*
Effects of Alcohol on the Cardiovascular Adjustments of the Diving Reflex in Man

Research Notes

- The Potential Application of Cryobiology to Aquaculture**
Hypothermia-Induced Ventricular Fibrillation

Newsletters

- The Seiche** (a quarterly newsletter published by Sea Grant Extension providing information about the Minnesota coast of Lake Superior)
Lacustrine Lessons (published during the school year by Sea Grant Extension, provides curriculum ideas about the marine environment for teachers)
North Shore Correspondence (an informal Extension publication for those interested in tourism and recreation along the North Shore)

The materials listed are available free of charge except where noted. Contact:

Sea Grant Extension Program
109 Washburn Hall
University of Minnesota
Duluth, MN 55812
(218) 726-8106

or

Sea Grant Institute
435 Animal Science/Veterinary Medicine
University of Minnesota
1988 Fitch Avenue
St. Paul, MN 55108
(612) 373-1708

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