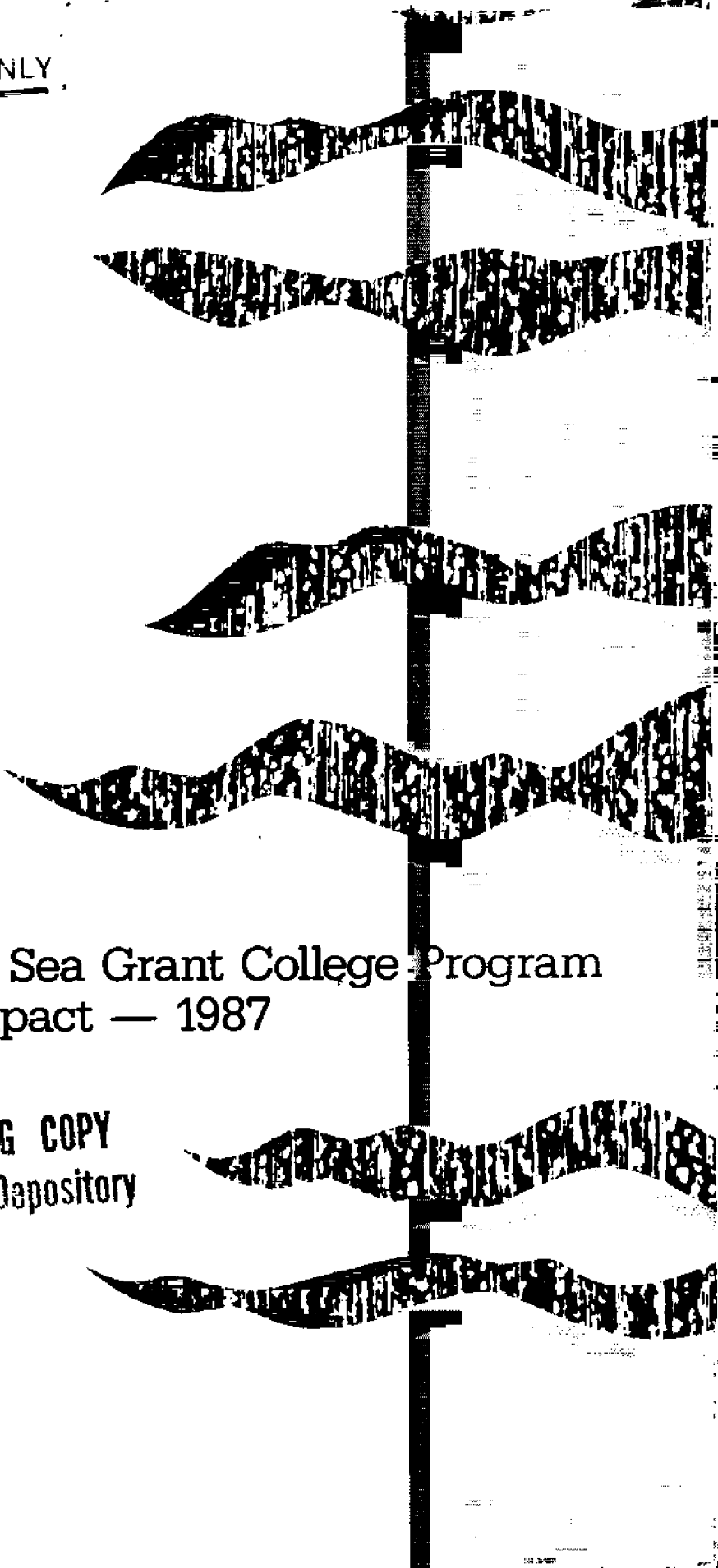


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The National Sea Grant College Program
Economic Impact — 1987

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The report on Sea Grant's economic impact was compiled from analyses conducted by the directors of the 30 Sea Grant Programs. It is intended as a one-year picture of Sea Grant's economic accomplishments. All impacts reported occurred in 1987. Where appropriate, multiple year values are recorded on an annual basis. The report is intended as an anecdotal record of Sea Grant's economic reach. As such, no attempt was made to net out the cost of the many productive resources employed to produce these impacts. The analysis is also partial in nature. It is based on examples, not total coverage. Hence it is conservative.





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The National Sea Grant College Program Economic Impact — 1987

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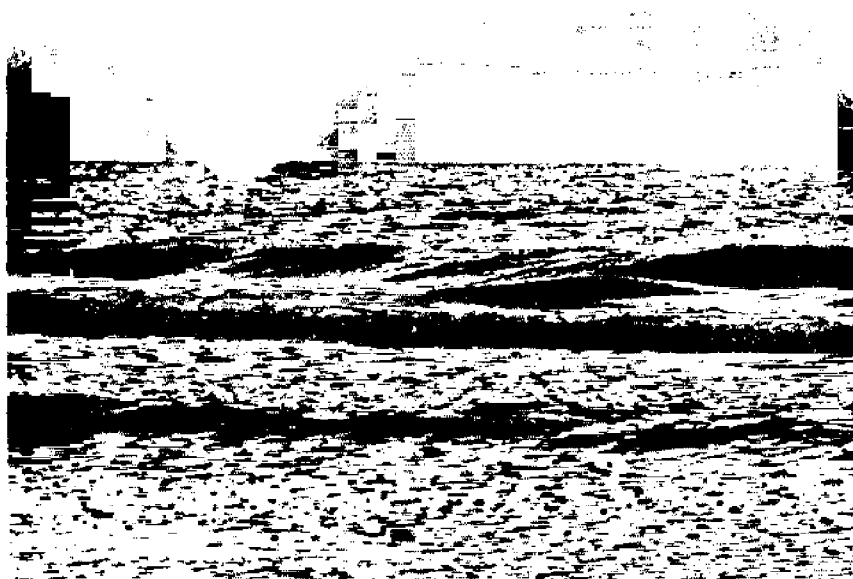


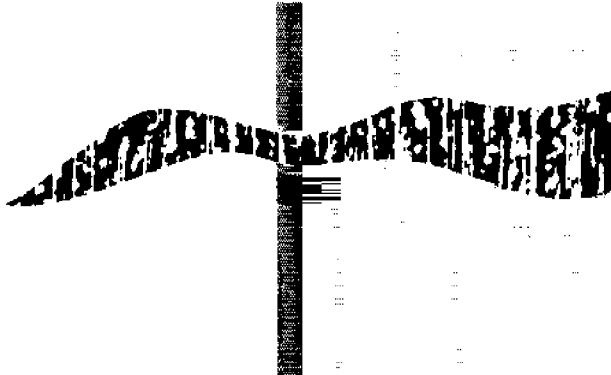
Summary

The Sea Grant Program

The Sea Grant Act of 1966 launched the development of a network of Sea Grant programs that today span 30 coastal and Great Lakes states. It is a directed national program of marine research, technology transfer and education. Sea Grant is a partnership, a state-federal concord committed to advancing marine resource development and solving coastal problems. Program costs are shared almost equally, often with industry contributing a part.

Through the nexus of its national research agenda, extension network and educational programs, Sea Grant ensures the lag time between research discovery and application is significantly reduced. Sea Grant is quick to recognize pivotal marine opportunities and issues, engage top scientific talent and quickly transfer research results from the lab or field into practical use.



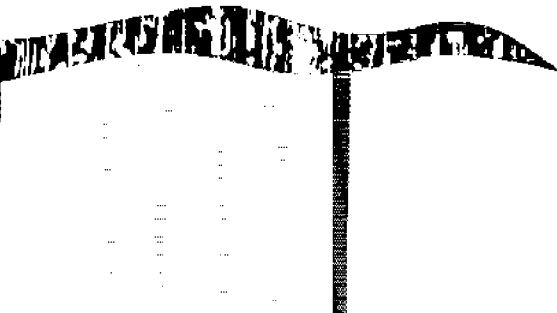


The Impact of Sea Grant on the National Economy

By stimulating new business opportunities and implementing cost-saving productivity improvements, Sea Grant had an \$842 million impact on the national economy in 1987. A 1981 analysis of Sea Grant estimated a \$230 million annual contribution to the national economy. That the value more than tripled should be seen as a remarkable achievement, especially in the face of declining program resources throughout the 1980s. But it is also reason for concern. A large number of the economic gains reported here had their gestation period in the 1970s. Will a report eight years from now be able to report similar success?

The report only partly gauges Sea Grant's "reach" into the marine economy. It does not try to be painstakingly complete by reporting every Sea Grant accomplishment. For example, almost no attempt was made to account for better resource management decisions that flow from having better scientific knowledge. Returns from Sea Grant's investment in human capital development, from graduate education to extension workshops, went largely unmeasured. The report does not endeavor to assign a value to the lives saved as a result of marine safety training programs. Nor was it possible to track systematically or to account for the continuation of the impacts reported in 1981.

This report highlights how the National Sea Grant College Program serves to improve the economic well-being of the United States. It demonstrates Sea Grant's entrepreneurial capacity and commanding presence in the development of the marine sector of the economy. The 1987 record of Sea Grant's economic achievements, illus-



trated in the examples that follow, is indicative of Sea Grant's commitment to the development of marine resources and the growth of marine industries

A summary of the report findings is given below (Table 1) for the eight major areas of activity that comprise the \$842 million Sea Grant economic impact achieved in 1987.

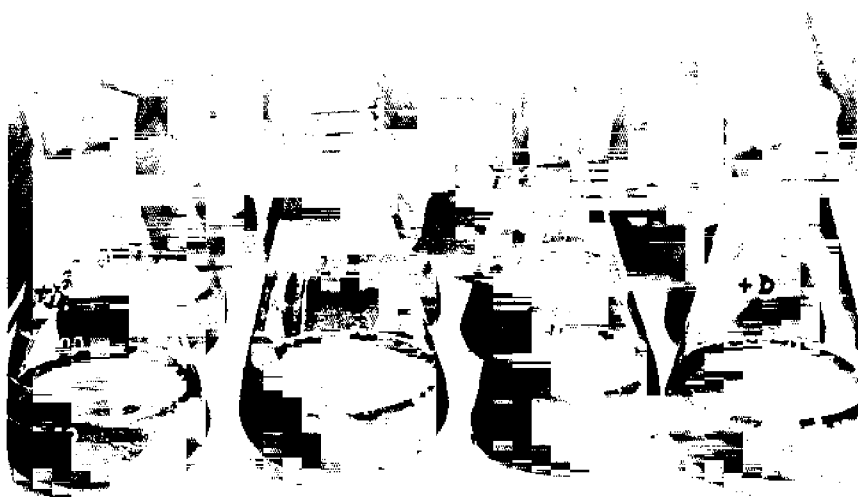
Table 1
National Sea Grant College Program
Economic Impact — 1987

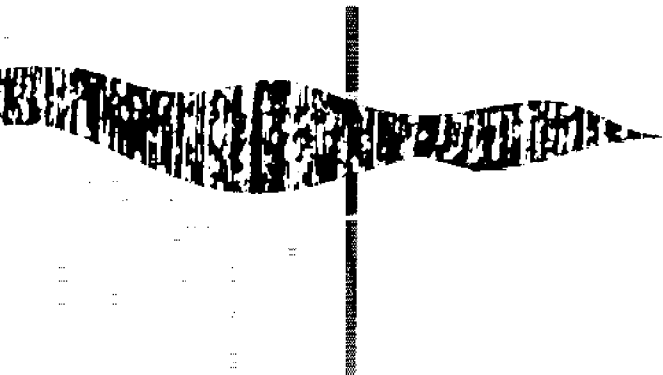
| | |
|--|-----------------------|
| Marine Biotechnology | \$ 13,770,000 |
| Commercial Fisheries | \$ 167,161,700 |
| Seafood Processing | \$ 17,570,000 |
| Marine Recreation and Tourism | \$ 321,074,500 |
| Aquaculture | \$ 92,545,000 |
| Coastal and Offshore Construction | \$ 91,195,000 |
| Marine Trades and Service Industry | \$ 85,540,000 |
| Marine Safety and Public Health | \$ 53,100,000 |
| TOTAL | \$ 841,956,200 |

The material that follows provides summary information on each of the eight major categories outlined in the table above.

Marine Biotechnology

Sea Grant's marine biotechnology program is new. The limited commercial impacts reflect its infancy. However, the future dividends from the novel marine substances already discovered by Sea Grant is expected to be substantial. For example, Sea Grant's work on anti-inflammatory marine drugs for the treatment of arthritis could reap sales in excess of \$200 million. Scientists extracting biomedicinals from tropical marine algae identified marine substances with potent cytotoxicity to cancer cells. Extracts from a red algae that is structurally identical to potent immunohormones that sell for \$4,000 per milligram will be available in gram quantities. Patents on assemblages of bacteria that efficiently metabolize and detoxify chlorinated hydrocarbons, phenols and other compounds have been licensed for effluent cleanup with a projected \$10 million market.





Sea Grant has sponsored long-term research to find applications for chitin and chitosan, natural polymers derived from marine shellfish wastes. Many patents have been awarded to Sea Grant scientists, and some are now licensed to commercial firms. Although the commercialization of this technology is just beginning, a recent forecast projected the impending U.S. market at \$335 million. Sea Grant's research on surgical sutures and wound-healing medications could reach \$100 million. New uses for chitosan are being found in water quality applications and agriculture.

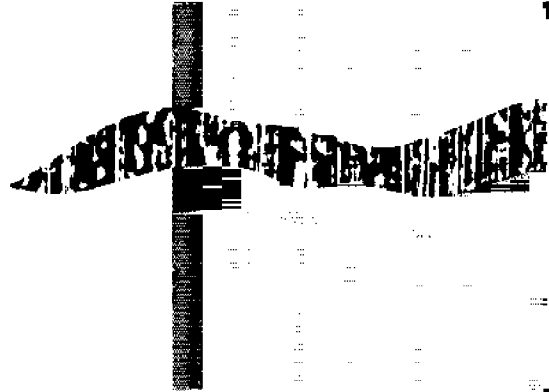
Currently, Sea Grant's biotechnology research on sludge detoxification, shellfish disease, anti-fouling substances and marsh grass control has resulted in a \$14 million gain.

| | |
|---|----------------------|
| Anti-fouling technology | 3,000,000 |
| Oil field sludge detoxification | 7,000,000 |
| Lobster disease control | 2,000,000 |
| Marsh grass control | 1,770,000 |
| SUBTOTAL | \$ 13,770,000 |

Anti-fouling technology

8
—

| | |
|------------------|---|
| CHALLENGE | Reduce the industrial costs from bio-fouling and scaling caused by marine organisms. |
| SOLUTION | Identified and isolated biologically safe and effective substances that inhibit calcium carbonate deposition. |
| IMPACT | Four patents have been awarded for these inhibitor materials that could |



reduce the industry bill for anti-scaling compounds from \$1 billion to \$16 million. A new \$3 million business corporation has been created to produce nontoxic and biodegradable water treatment products based on these discoveries.

SOURCE Mississippi/Alabama, South Carolina

Oil field sludge detoxification

CHALLENGE Detoxify oil field sludge in waste storage pits.

SOLUTION Isolated bacteria that are efficiently adapted to metabolizing toxic components of oil field sludge. These microbes can be immobilized on a solid particulate substrate for surface dispersal on sludge pits.

IMPACT Pilot-scale tests showed this technology to be efficient in breaking down oil field toxic compounds without harmful side effects. A firm is applying this technology to the Old Inger Superfund site, an application that yields savings of \$7 million over other technology.

SOURCE Louisiana

Lobster disease control

CHALLENGE Reduce the economic loss resulting from disease-related mortality of lobsters temporarily held in pounds.

SOLUTION Researched the bacterial disease



"gaffkemia," and succeeded in developing the first effective FDA-approved drug for crustaceans.

IMPACT Development of lobster feed medicated with the anti-gaffkemia drug significantly reduces mortality and saves lobstermen more than \$2 million a year.

SOURCE Maine/New Hampshire

Marsh grass control

CHALLENGE Control the spread of the undesirable marsh grass, *Phragmites australis*, in an economical manner.

SOLUTION Sponsored basic plant cell research to understand the mechanisms of chemical control of *Phragmites*, a common grass that chokes out grasses more favorable to maintaining productive aquatic habitat. Based on these findings, the herbicide application timing was changed. Now, 94 percent effective control is achieved compared to the previous rate of 59 percent.

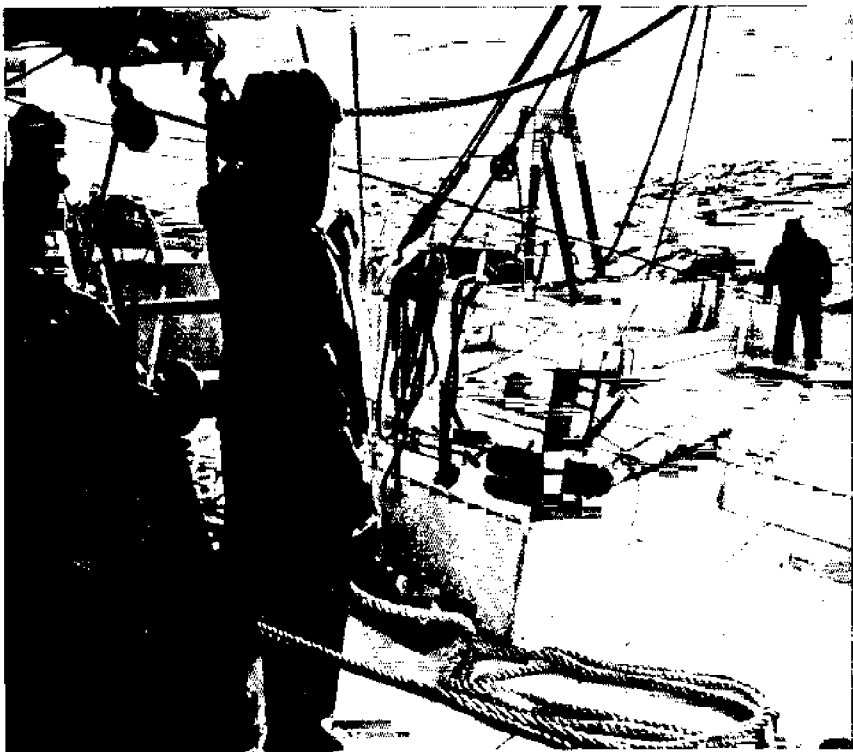
IMPACT The reduced frequency of application saves \$1.77 million per year in coastal spraying.

SOURCE Delaware

Commercial Fisheries

Sea Grant research and extension activities develop and expand commercial fisheries and improve the management of scarce fishery resources. World fishery stocks are being harvested near their maximum level. Consequently, resource information becomes a critical commodity. Many Sea Grant efforts are aimed at developing techniques for predicting short-term (interannual) and long-term (interdecade) resource availability. Expectations about resource availability have a substantial impact on investment decisions throughout the fishing industry.

During the next decade, Sea Grant research in fisheries oceanography should provide effective means for enhancing overexploited stocks. Sea ranching, for example, holds





the promise of expanding, rather inexpensively, natural production for highly valued species such as salmon, striped bass and reef fishes. Restoring wetlands and revegetating coastal waters with appropriate submerged aquatic plants offer the possibility of enhancing depleted estuarine fish and shellfish stocks.

Sea Grant's assistance in increasing the productivity of the commercial fishing industry resulted in a \$167 million impact in 1987. This was achieved through more efficient resource utilization, technology development and seafood industry diversification.

| | |
|-------------------------------|-----------------------|
| Soft-shell blue crab industry | 21,175,000 |
| Underwater obstructions | 20,600,000 |
| Fishing vessel fuel savings | 1,185,000 |
| Reopen shellfishing waters | 1,150,000 |
| East Coast oyster industry | 1,440,000 |
| Tuna and shark fisheries | 750,000 |
| Herring export fishery | 2,250,000 |
| Bluefin tuna handling | 2,500,000 |
| Gulf finfish resources | 23,000,000 |
| Shrimp industry trawl nets | 3,500,000 |
| Fishing technology adoption | 1,000,000 |
| Fishing gear selectivity | 10,000,000 |
| Eel fishery | 250,000 |
| Hard clam relay | 750,000 |
| Bay scallop fishery | 250,000 |
| Ocean quahog fishery | 2,400,000 |
| Deep water red crab fishery | 2,800,000 |
| Sea urchin fishery | 161,700 |
| Pollock fishery trawl | 72,000,000 |
| SUBTOTAL | \$ 167,161,700 |



Soft-shell blue crab industry

CHALLENGE Increase the economic return to the stagnating blue crab fishery by boosting production of the high value soft-shell product.

SOLUTION Sponsored a national research program that developed efficient crab shedding systems using innovative biological filters to reduce mortality and chemicals to control molting cycles; devised a successful national extension program to transfer this technology to the Atlantic and Gulf Coast blue crab fishermen.

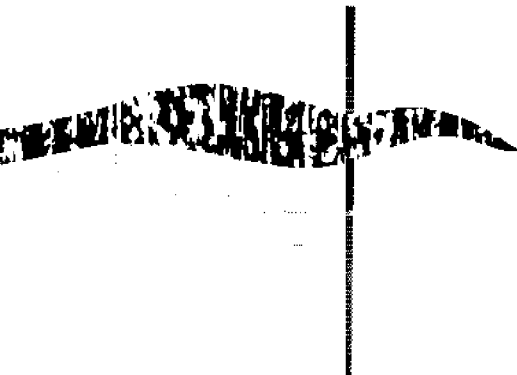
IMPACT Soft-shell annual production is estimated to have reached more than \$21 million in 1987, a growth that added employment and raised the status of many marginal jobs in the blue crab industry.

SOURCE Louisiana, Maryland, North Carolina, New Jersey, Mississippi/Alabama, Virginia, Florida, Georgia

Underwater obstructions

CHALLENGE Reduce fishing vessel and equipment damage from unseen bottom obstructions.

SOLUTION Collected information from the fishing and offshore oil industries on the location and type of underwater obstructions; produced publications with LORAN coordinates of the obstruc-



tions and disseminated this information to boat captains.

IMPACT

Estimated savings to Gulf and South Atlantic fleets from reduced gear loss and lost fishing time is \$20.6 million annually.

SOURCE

North Carolina, Texas

Fishing vessel fuel savings

CHALLENGE

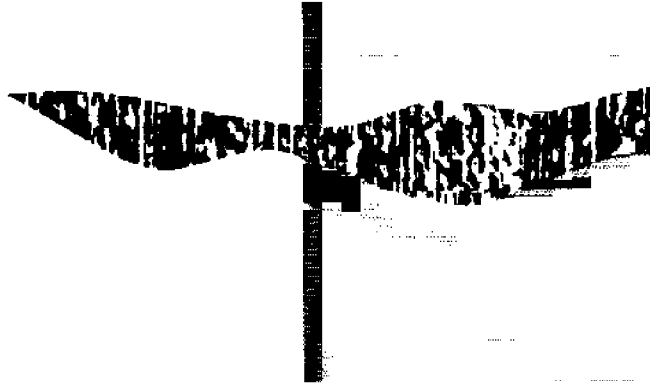
Mitigate the adverse effects of rising operating costs on the commercial fishing industry.

SOLUTION

Engineered a propulsion system that uses low-cost liquefied natural gas (LNG) and incorporates the recovery of refrigeration from the cryogenically stored LNG. Extension agents evaluated the energy-saving potential of new fishing technology and provided



Alaska Sea Grant College Program



industry with technical assistance for fuel-saving conservation.

IMPACT

As shrimp vessels adopt the LNG system, they can reduce operating costs by \$50,000 per vessel. Further fuel savings were realized from recommended use of more efficient trawl doors, self-polishing paints and re-pitched propellers. Total fuel cost savings of approximately \$1.2 million were realized in 1987.

SOURCE

Mississippi/Alabama, Texas, California

Reopen shellfishing waters

CHALLENGE

Reopen large acreages of waters closed to shellfishing due to contamination by pathogens.

SOLUTION

Developed a research program to find reliable, low-cost techniques to measure pathogen levels and depuration rates. Scientists designed a computer model to predict pathogen concentrations from environmental data. This enabled regulatory agencies to set less restrictive regulations for shellfish harvest closures.

IMPACT

By temporarily opening shellfish waters during times when pathogens are absent, fishermen realized a net increase of \$1.15 million in income.

SOURCE

California, North Carolina



East Coast oyster industry

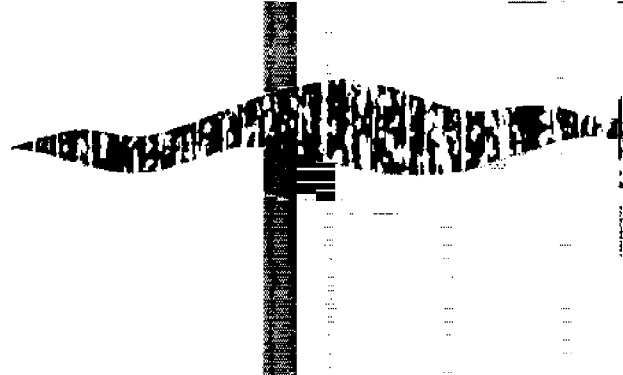
- CHALLENGE** Restore the economic health of the East Coast oyster industry.
- SOLUTION** Supplied the industry with the results of long-term research on oyster spat and nutrition, upgraded hatchery techniques and produced a manual on product quality standards.
- IMPACT** Research led to increased oyster plantings worth \$840,000 this year; increased harvests from better larval survival and improved product quality yielded an additional \$600,000.
- SOURCE** Maryland, Florida, New York

Tuna and shark fisheries

- CHALLENGE** Enlarge the fishery for underutilized tuna, shark and local reef species.
- SOLUTION** Identified problems and provided technical assistance to fishermen, fish processors and retail outlets.
- IMPACT** Sales of these species, fresh and processed, have raised the income of fishermen and retailers by \$2.25 million over the last three years.
- SOURCE** Puerto Rico

Herring export fishery

- CHALLENGE** Increase the capacity of the domestic fishing industry to harvest Northwest Atlantic herring stocks previously fished predominately by foreign fleets.



SOLUTION Provided New England fishermen the technical aid needed to adapt economically efficient European pair trawling techniques for catching herring.

IMPACT Eighteen vessels successfully entered the fishery after adopting the pair trawling technique, producing a \$2.25 million annual export fishery.

SOURCE Rhode Island

Bluefin tuna handling

CHALLENGE Improve the product quality of fresh bluefin tuna through better at-sea and dockside handling practices.

SOLUTION Produced state-of-the-art tuna handling information and distributed it to tuna fishermen and dealers.

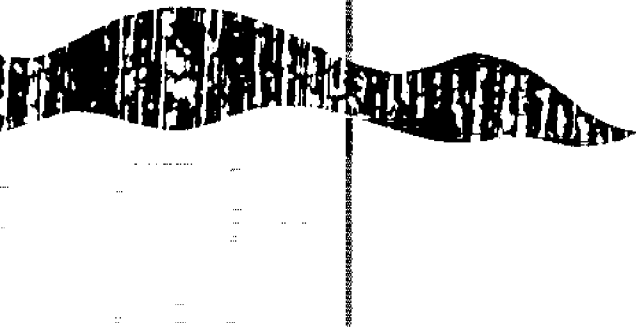
IMPACT Tuna fishermen and dealers who adopted these handling techniques report that the increased product quality resulted in higher revenues of about \$2.5 million annually.

SOURCE Massachusetts, New York

Gulf finfish resources

CHALLENGE Expand industry capacity to exploit the finfish resources of the northern Gulf of Mexico.

SOLUTION Pursued a research program to understand the population dynamics, life history and abundance of selected fin-



fish species; provided technical assistance to the industry on gear development and processing.

IMPACT Increased utilization of finfish stocks boosted the annual landed value by over \$23 million since 1982.

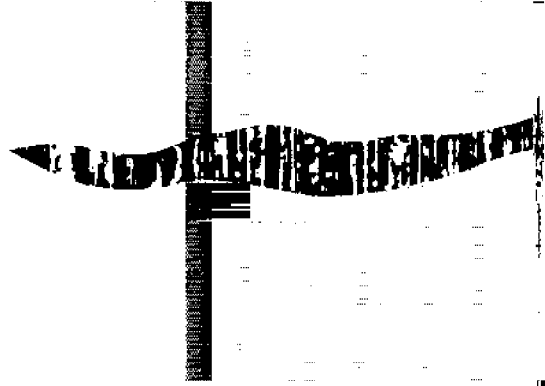
SOURCE Louisiana

Shrimp industry trawl nets

CHALLENGE Design a trawl device that reduces sea turtle mortality and minimizes the costs to the shrimping industry.

SOLUTION Encouraged netmakers to develop an efficient, less costly turtle excluder device (TED) than was available. With Sea Grant assistance, a netmaker de-





signed and built a soft TED that met federal standards.

IMPACT The economical soft TED has been certified for use, saving the industry an estimated \$3.5 million per year over the more costly alternatives.

SOURCE Georgia, North Carolina, Florida

Fishing technology adoption

CHALLENGE Improve the rate of adoption of technological innovations in the fishing industry.

SOLUTION Developed annual fishing industry forums that proved to be successful in giving fishermen fast access to the newest technology and latest resource information.

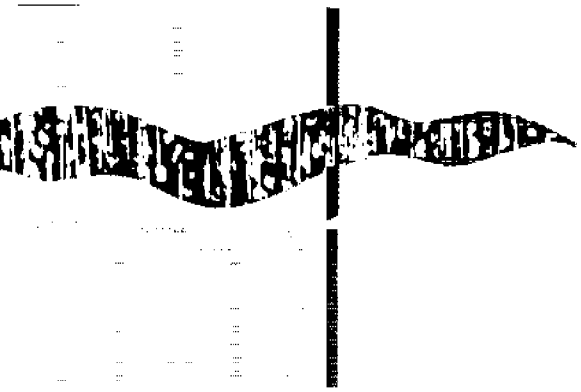
IMPACT As a result of a 1987 North Carolina forum, fishermen invested more than \$1 million in the newest fishing technology. Forums started under Sea Grant leadership are now managed by fishermen's associations.

SOURCE North Carolina

Fishing gear selectivity

CHALLENGE Maintain the long-term yield of fisheries by reducing the mortality of juvenile fish caught incidentally to targeted species.

SOLUTION Began a gear research program based on species selectivity and rigged a separator trawl net for commercial



shrimpers. Performance tests show a juvenile finfish separation rate of 90 percent and a shrimp retention rate of 95 percent.

IMPACT The economic return for having juvenile fish grow to a harvestable size reaches \$10 million and above in just the finfishery. Gear that separates species also enhances product quality by reducing crushing from excessive weight in the net.

SOURCE Maine/New Hampshire

Eel fishery

CHALLENGE Develop new fisheries for nontraditional resources.

SOLUTION Initiated biological investigations on the deep water eel resource and provided extension support for processing the product for domestic and foreign markets.

IMPACT Landed value of this young fishery is \$250,000 with the added benefit of no recreational or environmental conflicts.

SOURCE Florida

Hard clam relay

CHALLENGE Reduce the 30 percent mortality loss that occurred when relayed clams were placed unprotected in new beds.

SOLUTION Demonstrated that steel cages for



hard clam relay offered advantages over the traditional method of direct bottom placement.

IMPACT The cage method reduced losses to an acceptable 5 percent. The added clam harvest translates into an estimated additional \$750,000 annually.

SOURCE Virginia

Bay scallop fishery

CHALLENGE Improve the yield of the bay scallop fishery.

SOLUTION Studied scallop growth at various locations and determined that meat yield increases by 10 to 60 percent during October.

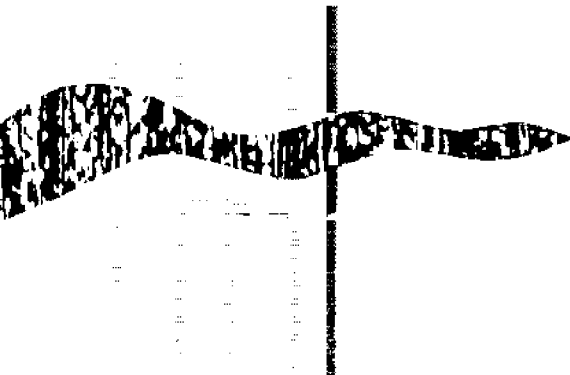
IMPACT Several towns postponed the opening of scallop season from October 1 to November 1, increasing income to bay scallop fishermen by \$250,000 annually.

SOURCE Massachusetts

Ocean quahog fishery

CHALLENGE Shift fishing capacity to the underutilized ocean quahog to broaden the industry's economic footing.

SOLUTION Directed gear research that enabled fishing vessels to convert economically to efficient hydraulic harvesting technology. In addition, Sea Grant provided technical assistance on proper handling methods.



IMPACT The harvest of ocean quahogs in the Gulf of Maine has increased tenfold this decade, presently yielding a landed value of \$2.4 million. In addition, it has taken pressure off the lobster and scallop fisheries.

SOURCE Maine/New Hampshire

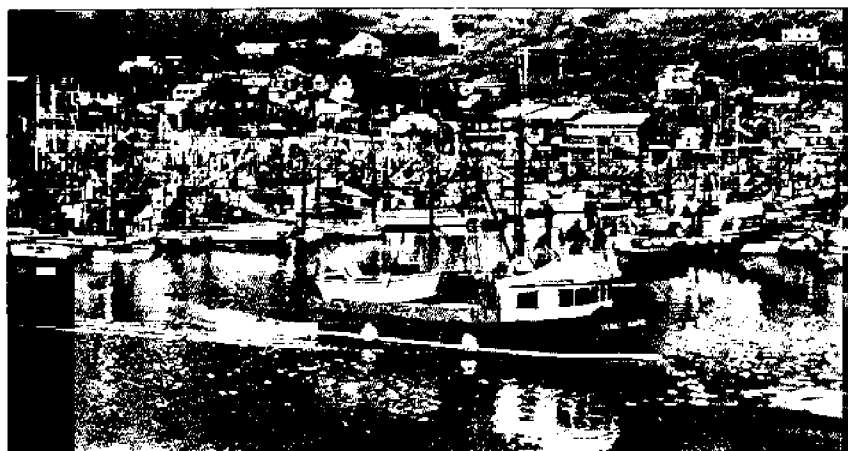
Deep water red crab fishery

CHALLENGE Develop the fishing technology to harvest deep water red crabs, an abundant but unexploited resource.

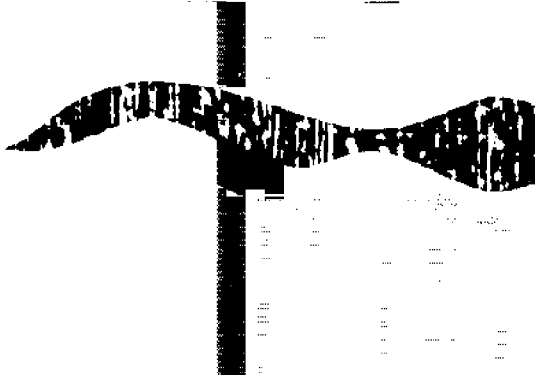
SOLUTION Pioneered the technology for the industry to harvest this resource off the coast of New England.

IMPACT The red crab fishery added \$2.8 million a year to the revenues of the New England fleet. In addition, a mid-Atlantic fishery is developing.

SOURCE Rhode Island



Alaska Sea Grant College Program



Sea urchin fishery

- CHALLENGE** Develop new economic opportunities for small-boat fishermen.
- SOLUTION** Established a sea urchin fishery based on results from resource surveys of sea urchin beds, the evaluation of the roe potential and research on efficient processing methods.
- IMPACT** In 1987, five small-boat fishermen harvested 154,000 pounds of sea urchins valued at \$161,700; for 1988, an increase of 50 percent is expected.
- SOURCE** Alaska

Pollock fishery

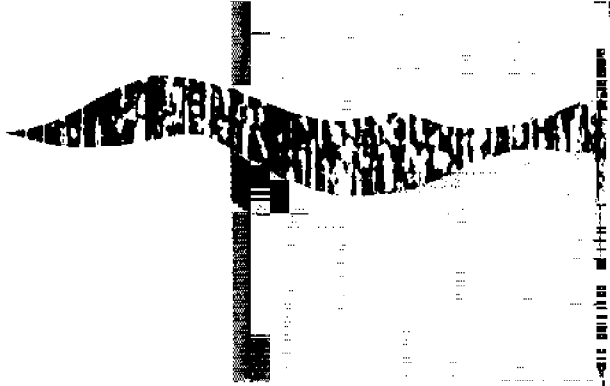
- CHALLENGE** Develop and test new gear designs to facilitate the expanded harvest of the domestic fishing industry.
- SOLUTION** Cooperated with a net manufacturer to design a midwater trawl that could be operated in waters less than 30 fathoms. Successful Sea Grant gear tests at the David Taylor Research Center opened up a major fishery for pollock in the Bering Sea.
- IMPACT** Wide acceptance of this midwater trawl amounted to sales of \$2 million in 1987. Furthermore, the economic success of several U.S. joint-venture operations, worth \$70 million, depends on this new trawl design.
- SOURCE** Massachusetts

Seafood Processing

Sea Grant's research in seafood science and technology enhances the competitiveness of the domestic fishing industry through improvement in processing technology, development of new products and byproducts, and assurance of seafood safety and quality. These issues are pertinent to expanding domestic and foreign markets for U.S. seafood products. Fish resources off the coasts of the United States are a major portion of the world's total. Yet the United States imports more than 60 percent of the seafood it consumes. In fact, the U.S. trade deficit in seafood was over \$4 billion in 1987.



Oregon Sea Grant College Program



The ability to capture a larger share of domestic and foreign markets depends in part on technological advancements. Sea Grant's research represents a significant source of innovations in seafood technology. It has been important to the industry because most fish processing companies are small with limited capability for research. The development of Sea Grant programs in seafood science also upgrades technology through the students it trains for industrial careers.

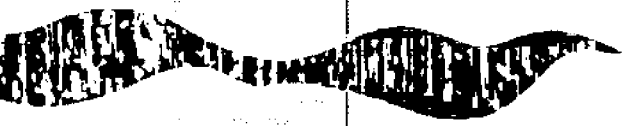
Through Sea Grant efforts to expand the economic base of the seafood processing industry, the annual aggregated economic impact amounted to \$18 million, including several successful examples of helping industry penetrate overseas markets.

| | |
|--|----------------------|
| Seafood product quality | 10,125,000 |
| Seafood processing wastes | 505,000 |
| Export of soft-shell blue crab | 4,000,000 |
| Tuna exports | 530,000 |
| Surimi production | 1,275,000 |
| Smoked fish processing | 1,000,000 |
| Menhaden food products | 135,000 |
| SUBTOTAL | \$ 17,570,000 |

Seafood product quality

- CHALLENGE** Increase seafood industry competitiveness by improving product quality.

- SOLUTION** Conducted a national research and technical assistance program to better seafood quality and safety by developing new onboard handling technologies, finding innovative methods for



preserving fish and extending shelf life, reducing costly spoilage, increasing byproduct recovery, determining critical processing quality control points and helping industry install rigorous sanitation standards.

IMPACT

The impacts on the seafood industry have included development of at-sea storage, improved pasteurization, vacuum and modified-atmosphere packaging, and sanitation control. In 1987, it's estimated that Sea Grant research, technology development and extension efforts yielded the industry more than \$10 million from waste reduction, product quality dividends and expanded markets once hindered by spoilage problems.

SOURCE

Maryland, Louisiana, Florida, Texas, Virginia, North Carolina, Wisconsin, Georgia

Seafood processing wastes

CHALLENGE

Find inexpensive alternatives for the disposal of wastes in the seafood processing industry.

SOLUTION

Worked to find acceptable disposal alternatives. These included manufacturing fertilizers and feed stocks from fish wastes, extracting food-grade by-products and developing environmentally sound direct-discharge practices.

IMPACT

Sea Grant developed disposal methods that generated marketable



products and reduced unwarranted regulatory costs. In 1987, a partial estimate of cost savings amounted to \$505,000.

SOURCE Wisconsin, Louisiana, Georgia, Florida

Export of soft-shell blue crab

CHALLENGE Expand export markets for American soft-shell blue crabs.

SOLUTION Participated in trade shows to boost market penetration of soft-shell blue crab products worldwide. Substantial and stable supplies of a quality product are possible because of Sea Grant advances in shedding technology.

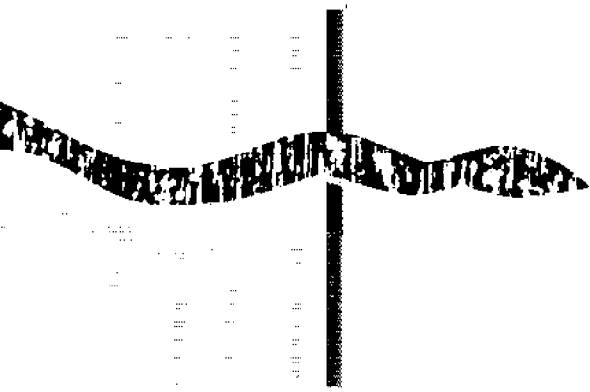
IMAGE The development of export markets for soft crabs opened a new source of revenue to complement its strong domestic market. The export market is now valued at approximately \$4 million annually.

SOURCE Virginia

Tuna exports

CHALLENGE Enable the fishing industry to realize the full value from available tuna resources.

SOLUTION Informed fishermen about the availability of satellite technology to locate tuna and provided research on quality and handling techniques required to penetrate the Japanese fresh fish market.



IMPACT In 1987, landings reached 783,000 pounds, resulting in a net gain to the fishermen of \$530,000. A North Carolina firm exported product to Tokyo where prices reach \$12 per pound.

SOURCE North Carolina

Surimi production

CHALLENGE Develop commercial products from the tons of fish now wasted by discarding underutilized and undervalued fish.

SOLUTION Organized a research program to understand the basic characteristics of fish flesh and to develop mechanisms for using minced fish in seafood and analog products; produced surimi, a fish paste, from species of commercially undesirable fish.

IMPACT Based on Sea Grant research findings, a company built a \$4 million surimi facility in North Carolina. The plant employs almost 60 people with an annual payroll of more than \$1.2 million.

SOURCE North Carolina

Smoked fish processing

CHALLENGE Help the industry produce a quality smoked fish product given increasingly stringent processing regulations.

SOLUTION Studied plant operations and developed technical procedures to comply with salt and moisture content rules for processing smoked fish.

IMPACT Added approximately \$1 million per year to the gross earnings of smoked fish processors.

SOURCE Wisconsin

Menhaden food products

CHALLENGE Add value to the menhaden fishery by converting it to an edible food product.

SOLUTION Initiated a research program to test the possibility of converting menhaden, a high volume, low value fish processed into industrial products, to surimi, a fish paste used to make seafood analogs.

IMPACT Based on Sea Grant research, the first commercial menhaden surimi plant in the world is being built. The \$2 million plant (\$135,000 amortized value over 15 years) offers tremendous potential for improving the economic return to the menhaden fishery.

SOURCE North Carolina

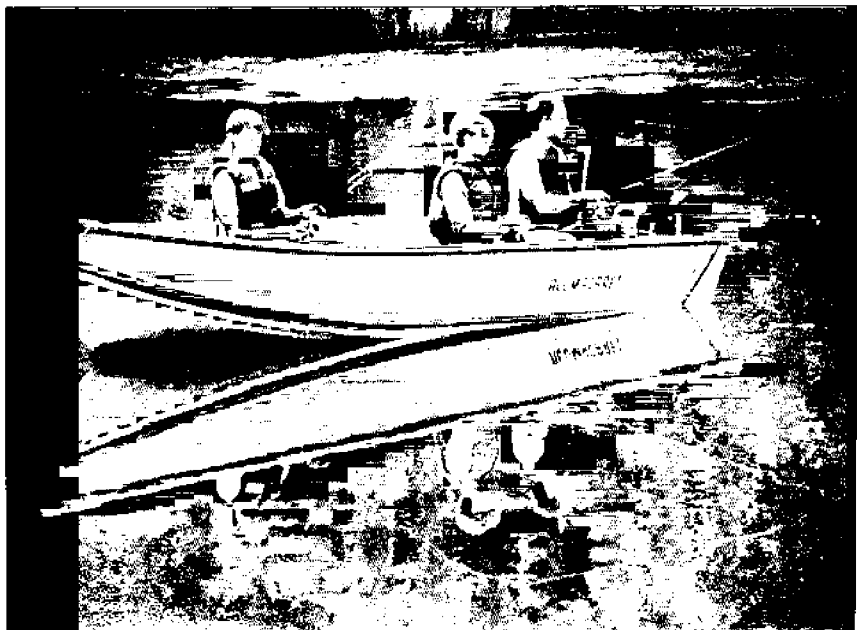


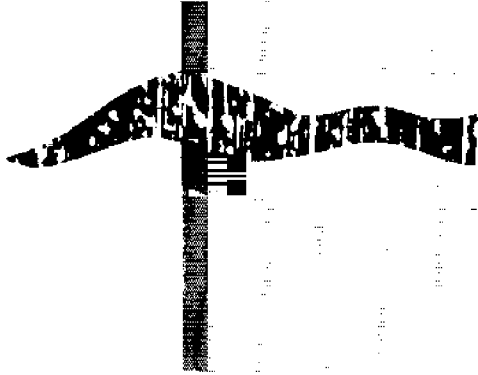
Alaska Sea Grant College Program

Marine Recreation and Tourism

Sea Grant's efforts to expand coastal recreation and tourism increased the level of economic activity \$321 million. Much of this effort, from the salmonid fishery to charter boating and tourism development, occurred in the Great Lakes, broadening the economic base of many coastal communities.

The development of the salmonid fishery in the Great Lakes is a noteworthy Sea Grant success story. It began 20 years ago when Sea Grant initiated a research program on the West Coast to determine why hatchery-produced salmon were failing to return to their rivers of origin in the Pacific Northwest. From these pioneering studies on homing and chemical imprinting, Sea Grant developed reliable artificial imprinting techniques. Also, research on the salmon's smolt life stage led to improved hatchery production. Today these innovations provide the





basis for commercial salmon ranching and salmon pen culture.

But this research also found an unexpected application. While studies continued on the West Coast, Sea Grant initiated cooperative studies with state fishery agencies to introduce Pacific salmon into the Great Lakes. The outcome was the establishment, first in Lake Michigan, of coho and chinook salmon stocks as desirable replacements for depleted indigenous species. This achievement was repeated in other Great Lakes as Sea Grant worked alongside state, federal and Canadian fishery managers to support this valuable recreational fishery. Sea Grant improved hatchery and conservation practices. It also organized extension efforts across the Great Lakes to advise communities and businessmen interested in developing increased access to the fishery. Sea Grant's leadership in disseminating research quickly and extensively is one hallmark of the program that few other research programs can mirror.

| | |
|--|-----------------------|
| Great Lakes salmonid fishery | 300,000,000 |
| Coastal recreation development | 6,412,500 |
| Great Lakes tourism industry | 7,562,000 |
| Plastic debris awareness | 1,900,000 |
| Perch fishery rehabilitation | 2,000,000 |
| Artificial reef development | 1,200,000 |
| Shipwreck preserves | 2,000,000 |
| SUBTOTAL | \$ 321,074,500 |

Great Lakes salmonid fishery

CHALLENGE Rebuild quality recreational fishing in the Great Lakes by establishing and



maintaining the hatchery-stocked salmon and trout fish populations.

SOLUTION

Transferred results from Sea Grant's long-term Pacific salmonid research program on artificial imprinting, hatchery production and genetics to the Great Lakes; sponsored new research to analyze predator-prey interactions, estimate forage base demands, develop acoustic assessment technologies and evaluate management options; provided technical assistance in hatchery operations, salmonid management and recreational fishery development.

IMPACT

Nonexistent 20 years ago, the stocked salmon and trout Great Lakes recreational fishery contributes approximately \$2 billion a year to the Great Lakes economy. An arbitrary, but conservative estimate might justifiably attribute 15 percent of this total to Sea Grant.

SOURCE

Wisconsin, Michigan, New York, Minnesota

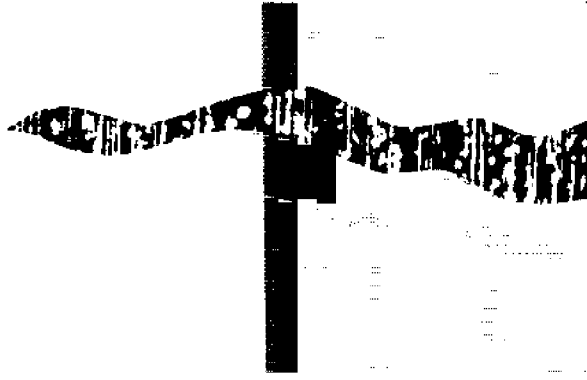
Coastal recreation development

CHALLENGE

Expand the public's access to coastal recreation opportunities.

SOLUTION

Worked with coastal community planners to assess recreational facilities, infrastructure and service needs; aided communities in planning capital investment programs for recreation



development; and helped recreation industry officials to organize trade marketing associations.

IMPACT

Coastal communities and businesses spurred on by Sea Grant are investing over \$50 million in new facilities (1987 amortized value of \$4,125,000) to increase coastal recreation opportunities.

SOURCE

Puerto Rico, Texas, New York, Oregon

Great Lakes tourism industry

CHALLENGE

Expand the Great Lakes coastal tourism industry.

SOLUTION

Undertook demographic research that revealed sizable untapped potential; conducted business development education programs for aspiring entrepreneurs wanting to start coastal recreation and tourism businesses.

IMPACT

Sea Grant's efforts were identified as being integral in decisions to start new coastal businesses that added \$7.5 million to Great Lakes tourism in 1987. An estimated \$16 million to \$18 million in new ventures that Sea Grant fostered are being developed.

SOURCE

Minnesota, Illinois/Indiana, Ohio

Plastic debris awareness

CHALLENGE

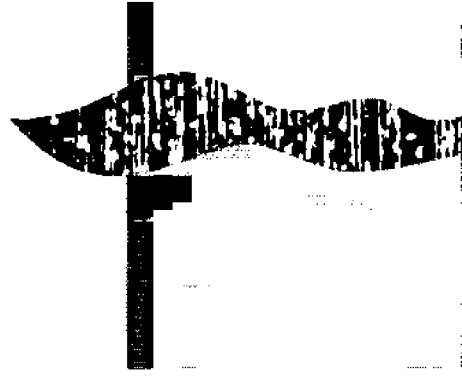
Protect the ocean recreation and tourism industry through increased community awareness of beach debris and conservation practices.



- SOLUTION** Developed an education program on the harmful effects of ocean and coastal litter, especially from plastics. Sea Grant agents helped communities organize awareness and volunteer programs, including beach adoption and cleanups.
- IMPACT** Coastal communities in three states report saving \$1.9 million in beach cleaning costs. More importantly and of inestimable value, the education programs have heightened public interest in ocean pollution problems.
- SOURCE** Puerto Rico, North Carolina, Florida

Perch fishery rehabilitation

- CHALLENGE** Rehabilitate perch stocks and double the combined Green Bay recreational and commercial catch by 1991.
- SOLUTION** Established a research program that included fishing gear technology, life-history and abundance studies, and bioeconomic modeling to forecast stocks.
- IMPACT** Rehabilitation is expected to increase the commercial perch fishery by 40 percent and double the recreational catch by 1991. In 1987, net economic benefits from rehabilitation exceeded \$2 million and are expected to total \$16 million through 1995.
- SOURCE** Wisconsin



Artificial reef development

CHALLENGE Expand sport fishing access through the rational development of artificial reefs.

SOLUTION Implemented a scientific research program to plan and monitor the placement of offshore fishing reefs; provided extension support to community groups organizing construction efforts.

IMPACT Artificial habitats are being placed more rationally. Approximately \$1.2 million in donated reef materials and volunteer support were generated.

SOURCE Florida, Ohio

Shipwreck preserves

CHALLENGE Utilize shallow-water shipwrecks in the Great Lakes to expand recreational opportunities.

SOLUTION Provided educational programs that led to the dedication of wreck sites as underwater preserves. This stimulated the growth of shipwreck diving businesses and support services.

IMPACT Six underwater preserves have been established. One community reports \$2 million in new diving business.

SOURCE Michigan

Aquaculture

For 20 years, Sea Grant has led the drive to create a domestic marine aquaculture industry. With a program focused on the science, technology and economic potential of nine different marine species, Sea Grant stimulated new production and increased industry productivity by \$92 million in 1987. But it is just the beginning. Research currently underway will lead to even more significant improvements. Sea Grant efforts to improve hatchery production technologies, to control organisms' life cycles, and to check disease will allow aquaculture to become a major source of seafood in the United States.

Disease control, for example, is a promising research area. Recombinant DNA technology was used to find vaccines that are effective against viral diseases in salmonids. The vaccines, which are under patent application, have reduced mortality up to 80 percent, saving the



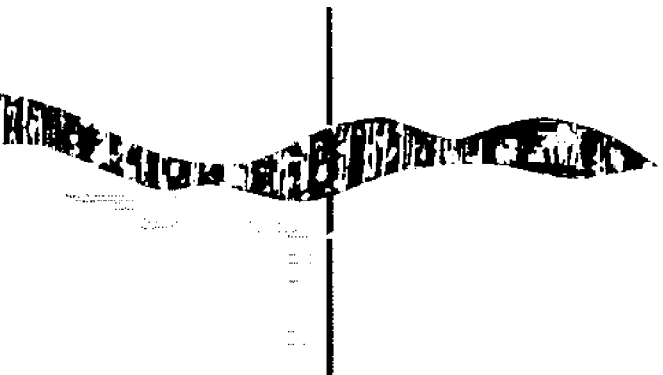


aquaculture industry millions of dollars. Genetic probes are being developed for rapid detection of shrimp viral diseases that have caused the failure of several U.S. shrimp aquaculture companies. Another path of attack on disease is through research to cultivate disease-resistant brood stock. For example, work on East Coast oysters has led to artificially bred strains resistant to the two most damaging oyster diseases.

Some barriers to commercial production are institutional rather than technical. Sea Grant is coordinating a national effort to standardize and simplify laws and regulations pertaining to aquaculture. Resolving permit and regulatory problems will facilitate more commercial ventures.

The following suggests some of the ways Sea Grant has spurred development of the U.S. aquaculture industry.

| | |
|-------------------------------|----------------------|
| Crawfish aquaculture industry | 41,260,000 |
| Tropical aquaculture | 17,600,000 |
| Blue mussel culture | 2,300,000 |
| Hybrid striped bass | 300,000 |
| Shrimp aquaculture | 2,870,000 |
| OTEC aquaculture | 650,000 |
| Sturgeon aquaculture | 2,000,000 |
| Hard clam culture | 2,190,000 |
| Salmon hatchery mortality | 250,000 |
| Bivalve larvae survival | 125,000 |
| Shellfish culture technology | 3,000,000 |
| Pacific oyster culture | 20,000,000 |
| SUBTOTAL | \$ 92,545,000 |



Crawfish aquaculture industry

CHALLENGE Develop the economic potential of the crawfish aquaculture industry.

SOLUTION Built a crawfish aquaculture research program that has emphasized research on pond production, feed nutrition, water quality, disease elimination and predation control; closely coupled this research with an extension program.

IMPACT Crawfish aquaculture pond acreage has quadrupled to 125,000 acres during the 15-year period that Louisiana Sea Grant has been nurturing the industry. In 1987, 100 million pounds of crawfish valued at \$40 million were produced and an additional \$800,000 in new soft-shell crawfish production was realized. Recently, South Carolina Sea Grant introduced this technology in their region with early production reaching \$460,000.

SOURCE Louisiana, South Carolina

Tropical aquaculture

CHALLENGE Stimulate the development and growth of tropical aquaculture.

SOLUTION Provided over two decades of research and extension support for all commercial species, including prawns, tilapia, marine shrimp, and microalgae.

IMPACT In Hawaii, aquaculture production grew 25-fold in the 1980s and contrib-



uted \$6.3 million in product value in 1987. In Puerto Rico, development of aquaculture is focused on small-scale farmers who generated \$5 million in sales over the last five years. A second important Sea Grant spinoff is the emergence of Hawaii as a major international center for tropical aquaculture research and development firms that add some \$10 million in economic activity.

SOURCE Hawaii, Puerto Rico

Blue mussel culture

CHALLENGE Increase production of the cultured blue mussel.

SOLUTION Inaugurated a research program in the early 1970s that has led to a healthy commercial industry. Current research on mussel recruitment is addressing the industry's need for a stable supply of seed mussels.

IMPACT The blue mussel is rapidly becoming a high quality consumer product in the U.S. with production of 6 million pounds worth \$2.3 million. As demand increases and a steady seed supply found, production could quickly grow to \$30 million.

SOURCE Maine/New Hampshire

Hybrid striped bass

CHALLENGE Address the problem of insufficient seafood supplies for fisheries limited



by declines in natural stocks.

SOLUTION

Initiated a research program to develop a fast-growing, high-value hybrid striped bass for commercial culture; transferred scientific results to potential growers through extension demonstration programs.

IMPACT

A North Carolina producer has marketed 100,000 pounds of hybrids with a value of over \$300,000; several other growers are set to enter the industry.

SOURCE

North Carolina

Shrimp aquaculture

CHALLENGE

Develop penaeid shrimp aquaculture as a viable commercial industry.

SOLUTION

Established a long-term research program that transferred the latest scientific results on penaeid shrimp culture technology to commercial pond and hatchery operators.

IMPACT

Full data are not available, but information from three firms indicate annual production of over 500 tons of shrimp worth \$2.87 million at the producer sales level.

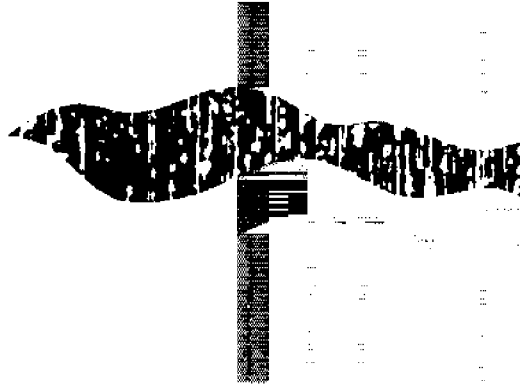
SOURCE

Texas

OTEC aquaculture

CHALLENGE

Demonstrate the technical and economic feasibility of aquaculture using



- ocean thermal energy conversion (OTEC).
- SOLUTION** Initiated a "proof-of-concept" research program under an industry-government partnership. It demonstrated that cold, pure, nutrient-rich deep OTEC water made an ideal medium for the aquaculture of marine protein.
- IMPACT** The result is the development of a rapidly growing, commercially viable OTEC aquaculture industry with production valued at \$650,000 in 1987.
- SOURCE** Hawaii

Hard clam culture

- CHALLENGE** Boost shellfish production through the culture of hard clams to meet increasing demand.
- SOLUTION** Diffused the results of hard clam research through workshops and demonstration projects to potential growers.
- IMPACT** Hard clam culture production increased industry revenues by \$2.19 million as a direct result of Sea Grant research.
- SOURCE** North Carolina, Connecticut

Salmon hatchery mortality

- CHALLENGE** Eliminate the high rates of mortality experienced in some salmonid hatcheries.

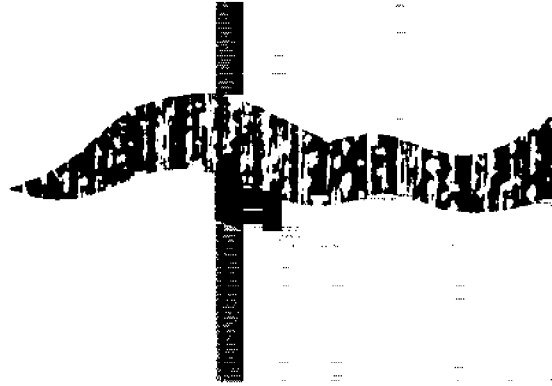
SOLUTION

Determined that high ammonia levels in hatcheries impeded smolting and were the leading cause of costly salmonid mortalities.

IMPACT

Applying these results increased salmon survival. It translated into a \$250,000 savings to one hatchery plus unmeasured benefits to the commercial and recreational fisheries.





SOURCE Rhode Island

Bivalve larvae survival

CHALLENGE Reduce the cost of bivalve hatchery operations by predicting the survival potential of larvae.

SOLUTION Developed an inexpensive lipid staining technique for hatchery use to indicate the health of larvae; acquainted hatchery operators with this technique through educational workshops.

IMPACT Halting the rearing of unfit larvae saved six hatcheries \$125,000 annually.

SOURCE Massachusetts

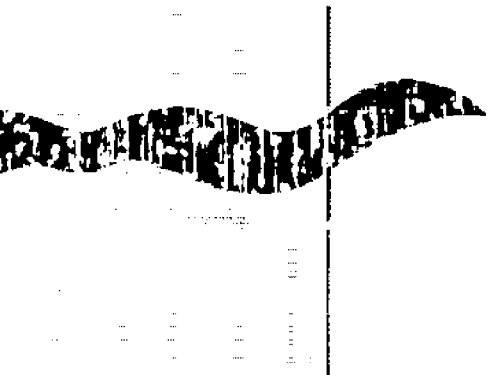
Sturgeon aquaculture

CHALLENGE Reverse the decline of sturgeon and rebuild the once valuable fishery.

SOLUTION Undertook research on the growth and reproduction of sturgeon that led to the development of culture methods and the establishment of a domestic white sturgeon brood stock.

IMPACT California has 10 registered commercial sturgeon operations in the research and development phase. The state is establishing a hatchery for stock enhancement, and gross revenues from sturgeon culture in California is nearly \$2 million.

SOURCE California



Shellfish culture technology

- CHALLENGE** Encourage commercial production of shellfish by adapting foreign culture technology.
- SOLUTION** Combined original research with foreign culture practices to establish new aquaculture enterprises.
- IMPACT** The production of high quality manila clams and mussels accounts for \$3 million in annual sales.
- SOURCE** Washington

Pacific oyster culture

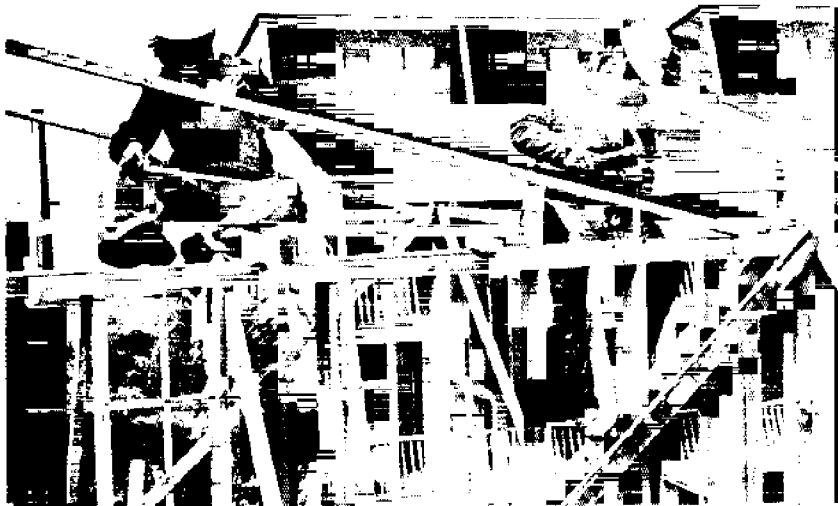
- CHALLENGE** Help revive the Pacific oyster culture industry.
- SOLUTION** Established a program of research, education and technology transfer to focus on oyster hatcheries and improved genetic strains.
- IMPACT** Once beset by failure of native species, the high cost of imported larvae and mortalities, new domestic hatcheries for the Pacific oyster have eliminated dependence on foreign supplies. The combination of inexpensive seed and improved stocks resulted in a \$20 million industry.
- SOURCE** Washington, California

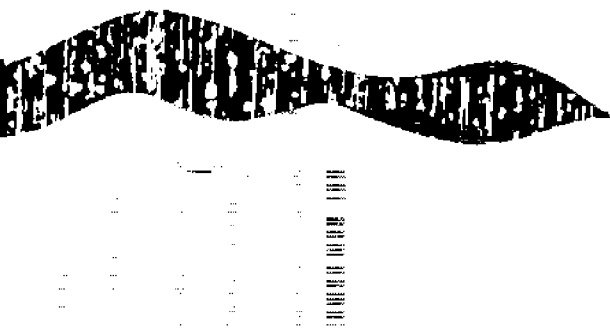
Coastal and Offshore Construction

As people and commerce move to our coastal and Great Lakes shores, pressure mounts to better utilize resources that are already strained. Sea Grant has aided in developing engineering tools that alleviate some of those pressures.

Sea Grant engineering research strives to design innovative and environmentally sound technology for developing coastal and ocean resources. Scientists and extension agents worked to help coastal homeowners build more hurricane-resistant homes, fight erosion, better their drinking water and lessen the environmental threat of their septic wastes.

Research in progress promises even larger dividends for the future of U.S. industry. Sea Grant is engineering a safer and less costly way to extract reliable engineering data on marine soils. A new device, the Piezocone penetrometer, was developed. It is becoming the standard in-





dustry tool for testing foundation soils at offshore structure sites. Sea Grant robotics research is addressing the remote manipulation of underwater vehicles. An inexpensive robot vehicle developed by Sea Grant travels under ice, records environmental or acoustical data on fishery resources, and returns to the mother ship. Another remote-control vehicle can operate in the deep ocean and perform a variety of experimental or observational tasks along the sea floor. As a result of these improvements, new uses for these vehicles are being found in research and commerce.

Recently, Sea Grant scientists engineered a collision-tolerant pile to mark navigational channels. The new system should save the U.S. Coast Guard \$10 million a year in replacement costs for markers lost through ship traffic mishaps.

Currently, activities aimed at environmentally sound, economical, and safe coastal and offshore construction have saved \$91 million.

| | |
|------------------------------|----------------------|
| Marine corrosion prevention | 1,700,000 |
| Beach erosion control | 5,260,000 |
| Coastal habitat preservation | 11,210,000 |
| Hurricane building codes | 50,000,000 |
| Great Lakes flood control | 1,000,000 |
| Coastal pond water quality | 6,000,000 |
| Coastal soils septic systems | 3,800,000 |
| Ice damage control | 1,500,000 |
| Great Lakes drinking water | 725,000 |
| Pile analysis instrument | 10,000,000 |
| SUBTOTAL | \$ 91,195,000 |



Marine corrosion prevention

CHALLENGE Reduce the economic loss from damage to coastal structures through marine corrosion prevention techniques.

SOLUTION Conducted a multi-institutional Sea Grant research effort on the behavior of metals in the marine environment to determine the chemical, metallurgical and biological factors that control localized corrosion and calcareous deposits.

IMPACT Conservative estimates from two colleges that participated in Sea Grant's national corrosion program identified \$1.7 million in annual savings from the use of research findings. The unmeasured savings could be one or more orders of magnitude higher.

SOURCE Delaware, Florida

Beach erosion control

CHALLENGE Restore and maintain rapidly eroding beaches that serve as the primary economic base for the tourism industry.

SOLUTION Directed long-term research to improve the basic understanding of beach erosion and initiated technical assistance programs to transfer efficient engineering and biological protection design principles.

IMPACT Research and extension efforts led to successful erosion control measures



such as the use of improved salt tolerant plants for vegetation cover, dune stabilization practices, and the design of protective structures. An estimate for 1987 points to \$5.26 million in annual savings from methods developed in Sea Grant's beach restoration research.

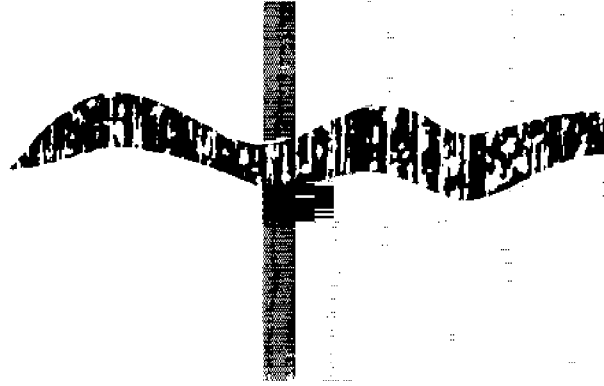
SOURCE Texas, North Carolina, Florida

Coastal habitat preservation

CHALLENGE Develop innovative preservation and mitigation programs to offset damage to coastal habitat.

SOLUTION Worked to develop a 31-acre coastal habitat park in Texas to offset marsh destruction; wrote a mitigation plan for a new 90-acre managed wetland in Ohio to replace 17 wetland acres required for needed economic redevelopment; orchestrated a no-cost transfer of an 18-acre cay, rich in marine habitat diversity, to the U.S. Virgin Island government for scientific and educational programs.

IMPACT The full value of these preservation and mitigation endeavors is unknown. However, one indication is the level of resources committed to restoring or preserving coastal habitats and the economic activity rendered possible through mitigation. On this basis, an estimated value of \$11.2 million is attached to these Sea Grant efforts.



SOURCE Ohio, Texas, U.S. Virgin Islands

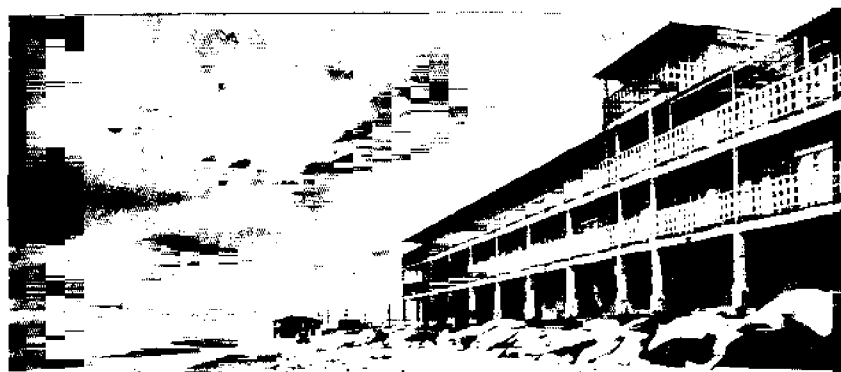
Hurricane building codes

CHALLENGE Reduce coastal property damages resulting from outdated and inadequate building codes in coastal states.

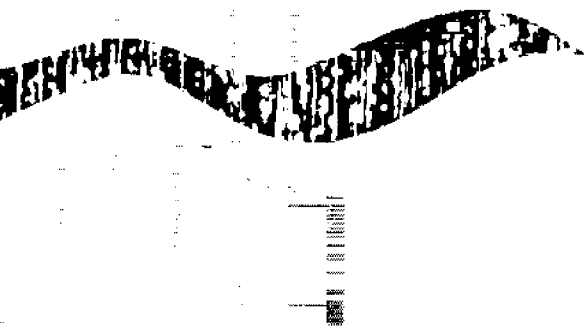
SOLUTION Conducted research on storm-related building damages and construction innovations. Results led to adoption of new building codes for coastal structures.

IMPACT Hurricanes Diana and Alicia were similar in intensity. But when Alicia struck (old building codes in force), the storm damaged 70 percent of the study area buildings. For Diana (new codes), the damages were reduced to less than 4 percent and authorities estimate that \$1.5 billion was saved (a \$50 million per year saving assuming a 30-year storm frequency).

SOURCE North Carolina



University of North Carolina Sea Grant College Program

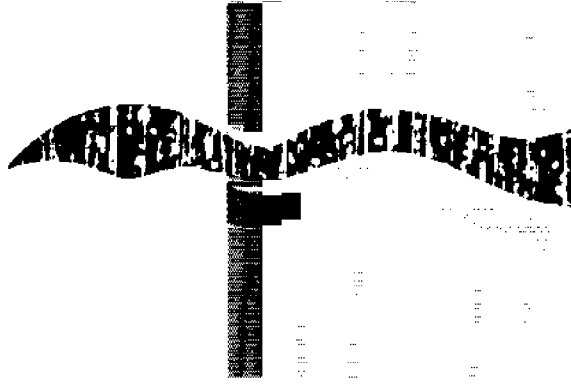


Great Lakes flood control

- CHALLENGE** Reduce flood damages from rising water levels in the Great Lakes that reached a 110-year record in 1986.
- SOLUTION** Provided technical assistance to Great Lakes shoreline residents, municipalities and businesses on effective flood prevention measures.
- IMPACT** Five hundred flood prevention projects were initiated in the Green Bay area alone. Acting upon Sea Grant's advice for preventing storm surge flooding, citizens and businesses avoided a conservatively estimated \$1 million in damages.
- SOURCE** Wisconsin

Coastal pond water quality

- CHALLENGE** Find economically conservative but environmentally effective ways to avoid water quality degradation of coastal ponds.
- SOLUTION** Conducted research on the nitrogen budget of coastal ponds. The results showed that the total nitrogen removed by a proposed sewage system of a nearby town would be minor compared with natural sources of nitrogen.
- IMPACT** Based on the scientific findings, the town abandoned the sewer project in favor of a septic treatment plant and saved \$6 million.



SOURCE Massachusetts

Coastal soils septic systems

CHALLENGE Reduce the contamination of surface waters from inadequate septic systems in coastal areas.

SOLUTION Performed research on coastal soils that led to the development of cost-effective septic systems that were approved and adopted in six states. By using the newly designed septic systems, coastal communities can maintain better surface water quality.

IMPACT One company used the systems in a \$95 million coastal development project (a \$3.8 million amortized value in 1987) that could not have been built without them.

SOURCE North Carolina

Ice damage control

CHALLENGE Develop cost-effective design recommendations for fixed and floating docks subject to Great Lakes ice damage.

SOLUTION Prepared an engineering manual on Great Lakes small-craft harbor and structure design for ice conditions; conducted technical conferences and field analysis.

IMPACT Harbor facility and marina operators reported saving \$1.5 million in maintenance costs and ice damage using



the information contained in the manual.

SOURCE Wisconsin

Great Lakes drinking water

CHALLENGE Provide a low-cost, reliable source of drinking water to rural Great Lakes communities.





- SOLUTION** Demonstrated that water can be induced to flow from the Great Lakes to wells through the lake bed; developed a mapping technique that showed the precise location of permeable lake-bed zones. Research also showed that some lake beds provide sufficient treatment to preclude the need for a filtration plant.
- IMPACT** A rural Wisconsin town is using this technology to plan their municipal water supply. The elimination of the filtration plant and the need to deepen existing wells will save \$725,000.
- SOURCE** Wisconsin

Pile analysis instrument

- CHALLENGE** Assure economical and reliable pile foundations for offshore structures.
- SOLUTION** Developed a new instrument, the Piezo Lateral Stress (PLS) cell, to study pile shaft behavior with greater accuracy than previous methods of analysis.
- IMPACT** The PLS method averts the need for expensive large-scale pile tests by providing more accurate results with less costly, small-scale testing. This technology saved the offshore industry \$10 million in 1987.
- SOURCE** Massachusetts



Marine Trades and Service Industry

As people flock to our shores, our coastal resources become overburdened and overused. But Sea Grant is using advancing environmental technology to better handle some of the burdens and conserve these precious resources.

Remote sensing has potential for application in the private sector and in government. Geographic information systems that integrate remote sensing imagery with conventional environmental data and land-use demographic statistics will allow comprehensive and effective environmental planning and monitoring. Sea Grant research to develop effective sensors and powerful techniques for analyzing remote sensing information will lead to more timely management of living and nonliving resources and to the precise tuning of environmental regulations. Savings to industry or in the conservation of resources could total millions of dollars per year.



University of North Carolina Sea Grant College Program



Corrosion is a problem of enormous economic magnitude. The National Bureau of Standards has estimated that corrosion costs the U.S. about \$70 billion annually. Sea Grant's research is focused on marine corrosion protection and the biological and chemical mechanisms that control it in the marine environment.

Sea Grant research on coastal waste handling, remote sensing applications and marine corrosion prevention accounted for an aggregate annual impact of \$85 million in 1987.

| | |
|--------------------------------|----------------------|
| Remote sensing applications | 1,635,000 |
| Offshore water quality models | 75,000,000 |
| Marina and boat corrosion | 1,935,000 |
| Marina waste handling system | 570,000 |
| Ocean outfall prediction | 200,000 |
| Marine x-ray spectroscopy | 1,200,000 |
| Acoustic assessment technology | 5,000,000 |
| SUBTOTAL | \$ 85,540,000 |

Remote sensing applications

CHALLENGE Improve the productivity of marine industries through application of NOAA's remote sensing ocean data.

SOLUTION Joined with NOAA's satellite and weather services to educate marine industries about promising uses of satellite imagery.

IMPACT Sea Grant extension showed shipping companies and fishermen how to use satellite imagery technology. As a

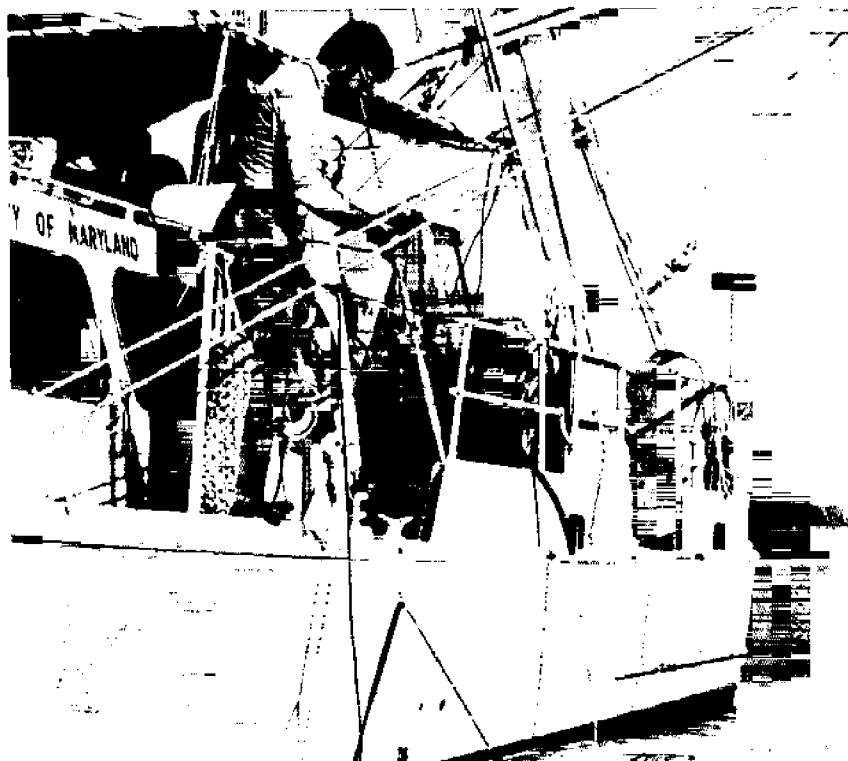
result, they claim an average annual savings of \$1.6 million in fuel costs from more efficient ship routing and reduced fishing search time.

SOURCE Florida, North Carolina

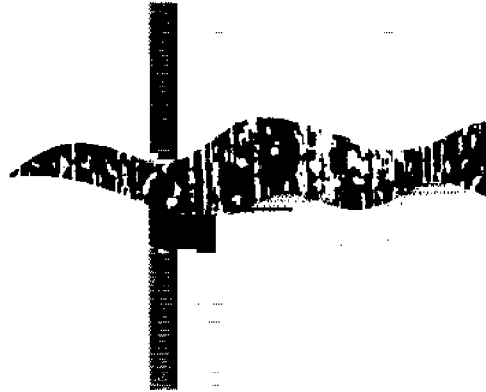
Offshore water quality models

CHALLENGE Optimize the design of offshore disposal systems for municipal waste to minimize costs while protecting the environment.

SOLUTION Used computer models that predict water movement and contaminant



University of Maryland Sea Grant College Program



- dispersion to evaluate alternative locations for Boston's new sewage outfall.
- IMPACT** The modeling showed little environmental benefit to water and sediment quality by moving the outfall farther offshore. The site chosen is approximately three miles closer to land and saves construction costs of \$75 million.
- SOURCE** Massachusetts

Marina and boat corrosion

- CHALLENGE** Attenuate the damage costs from marine corrosion to boat owners and marina operators.
- SOLUTION** Produced benchmark techniques for measuring marine corrosion potential; conveyed research results on marine corrosion prevention to national audiences.
- IMPACT** Professional marine surveyors and marina operators conservatively estimate these techniques save the national boating public \$1.94 million annually.
- SOURCE** Maryland, Delaware, Rhode Island

Marina waste handling system

- CHALLENGE** Find an economical and efficient means for marinas to comply with federal septic waste disposal regulations that require disposal systems on all boats and marina pumpout facilities.

SOLUTION Designed a low-cost waste-handling system using equipment priced within reach of small- to medium-sized marinas.

IMPACT A sampling of marinas that installed the Sea Grant system report savings of \$5,000 each over available alternatives. Extrapolated to marinas located in North Carolina, the savings are \$570,000.

SOURCE North Carolina

Ocean outfall prediction

CHALLENGE Lower the costs of effluent treatment by predicting the course of ocean outfall plumes.

SOLUTION Examined the spatial and temporal dynamics of major urban ocean outfalls to predict the dimensions of the sewage effluent plume; devised more efficient management of waste treatment plants based on these results.

IMPACT In Southern California, this analysis resulted in an annual \$200,000 savings from lower chlorination costs for effluent stream treatment.

SOURCE California

Marine x-ray spectroscopy

CHALLENGE Develop an x-ray spectroscopy unit with the capability for marine use.



SOLUTION Adapted the newly developed mercuric iodide detectors that require no cryogenic-cooling.

IMPACT Engendered a new industry in at-sea portable x-ray spectroscopy instrumentation. Approximately \$1.2 million in annual sales is expected the first year.

SOURCE California

Acoustic assessment technology

CHALLENGE Adapt acoustical procedures developed by the U.S. Navy for submarine detection for use in fisheries and environmental assessment.

SOLUTION Research on acoustical techniques and improved information handling capabilities led to new technologies that are internationally used in fisheries management and environmental impact assessments.

IMPACT The acoustic technology provides better and more cost-effective assessment and research capabilities. As a spinoff of this Sea Grant research, a new business was begun to manufacture acoustical and data analysis equipment. Its sales reached \$5 million.

SOURCE Washington



Marine Safety and Public Health

Sea Grant's efforts in marine safety and public health focused on vessel and crew safety, fish poisoning and diving accidents. It generated \$53 million in reduced business costs and added production of new safety technology.

One of Sea Grant's biggest successes deserves special mention. In the early 1970s, the Michigan Sea Grant Program undertook research to reduce the excessive loss of life from drowning accidents while working and recreating around cold water. It was discovered that many drowning victims in cold water could completely recover after immersion of up to an hour if resuscitated properly. A national education campaign to teach medical personnel the technique was undertaken. Martin Nemeroff, the Sea Grant researcher who discovered the technique, is aware of over 1,500 lives saved using this technique. There are undoubtedly thousands more.



Minnesota Sea Grant College Program



Sea Grant is currently addressing the problems associated with fishing vessel safety. According to the National Transportation and Safety Board, commercial fishing is the most hazardous vocation in the nation in terms of mortality and injury. Sea Grant has recently teamed with the National Council on Fishing Vessel Safety and Insurance to develop and distribute training materials throughout the country. Ultimately, a network of professionals and volunteers located in commercial fishing ports will be recruited and trained by Sea Grant. The program can make a significant contribution to saving lives and reducing the high cost of insurance.

| | |
|-------------------------------------|----------------------|
| Life-saving flotation devices | 3,000,000 |
| Ciguatera fish poisoning | 2,000,000 |
| Shrimp vessel safety | 41,000,000 |
| Decompression computer | 6,000,000 |
| Marine safety training | 1,100,000 |
| SUBTOTAL | \$ 53,100,000 |

Life-saving flotation devices

CHALLENGE Reduce the loss of lives resulting from cold-water drownings.

SOLUTION Research on the effectiveness of flotation devices in saving lives spurred a company to manufacture three new lines of personal flotation devices.

IMPACT The company added \$3 million per year to gross sales with the addition of these lines and expects to triple this by 1995. More importantly, Sea Grant's educational efforts contributed



to fewer drownings, down from 10 per 100,000 boats in 1979 to 4 per 100,000 boats in 1987.

SOURCE Minnesota

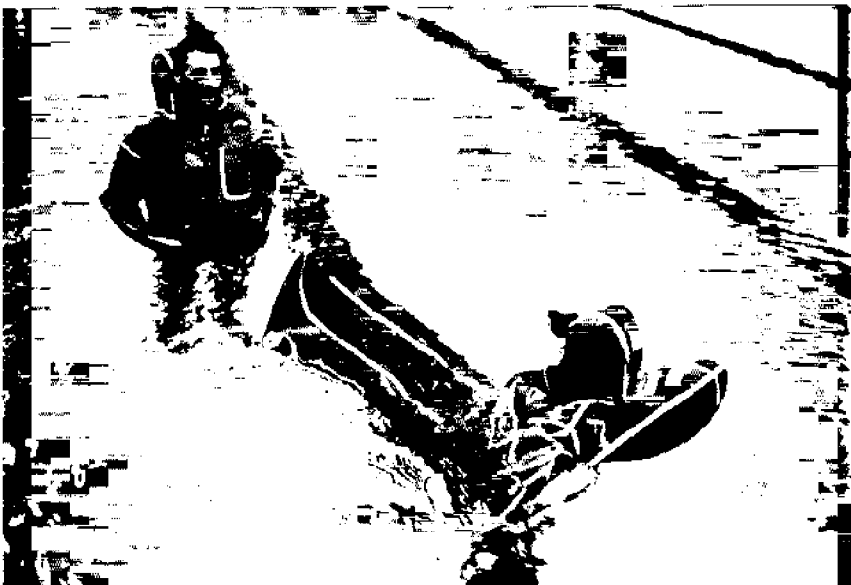
Marine safety training

CHALLENGE Improve safety in the marine transportation industry.

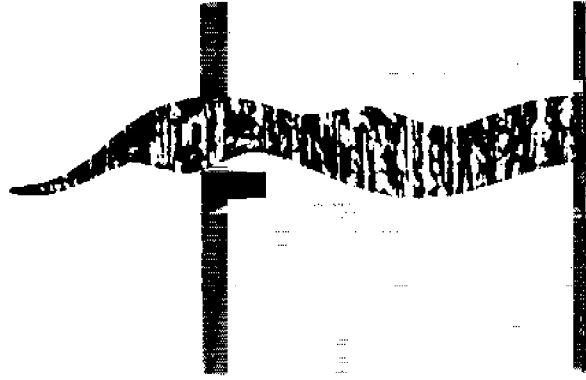
SOLUTION Conducted marine safety training seminars for over 1,500 transportation industry safety professionals.

IMPACT A marine trades association attributes an industry savings of \$1.1 million to Sea Grant's program to augment professional safety training techniques.

SOURCE Texas



Oregon Sea Grant College Program

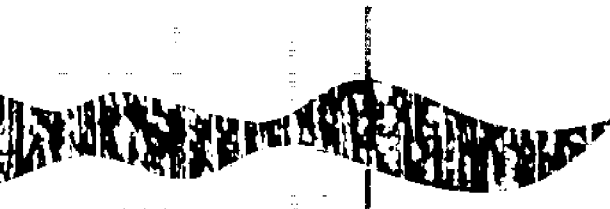


Ciguatera fish poisoning

- CHALLENGE** Reduce the human health risk and economic loss resulting from ciguatera fish poisoning.
- SOLUTION** Initiated a research and education program designed to reduce the number of cases of ciguatera poisoning among tropical island populations and among importing countries.
- IMPACT** The number of cases of poisoning from the ciguatera toxin has been significantly reduced. The estimated savings in medical expenses, work-time loss and stability in seafood sales reach \$2 million per year.
- SOURCE** Puerto Rico, U.S. Virgin Islands

Shrimp vessel safety

- CHALLENGE** Reduce the escalating insurance costs that caused many shrimpers to cease fishing and 20 percent of the fleet to operate without coverage.
- SOLUTION** Conducted research to document Gulf of Mexico shrimping practices; produced a training film that addressed safety violations that commonly result in personal injury and vessel damage and translate into higher insurance costs.
- IMPACT** The film is the basis for several shrimp boat safety programs, including the U.S. Coast Guard's. Insurance premiums were reduced 30 percent for



an annual fleet savings of \$39 million. In addition, out-of-pocket damages were reduced by \$2 million.

SOURCE Texas

Decompression computer

CHALLENGE Improve diver safety through new tables for no-decompression, multi-level diving.

SOLUTION Developed Doppler ultrasonic bubble detection technology to determine acceptable pressure values for the new tables. Subsequently, a diving equipment manufacturer used this technology to produce the first decompression computer that is reliable and affordable.

IMPACT Gross sales for this firm approach \$6 million per year and its success, 25,000 units in use since 1983, spurred a new industry. Sport diving safety has improved in immeasurable ways with the advent of decompression computers.

SOURCE Michigan

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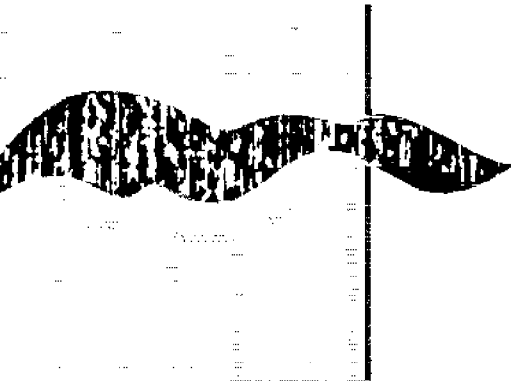
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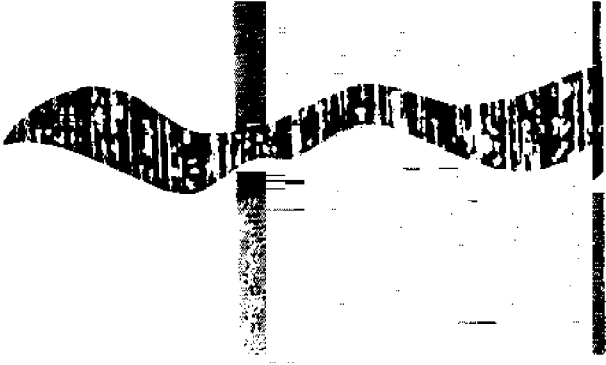
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