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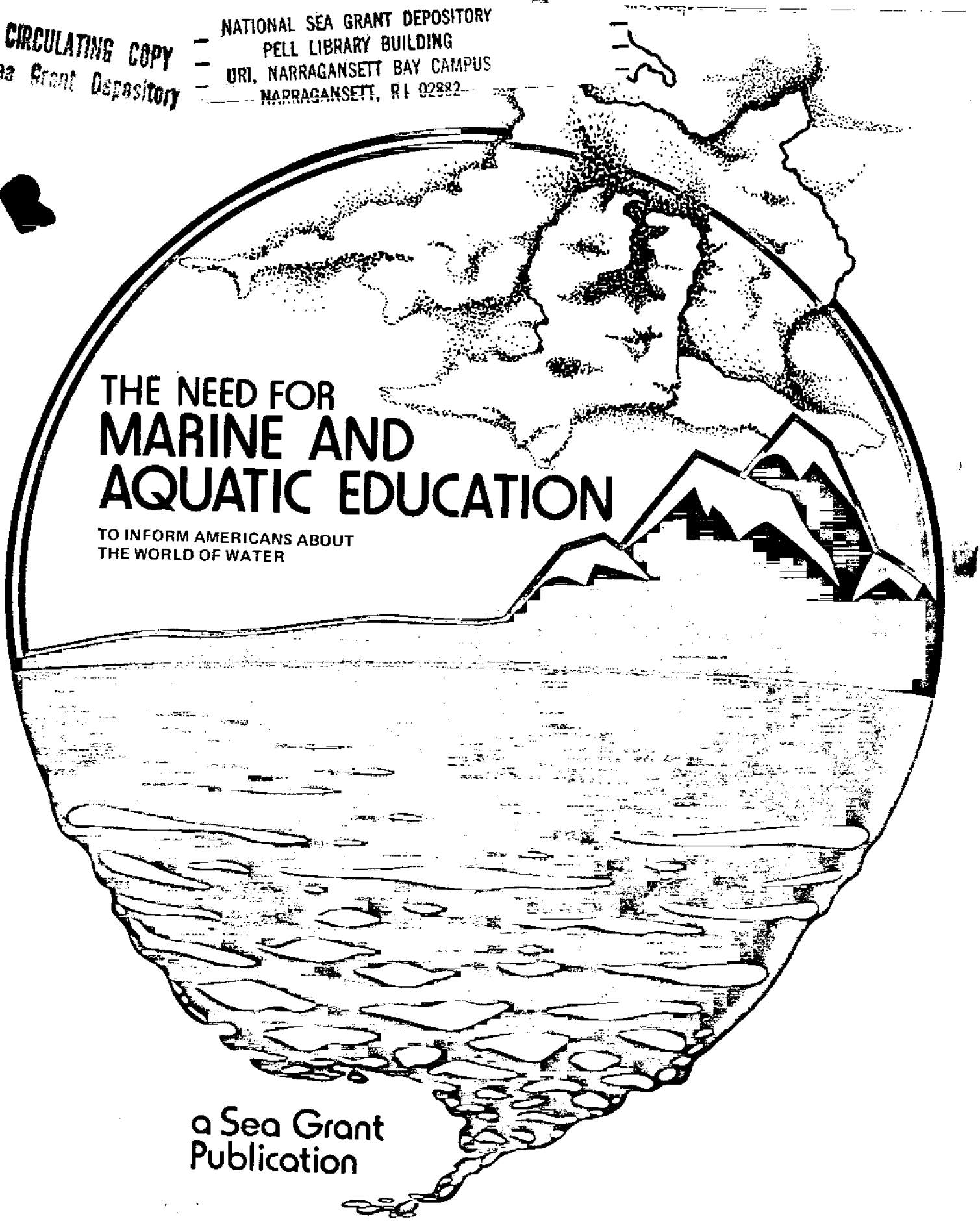

THE NEED FOR MARINE AND AQUATIC EDUCATION

TO INFORM AMERICANS ABOUT
THE WORLD OF WATER

a Sea Grant
Publication

SEA GRANT: A Decade of Dedication to the Oceans

The National Sea Grant Program came into being over a decade ago with the enactment of the Sea Grant College and Program Act, signed into law in October 1966. Its sponsors had a most ambitious goal—to develop a solid base of practical, useful knowledge at colleges and universities throughout the nation by drawing on scientists and engineers who were committed to the ocean and its resources. More important, the idea behind Sea Grant was—and still is—to direct all other disciplines toward a better understanding, use, management, and protection of the resources of the seas and the Great Lakes.

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Right now more than 700 individual projects are underway at scores of institutions and laboratories across the country. Their work embraces disciplines not just in the life and physical sciences but in business, law, economics, government, and management to meet the needs of industry, commerce, and recreation.

A STATEMENT ON

THE NEED FOR MARINE AND AQUATIC EDUCATION

To Inform Americans About The World of Water

by
Harold L. Goodwin
and
James G. Schaadt

March 1978

NATIONAL SEA GRANT POLICY FOR MARINE EDUCATION PROJECT

Harold L. Goodwin, *Project Consultant*
James G. Schaadt, *Project Coordinator*

Delaware Sea Grant College Program

Dr. William S. Gaither, *Director*
Dr. Carolyn A. Thoroughgood, *Associate Director; Director, Marine Advisory Service*
Dr. Kent S. Price, *Associate Director*
Kathi Jensen, *Marine Information Coordinator*

Karen L. Woods, *Graphic Design/Layout*
Pam Donnelly, *Composition*

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Foreword

This statement outlines why marine and aquatic education is important, and defines it so that discussion can continue and at least spring from a common definition. The statement is not a program or a specific plan, although it does present some considerations that may be important when a program or plan is developed. We do not present the document as the definitive statement on the need for marine and aquatic education. It is a working paper, subject to improvement and modification.

Although identification of authors is usually necessary to assign responsibility, this statement is a synthesis of thought and comment by more than a thousand people. A history of the statement's development is appended.

Water: The Essential Ingredient

Whether it is the water of the global sea or the fresh water of the land, our lives and fortunes depend on it. Although this always has been true, progress and expansion during the last quarter of our national existence were based on a false assumption. We have acted as though the bounty of land and water were without end, and as though the rivers, estuaries, and seas could absorb without harm an infinite amount of wastes.

Now, a combination of growth, demand and pollution pushes us rapidly toward our fresh water limits, and depletion of some land resources forces us to turn again to the seas. The increase in population and the movement of people toward our fresh and saltwater shores place enormous pressures on the fragile coastal zones and adjacent waters while growing industrial use creates further pressure and sometimes conflict.

A national reawakening to the importance of our fresh and salt waters is late, but not too late if an informed public understands and supports careful, planned use of our oceanic and fresh water resources. To inform the public is the task of marine and aquatic education.

There are specific and important conditions that make marine and aquatic education a matter of urgency, and these are summarized later. But there is a basic reason for informing Americans about the world of water. In photographs taken by Apollo astronauts from space and the surface of the moon, we see our planet in perspective for the first time in human history. We see a bright world of blue water framed by the black of space and partly concealed by lovely patterns of white water vapor clouds. In the Polar regions is the glitter of frozen water. Through breaks in the cloud patterns the continents are visible, shapes of brown and green interrupting the blue of oceans. As the earth turns, it becomes evident that the continents are islands in the global sea that gives earth its unique character.

The circling sea is the source of water that makes possible all the life forms of earth. It is the heat reservoir that moderates climates even in the Polar reaches, and makes the Temperate Zones habitable by humans.

From the perspective of the moon, the prime reason for marine and aquatic education is emphasized by the most important of facts about our planet:

We are dwellers on a water world.

The Need For Marine and Aquatic Education

The United States began as a sea nation, its life and economy tied closely to the seas, the great rivers and lakes. But while dependence on the salt and fresh waters has never diminished, and indeed is growing with new urgency and vigor, our nation of sea people has become a nation of landlubbers.

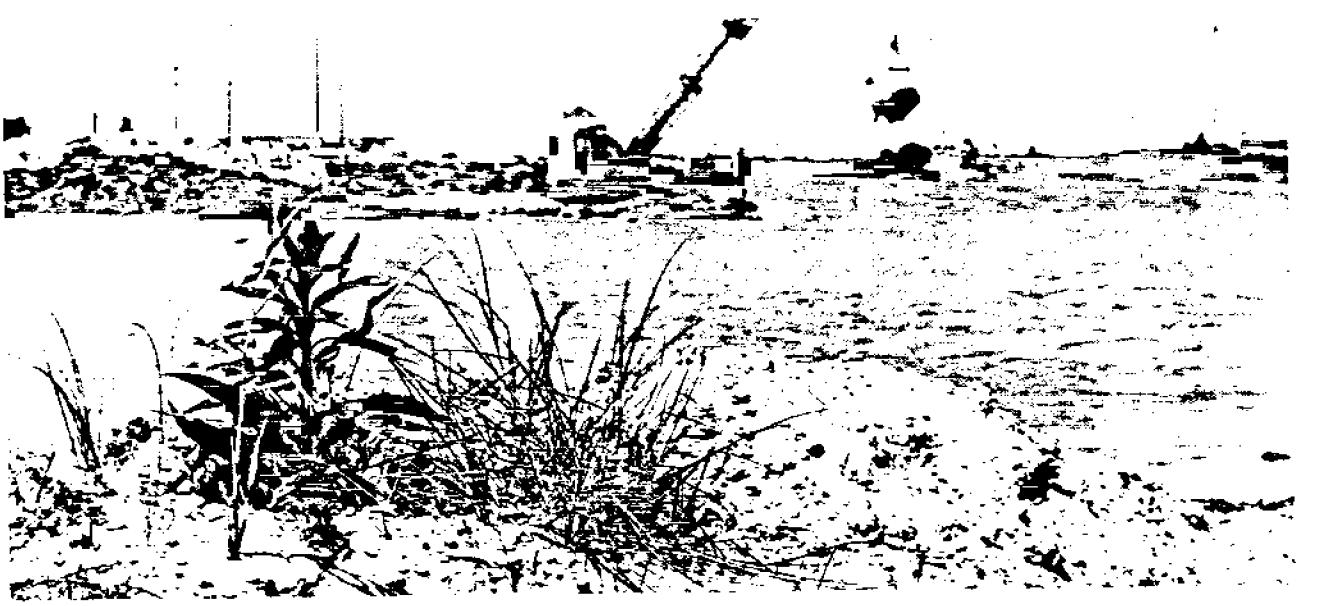
American education has been that of a land people. We have not been taught the importance or methods of protecting, using, and managing the resources of neighboring lakes, rivers and seas, coastal zones, and continental shelves. It has not been impressed upon us that the supply of fresh water is limited and cannot be increased. We have not learned that fresh and salt water are limited in their ability to contain our wastes, or that clean, fresh water is essential to our personal existence.

The current educational content does not include our great legacy of maritime history. The teaching of current events seldom includes the facts of our daily dependence, whether we live on the coasts or far inland, on waterborne commerce. Even environmental education, accelerated by the Environmental Education Act of 1970, has not resulted in a measurable increase in our understanding of the ecological implications of how we use our fresh water supplies and coastal seas.

Water has been taken so much for granted that we perceive dimly, if at all, the importance of the oceans and fresh water supplies not only for the present, but for our tomorrows. The fact is that our personal, corporate, and national lives depend now, and will depend even more in the future, on the quality and supply of fresh water and the careful, planned use of the sea and its resources.

In advocating marine and aquatic education, there is danger that advocacy will be interpreted as a call for another subject to be added to the educational load. This is not the purpose.

The need for marine and aquatic education is more basic. It refers not to a subject, but to a fundamental that pervades all aspects of human life, one which should be woven into the total fabric of education. From water as the principal component and primary need of the human body to American dependence on the uses and resources of the sea for employment and a standard of living, marine and aquatic education should be built into nearly every subject taught in our schools. This is not to suggest that marine and aquatic education should dominate, only that the importance of water should so condition the subject matter of education that a balance with land and air is restored and water assumes the place its importance warrants.



Definitions

The Problem of Nomenclature

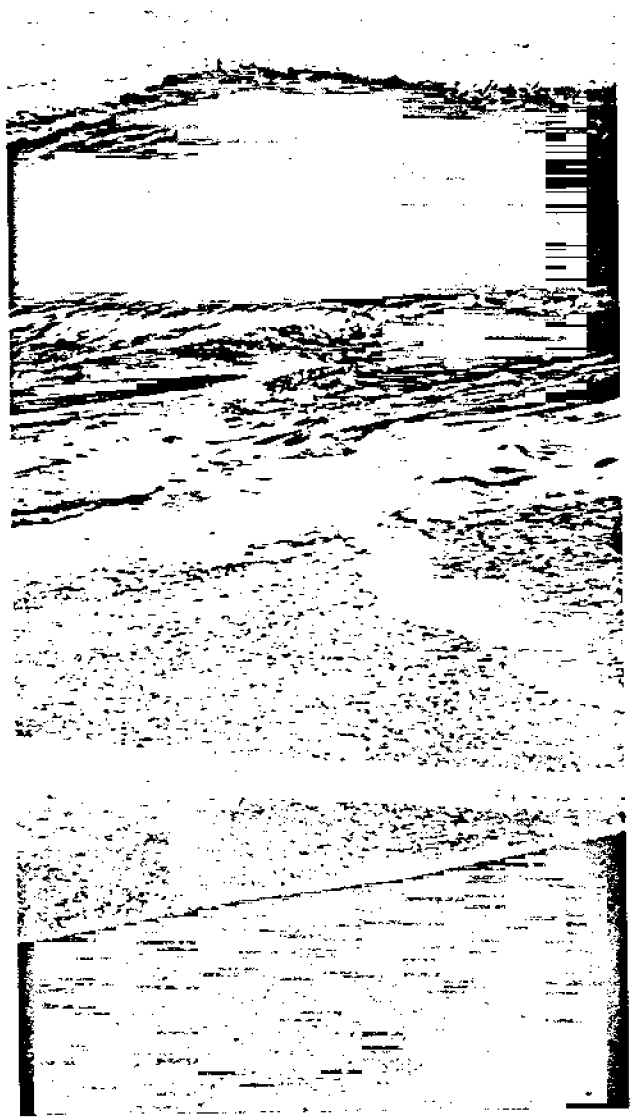
English, despite its remarkable range, flexibility, and opportunity for precision, does not have a common-use noun or adjective to embrace the entire world of water from salt to fresh, from vapor to ice. *Hydrosphere* is a perfectly good word to describe all the water on earth's surface and all that exists in the atmosphere, but it is not in common use. As an adjective to modify *education, hydrospheric* would confuse more than it would illuminate. *Biosphere* has been suggested but, although it might be reasonably accurate since it describes that part of the spherical earth where life is possible, i.e., where there is water, the word suffers from the same awkwardness and unfamiliarity.

Lacking the right adjective and noun, informing Americans about the world of water is most accurately described by the cumbersome term, *marine and aquatic education*.

A Definition of Marine

The sea covers 70.8 percent of the planet's surface and contains more than 97 percent of earth's water. While we divide the sea into regional pieces for geographic convenience, the sea is truly global. Each of the continental masses can be circumnavigated, although polar ice makes it feasible only for nuclear-powered submarines traveling under the ice. Without the Suez and Panama Canals, of course, circumnavigation would have to be from polar sea to polar sea. Nevertheless, any saltwater port on earth is reachable from any other saltwater port, at least from a fish's perspective.

The global sea is the planet's dominant feature. The Latin for sea is *mare*, source of our adjective, *marine*. The unifying characteristic of all things *marine* is saltiness. Consequently, the *marine environment* is that environment which contains or is directly influenced by salty water, whether it be the open ocean with salt concentrations of 35 parts per thousand or more, or the upper reaches of tidal rivers where salinity approaches zero. The Great Lakes are defined arbitrarily as part of the marine environment in U.S. legislation; it might be said that the freshwater Great Lakes are salty by Congressional definition, or because we refer to them poetically as "inland seas."



A Definition of Aquatic

Aquatic is defined as "of or pertaining to water," as a substance or habitat, though both the G&C Merriam Webster (2nd edition) and Oxford dictionaries rate the definition as "rare" or "obsolete." In common use, although such use is not extensive, *aquatic* generally refers to water in the generic sense. Except for water sports when it is applied to either salt or fresh, the word most often is applied to fresh water. Lacking a more precise and widely accepted word, *aquatic* is used in this statement to mean

fresh water as distinct from marine, or salty, water. The purpose is to emphasize that *marine and aquatic education* includes water in all its forms and locations.

A Definition of Education

Because information about something as fundamental as water should be part of the basic knowledge of every person, the audience for education in our context includes people of all ages and conditions. The term *education* is used in its broadest sense to refer to the entire variety of experiences through which people learn: formal and informal educational activities from kindergarten to graduate school and continuing education; recreational, work, and life experiences, and all forms of communication from personal to mass media.

A Definition of Environment

Environment refers to the totality of physical, chemical, biological, social, economic, political, cultural, aesthetic, and structural surroundings of organisms, including ourselves and other people. *Environmental education* is, or should be, based on the principles of *ecology*, the study of relationships and interactions between living organisms, and their environments and each other.

Marine and Aquatic Education

Given these definitions of marine, aquatic, environment and education:

Marine and aquatic education is that part of the total educational process which enables people to develop a sensitivity to and a general understanding of the role of the seas and fresh water in human affairs and the impact of society on the marine and aquatic environments.

Marine and aquatic education is a part of environmental education.

The Goals of Marine and Aquatic Education

The goals of marine and aquatic education do not exist in isolation from other educational goals. On the contrary, they should be considered an integral part of the goals of environmental education, and a valuable asset in achieving the goals of general education. The goals are:

– To develop a public which has a basic understanding of the marine and aquatic components as part of the whole environment, and their importance to American life and society.

– To create a public with an awareness of and sense of responsibility for water; to evolve a new "water éthic" embracing the proper uses, protection, and conservation of the oceans, the coastal zone, and freshwater resources.

– To motivate people to take part in decisions affecting the sea and fresh water while equipping them with principles and information necessary to evaluate problems, opportunities and events.

Achieving these goals would result in the American public becoming "literate" in marine and aquatic affairs.

Some Assumptions

Without some basic understanding of such a primary aspect of life as the importance of the oceans and fresh waters to health, fortune, and the quality of life, people are ill-equipped to participate in or influence vital decisions affecting their own welfare. Therefore, education which does not treat the world of water in proper balance and perspective is incomplete.

When the world of water is included in the formal educational process, it is most often in science classes. It is not generally appreciated that sea and freshwater considerations are equally pertinent and necessary in the study and application of economics, sociology, political science, engineering, history, literature, and art. Marine and aquatic illustrations and experiences can enrich all of those subjects.

The waters of earth, especially the oceans, exert strong fascination for nearly everyone; the elements of wonder and drama inherent in the world of water can be used to engage the attention and enthusiasm of both teachers and students. Water is fun, whether for the child happily stamping in a puddle, the adult exploring the beach, or students fascinated by the mystique of the sea.

It must be reemphasized that marine and aquatic education seeks only balance in which the world of water is recognized as integral to all important aspects of human life, endeavor, and knowledge. Education about the world of water is not just another subject, but a part of the fundamental base on which all learning experiences should be structured.

There are schools where specialized courses in marine science or other aspects of the water world may be important and appropriate, but for marine and aquatic education in the broader sense to take its place and achieve its national goals, it must be incorporated into existing educational programs. The American educational system is both formal and informal, diverse, complex, and well-established. Finding the proper fit for marine and aquatic concepts will take time, effort, and ingenuity. The National Sea Grant Program has provided stimulus and expert assistance, but only the educational system itself can provide the means for reaching the goals.

New emphasis on teaching basic skills apparently is accelerating, but basics, to be interesting and meaningful, must be taught in terms of examples. Because of their inherent wonder and attractiveness, the oceans, lakes, and rivers make learning these skills more stimulating and enjoyable. These characteristics can improve the effectiveness of the educator and make the acquired skills and knowledge of longer lasting benefit to the learner.

In American education, every situation differs from every other in one respect or another. Nevertheless, there are elements common to any program of implementation. Here are some of them:

– Plans and processes for including marine and aquatic concepts and materials in the curricula should be studied for their application to each specific situation. Possibilities range from simple insertion of case studies and examples to small units, modules, field experiences, or even courses.

— Essential to a program of implementation are teachers trained and knowledgeable in marine and aquatic subjects and who are comfortable with incorporating them into their teaching. Implementation requires both pre-service and in-service teacher training. Marine and aquatic education should be integral to the education of teachers.

— Development of new materials to fit various educational situations should be encouraged and supported, with provision for pre-testing in the field before they are made generally available. In addition, testing the effectiveness of the materials and methods should be part of each project.

— Plans should include reaching adults through continuing and public education.

— Programs should advocate participation in marine and aquatic education by organizations to which Americans belong. Programs already in progress include, in some places, those of the Scouts, Girl Scouts, and Campfire Girls; the Coast Guard Auxiliary and the U. S. Power Squadrons, and 4-H groups. A few public aquariums and museums already provide special services to groups and the general public.

— The extent to which marine and aquatic considerations pervade our national and personal lives is so great and diverse that an initial step in implementation might be to decide which of the myriad aspects of the world of water have priority and should be learned by people everywhere if the goals of a basic understanding of and sensitivity to the seas and fresh waters are to be achieved.

Recommendations

Although this statement is not a program or the proposal of a method, but simply a statement on the need for marine and aquatic education, some viewpoints were expressed so consistently and forcefully at the workshops held to create this document that they represent recommendations of a significant percentage, and probably a majority, of participating educators. The recommendations were:

1. Identify, catalog and describe current marine and aquatic education activities as a necessary step in establishing communication among people and institutions with common interests, and make the catalog available throughout the educational system.

2. Give priority to orientation and training for both in-service and pre-service teachers, and to preparation of materials for teacher training.

3. Take strong, positive action to involve social science and humanities teachers, and additional natural science teachers in assessing existing materials useful to their curricula, and in development of new materials.

4. As quickly as possible, involve textbook writers and publishers in marine and aquatic education activities.

5. Provide federal funding for materials development and for teacher training, but leave application to the states and localities.

6. Be prepared for the long haul. Accomplishment of the goals of marine and aquatic education will take time.

Conclusion

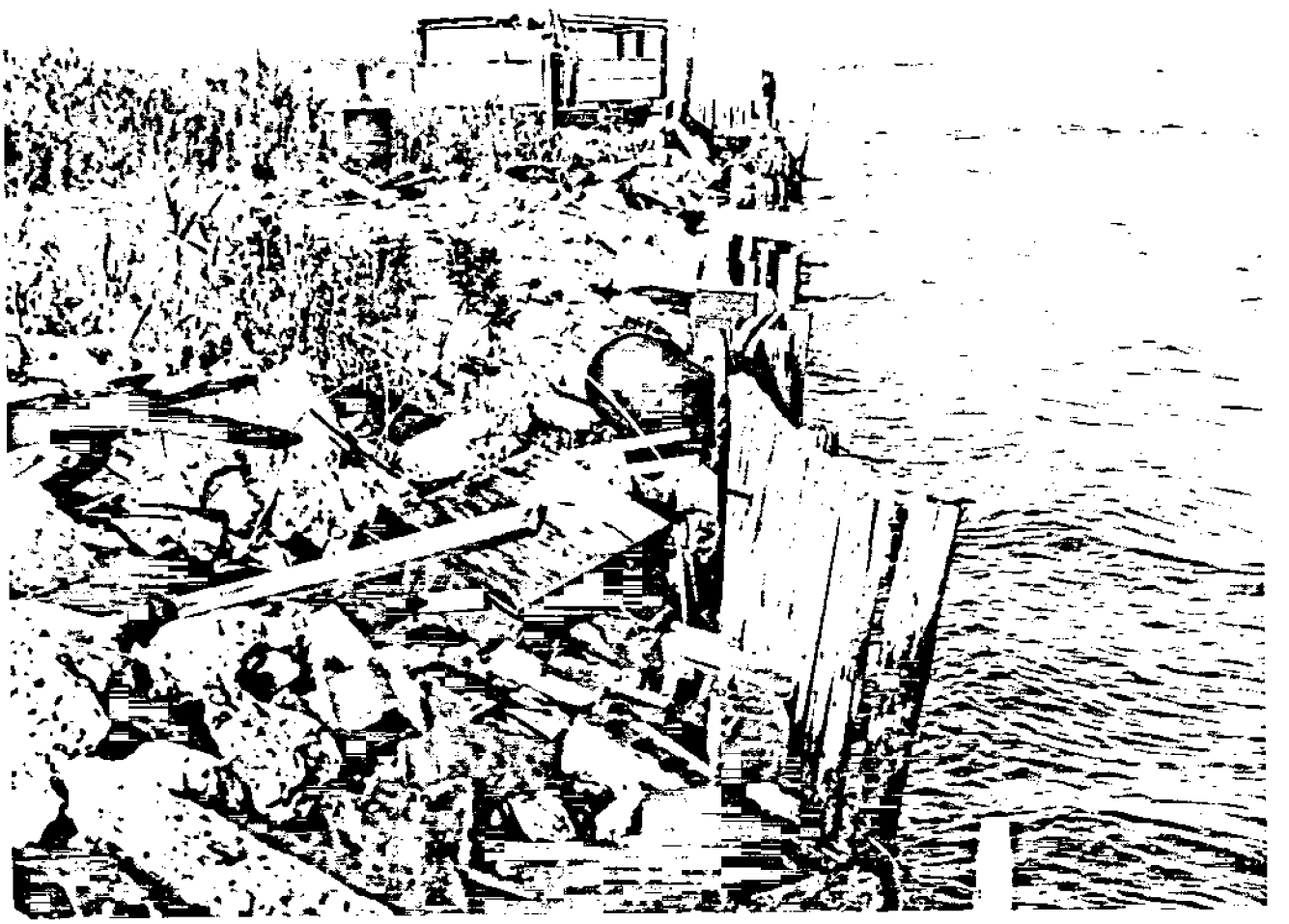
The concept of education about the world of water is new only in degree. There always have been elements of marine and aquatic education in school subjects because it is simply unavoidable. Not that anyone has tried to avoid including the world of water; it is just that its importance has been submerged beneath what have appeared to be greater urgencies.

Perhaps the reason marine and aquatic problems have not demanded our attention as an urgent priority is that water is a very forgiving substance. Damage to the water environment and misuse of its resources are more a matter of slow accumulation of insults, degradations, and poor management than of a quick crisis. The damage seldom appears suddenly, except for a disaster like an oil spill or a water shortage.

The consequence of slow change is that we have arrived at a time of urgency so gradually that the change is perceptible to those intimately involved with the world of water, but not so apparent to people at large. The fact is that we already are late in calling for marine and aquatic education. To inform people takes time, and the more complex and broad in scope the information, the more time it takes.

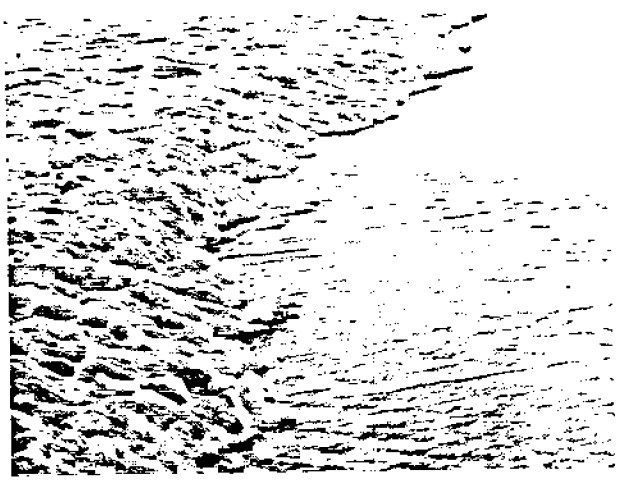
A marine-literate society sensitive to and with understanding of the world of water will take at least a generation to develop even after momentum toward the goal of such a society is achieved. Before a generation has passed, the problems of the marine and aquatic environments will loom much larger in the public eye.

We have a choice: to wait, then react too late to the crisis that has become obvious, or to get on with marine and aquatic education so that the crisis may be avoided.



A Water World Sampler

Conditions calling for marine and aquatic education cover the wide spectrum from personal to world problems and opportunities. The following samples can do little more than illuminate the scope and diversity that the world of water offers. Educators will have no problem relating the various topics to the subject matter taught in the classroom, even though materials that can be easily inserted into existing curricula are not yet readily available for many of the topics in the sampler.



Water, the Magic Substance

Earth is the right size planet in the right location to be a water world: size and mass are just right for keeping a dense atmosphere, and distance from the sun is just right so our world is not too hot and not too cold. These vital factors enable water to exist simultaneously in all three states, as liquid, gas, and solid. It is the only common substance for which this is true — a fact recognized about 2,400 years ago by Thales of Miletus, first of the Greek philosopher-scientists.

Consider, also, a peculiarity of water which determines the kind of world we inhabit: ice floats. Nearly all other substances shrink in volume as they cool; water does, too, until it reaches about 4°C when it begins to grow less dense, turning to a crystalline solid at 0°C with a volume about an eleventh greater than its liquid form. It is the only common substance that acts this way. There are a few others, bismuth, for example, but they are not common. Imagine what the world would be like if ice sank as it formed.

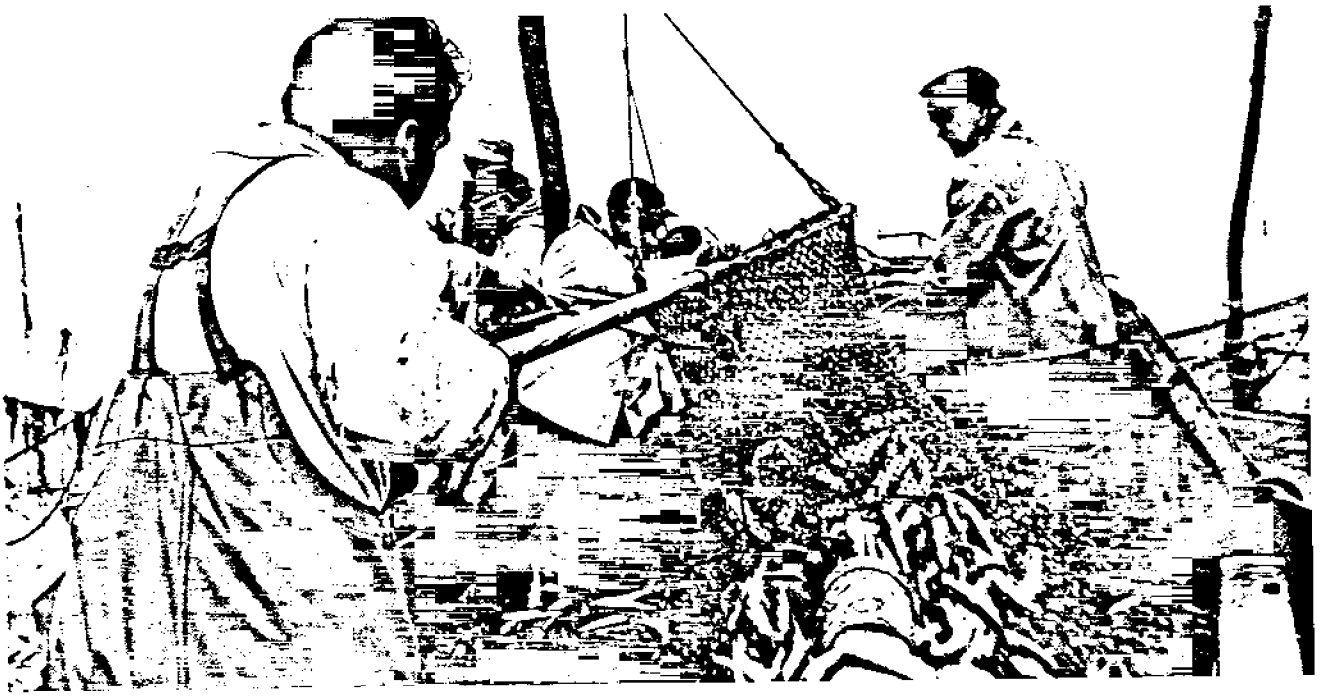
Two other characteristics about water are worth a reminder: its truly remarkable heat capacity enables it to soak up and store great amounts of heat without itself becoming relatively warmer, and it is able to dissolve nearly all natural substances. What's more, water itself is not changed chemically by most of the materials it dissolves. It can act as a carrier, as it does in the human body, and can be used as a solvent over and over almost endlessly. It is a nearly indestructible substance, and it is awesome to think that almost every molecule of water that ever existed is still around somewhere today.

As living creatures, our dependence on water is total. There are living organisms that can exist without light and air, but none that can exist without water. We are born of water and live as ambulatory streams of water contained in specialized tissues. The air we breathe must be moist with water vapor. Over a normal life span, we consume nearly 7,000 gallons of water to replace that which our bodies use at a rate of about five times our individual weights each year. This fact alone should make us very aware of the source and quality of water we drink. Many major population centers obtain their water from rivers, as the nation's capital does from the muddy Potomac, and some of those rivers are used and re-used several times along their waterways; many of us drink recycled water daily.

Water, as water, is an intriguing and important subject for inclusion in studies of physics, chemistry, biology, and earth sciences. But water as a stimulus and necessity also has a place in social studies, a place that may be inferred from the following quotations:

Bernard Frank: "You could write the story of man's growth in terms of his epic concerns with water."[1]

K. S. Davis and J. A. Day: "All these activities (concerted human action to provide water) require a subordination of individual selfishness to a sense of the general welfare, a harnessing of emotional energies to rational controls, and in general the development of those ethical concepts whereby stable social organizations are maintained. Thus, economic specialization and the basic moral tenets of the great religions may. . .have been born of water."[2]



The Resources of the Sea

The sea brings forth food, petroleum, minerals, and raw materials of many kinds. Like the planet itself, the sea has limits, but they most often are visible only for certain of its living species, or when uses conflict.

Our greatest untapped domestic petroleum reserves are off our coasts, under the seabed. The need to bring them into production must be balanced with potential harm to the environment, but in factual, not emotional, terms. Similarly, importing oil by ship can be accompanied by environmental disasters, as tanker accidents have demonstrated. The need for fuel is great, but so is the need to protect the environment. While decisions will be made at various levels of government, what is historically assured is that governmental handling of the hard choices will be conditioned by public pressure or the lack of it. Ocean management is a clear necessity if conflicting uses and interests are to be resolved sensibly.

American industry depends on about 20 critical minerals imported from many nations, not all of them our friends. Some of those essential minerals are available on our own continental shelves. Manganese nodules have attracted public attention, but are actually more valuable for the nickel and cobalt they contain. Other minerals are in the seabed where ancient streams once flowed; they include placer deposits of rare earths, and even gold. Our bromine and most of our magnesium have been extracted from seawater for many years, and sulphur is mined under the Gulf of Mexico. So ocean mining is not new, but its further development faces the same problems as offshore petroleum production, including the necessity for public understanding of the actual need and real impact on the environment.

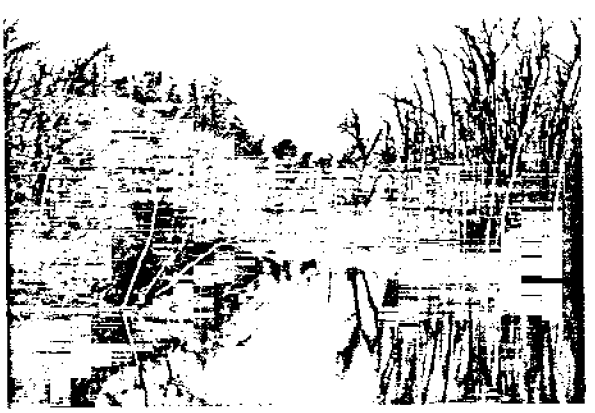
Americans consume more sea protein than the usual statistics indicate. Per capita consumption of table seafoods, after remaining at little more than 11 pounds for a decade, has risen more than a pound and appears to be climbing slowly. Overall, we use more than five times our consumption of table fish as industrial fishmeal that ends as a protein component in feeds for poultry and land animals. The fact that poultry has remained plentiful and relatively less expensive is due in large part to fishmeal. The return to the sea for table fish is, however, an omen for the future. Apart from the inevitable price rise in agricultural products as petroleum costs go up, dietary habits are changing. We are realizing that fish and shellfish contain no saturated fats, are high-grade protein, and supply essential minerals. Some species, especially the lesser known or less fashionable ones, are relatively cheap.

Although the waters off our shores are among the world's most productive, we import more than two-thirds of the sea products we consume. Foreign fleets have caught more than we in our home waters, taking the catch to their own shores, then selling it back to us. The 200-mile fishery zone now brings control of the harvest directly under U.S. government agencies, an essential step in better use of our oceanic resources.

One sea resource not often considered is a substantial percentage of the oxygen we breathe. Photosynthesis by the plants of the sea, mostly microscopic algae, produces oxygen as plants do on land. The tiny sea plants, called *phytoplankton*, form the base of the great oceanic food chains. Authorities differ on how much this "grass of the sea" contributes to planetary oxygen, but pollution on a sufficiently wide scale to affect the tiny plants could also affect significantly the amount of atmospheric oxygen, though this is not yet a real prospect. The larger plants of the sea, the brown kelp and red seaweeds, produce gelling and smoothing agents so widely used that it is impossible for the average American to get through a day without coming into contact with products that use seaweed agents.[3]

Fresh Water as a Valuable Commodity

The scarcest commodity of this water planet is fresh water. Of all the water on earth, totalling about 330 million cubic miles, only about two-thirds of one percent is available for human societies to use, and not all of that is located where it is needed. Where the fresh water is located near centers of civilization, it is polluted to a greater or lesser degree.



We do not often realize that much of the United States is semi-arid. Many of our most productive agricultural lands have depended on ground water, caught from the rains and stored in the earth over many years. Other agriculture depends on irrigation with water drawn from distant rivers.

As population increased, as industry developed with its high water consumption, and as agriculture spread to nearly all suitable soils, the demand for water grew until today, use of our great rivers approaches the maximum. Ground water is being used faster, in many places, than it can be recharged by the rains. Pollution has aggravated the scarcity very seriously, and even the price of potable water has increased dramatically in some parts of the nation, including the relatively well-watered ones.

There is little that even an informed citizenry can do about the whims of nature that cause drought or floods, but an aware public can support and even demand activities that plan for and take positive action to alleviate the effects of weather anomalies. Certainly the public has much to say about laws to prevent pollution or to enforce clean-up or compliance.

Somehow, Americans can get along without most things, improvising, substituting, applying the great national ingenuity. But one thing for which there is no substitute is clean water, whether fresh, in the brackish estuaries, or in the sea itself. We must learn to accept and act upon that inescapable fact.

Water Transportation and the Nation's Fortunes

The global sea provides a water pathway to the nations of the world across which the world's goods are carried. Agricultural products are one of America's major exports; they move by water from the coasts and from the heartland of the United States to customer-nations. Similarly, goods of other nations are transported across the seas to our coastal cities and through our inland waterways to ports far inside the country.

Less than ten percent of our cargoes travel across the oceans in American vessels. The United States Merchant Marine has declined for a variety of reasons, not all of them clear or simple. But surely one reason is that Americans as a whole are unaware of the degree to which our standard

of living rests on ocean transportation.

If asked to name our seaports, most Americans would name New York, Boston, San Francisco, Seattle, Houston, New Orleans, and other coastal cities. But the Great Lakes, vital for transportation, are connected to the oceans, too, and Cleveland, Chicago, Milwaukee, Duluth, Detroit, Buffalo, and other lake cities are major ports.

That's not all. While the United States has 12,383 miles of general coastline,[4] it has 25,543 miles of commercially navigable waterways. The Mississippi River System alone has nearly 9,000 miles of navigable waterways on which goods move by barge and ship to and from the ocean. Within this vast system are ports like Little Rock, Catoosa, Nashville, Louisville, Cincinnati, Charleston, Pittsburgh, Kansas City, Minneapolis, Omaha, and Sioux City.

Of the 50 states, only 10 have no access to the seas either directly or via the waterways of the nation.[5]

There was a time in our history when water transportation was the only means of moving substantial cargoes. Today ships are still the primary means and the least costly way to move bulk cargoes. Of all forms of transportation, water-borne shipments have the lowest fuel consumption per ton mile. As the fuel shortage grows worse and prices escalate, this fact has obvious implications for the growth and future of water transportation. Within the United States, for example, a gallon of fuel will move an airplane five ton-miles, a truck 50 ton-miles, a railroad shipment 180 ton-miles, and a barge on the inland waterways 330 ton-miles. Water transportation is not only our past and present, but more than ever, our future.

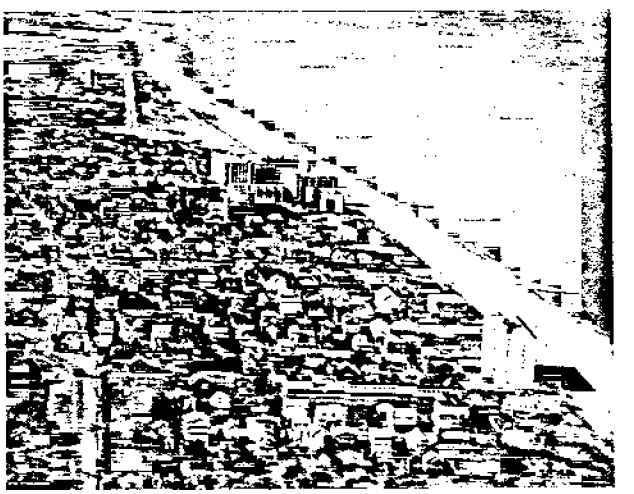
The Population Moves Seaward

More than half of all Americans now live within an hour's drive of the sea or Great Lakes shores, and by the end of the century more than three-fourths of us will crowd to the coastal regions. Conflict over the uses of the coastal zone where the land meets the water is a serious problem.

Traditionally, our wastes have been fed into the waters, and in spite of laws, regulations, and pressure, this is still the case in most places. What this means is clear from a single example. We express deep concern about, and many people oppose, offshore petroleum production; yet, the runoff into the sea of petroleum hydrocarbons from cities, either directly or carried by our rivers, is nearly 24 times as great as petroleum pollution from offshore drilling.[6]

The coastal regions are the terminals for water transportation. An increase in water transportation means larger service facilities onshore.

The coastal zone is a vital breeding place for marine life. Many of the fish and shellfish we prize spawn in the coastal shallows and still others spawn at sea and come to the coasts to feed and grow.



The coastal zones of lakes and seas are where beaches and most other recreational facilities are located. There, 120 million Americans seek aquatic recreation. The crowding recreationists often endanger their own lives or those of others, and they may unwittingly, or through carelessness, contribute to the damage of the very environment that attracted them in the first place.

Legislation requiring coastal zone plans has been a major step forward. Action to protect and make wisest use of the zones is progressing, but the degree to which plans are effective in keeping a vital national resource preserved and utilized depends on public understanding and support. More than 100 million people have a direct and personal stake in coastal America even today, and the rest of the population is affected by what happens there. Today's decisions and those of the next few years will set irreversible patterns of living.

A Heritage Worth Preserving

The nation's attention may have been diverted from the sea as the continent opened and our agriculture and industry grew to be the world's greatest, but the national sea heritage has remained. We need to be reminded of the place of the seas in our entire history and culture, and the reminders can enrich nearly every aspect of life and study.

The world oceans have remained free because American military seapower in this century enforced that freedom whenever it was threatened, and so world communication and commerce continue largely unhindered. How long our seapower can ensure freedom of the seas depends on the will of the people which, in turn, depends on their understanding of the necessity and the cost.

The decline of American merchant marine strength during the last three decades may have been slowed, and perhaps even halted — a judgment to be made a decade from now — but our

heritage of maritime commerce is a proud and romantic one that deserves to be recalled. The young United States developed shipbuilding as one of its first industries, to provide vessels to carry its prime resource, fish, into world trade, then to compete with high success for trade with the Orient. By 1850 the United States led the world in seamanship, shipbuilding, and naval architecture. Our nation was the first to provide scheduled Atlantic passenger service, and the tall wind ships captured record after record in speed of passage and money earned. The number of whaling ships alone exceeded the total number of vessels in today's U.S. merchant marine.

The Sea and the Humanities

America's long fascination with the sea is apparent in our art and literature, both very rich and very deep. It is perhaps symptomatic of our turning away from the sea that we remember James Fenimore Cooper for his frontier and Indian tales, forgetting that he served in both merchant and Navy ships and published his first sea novel, *The Pilot*, in 1823. His last sea tale, *Afloat and Ashore,* came out in 1844, four years after Richard Henry Dana's classic, *Two Years Before the Mast.* This tale of Dana's experiences as a foremast hand has never been out of print since 1840. The year 1851 saw publication of what some consider the greatest American novel, Herman Melville's *Moby Dick*. But it isn't necessary to go back in time for best sellers when Rachel Carson's *The Sea Around Us* continues through edition after edition and printing after printing. In 1977, a book of extraordinary beauty, spiced with wit and wisdom, won the Pulitzer Prize: William W. Warner's *Beautiful Swimmers*.

In the realm of art, the painter's preoccupation with water has given us a particularly rich and varied heritage. Winslow Homer's marine paintings come immediately to mind, perhaps because a new book of his paintings was released while this statement was being drafted. We don't always remember that the controversial and irascible James A. McNeill Whistler was also a marine painter, nor that Andrew Wyeth's Pennsylvania farms and fields were counterpointed by the coasts of Maine and the sea. When the Virginia Museum at Richmond and the Mariner's Museum at Newport News held an exhibition of American Marine Painting in 1976, the exhibit included paintings by 56 different artists and covered a range from primitive to abstract expressionism.

Fresh water has given us its own literature and art with the Great Lakes and the Ohio, Missouri, Mississippi and Hudson Rivers as the scenes or sources of inspiration. The Mississippi in particular gave us Tom Sawyer and Huck Finn along with other creations by Mark Twain.

Samuel Clemens got his pseudonym of Mark Twain from the cry of the leadsman sounding the depths, one example of a long tradition of enriching our language with sea terms. The sea origin of many words and phrases is obvious, but we use many words and terms whose salty beginnings are forgotten. To sample a few of both:

First rate, A-1, skylarking, to give a wide berth, to give a clean bill of health, out of commission, laid up, junk, beyond one's scope, on the rocks, man-handled, steward, berth, freight, crew, mainstay, overhaul, rakish, cranky, and — *the bitter end.*

Poetic references are easily found, too, and it is only necessary to make the point with a single example. We sing of *amber waves of grain,* to liken our prairies to the great oceans. The song glories in the wonders of "America the Beautiful" *from sea to shining sea.*

Appendix One

How This Statement Was Developed

The origin of this statement was a workshop held in June, 1976, when a group of educators met to review the role of the National Sea Grant Program in marine education. Logan Sallada of the Office of the U.S. Commissioner for Education pointed out that marine education has been handicapped by lack of a clear statement about its essential importance. The workshop group concurred and recommended that the chairman, Harold L. Goodwin, draft such a statement. The initial draft was reviewed by the workshop participants, revised, and sent to a wider group of educators including members of the Marine Technology Society's Committee on Education, the Education Council of the National Sea Grant Association, and the members of the National Marine Education Association who attended the 1976 association conference in California. Based on the comments and suggestions of these groups, the statement was revised again.

To produce a draft statement representing the views of an audience of educators broader than those already committed to the importance of marine education was the next step, and the University of Delaware Sea Grant College Program proposed to the Office of Sea Grant the procedure that was followed through the National Sea Grant Policy for Marine Education Project. The project enlisted the aid of educational institutions, principally Sea Grant Colleges, in conducting workshops involving a wider selection of educators. Emphasis was placed on state and local education officials, teachers, and representatives of organizations engaged in informal kinds of educational activities.

By the time the last workshop was completed in Arizona, in December, 1977, about 1300 people had reviewed the draft statement with opportunity to comment.

Whenever possible, the workshop coordinators mailed copies of the draft statement and a questionnaire to workshop invitees in sufficient time for review before the workshop. The workshop itself was to encourage free discussion. In a few cases, advance distribution of the statement was not possible and the workshop combined a reading and on-the-spot analysis. There was a surprising consistency among participant comments and a number of cogent and useful suggestions for improving format, language, and content. These were all carefully noted, and to the extent possible, ideas and suggestions were incorporated into the present statement.

This statement is presented as provisional because its purpose is to stimulate even wider discussion. No final statement on the need for marine and aquatic education can be prepared until there is more experience around the nation in incorporating the world of water into the process of education and a more definitive, data-based assessment is made.

Although the project to prepare the statement was based at the University of Delaware, the workshops were planned and conducted by other institutions, and directed by workshop coordinators of those institutions. It is to the coordinators that credit is due for the stimulating, provocative, and successful workshops — 26 in all, held in 16 states.

Two or more workshops were held in some states with different or joint coordinators. For the most part, University of Delaware project personnel attended the workshops, sometimes as participants and at other times as observers. Between them, the authors, Goodwin and Schaadt, attended all but five of the 26 workshops and can speak from experience about the hard work and dedication to the project of the following coordinators:

ARIZONA

L. Mayland Parker,
Department of Geography
John F. Lounsbury, Director,
Center for Environmental Studies
Arizona State University
Tempe, Arizona 85282

CALIFORNIA

Dorothy Bjur, Education Coordinator,
Institute for Coastal and Marine Studies
University of Southern California
University Park
Los Angeles, California 90007

FLORIDA

Al Volker
Advisory Service, Sea Grant Program
University of Miami
Coral Gables, Florida 33124

LOUISIANA

James Schweitzer
Center for Wetland Resources
Louisiana State University
Baton Rouge, Louisiana 70803

MAINE

Les Picker
College of Education
University of Maine
Orono, Maine 04473

Richard Schlenker
Maine Maritime Academy
Castine, Maine

MASSACHUSETTS

Warren Little, Director for Education
Linda Lucchesi
New England Aquarium, Central Wharf
Boston, Massachusetts 02110

MICHIGAN

Leslie Lin
Michigan Sea Grant Program
University of Michigan
Ann Arbor, Michigan 48105

MISSISSIPPI/ALABAMA

Barry McIlwain
Mississippi-Alabama Sea Grant Consortium
Ocean Springs, Mississippi 39564

NEW HAMPSHIRE

Peter Randall
Marine Advisory Program
University of New Hampshire
Durham, New Hampshire 03824

NEW YORK

Elizabeth Pennisi
Brian Doyle
Sea Grant Advisory Service
New York State
State University College
Brockport, New York 14420

OKLAHOMA

Theodore Mills
Department of Science Education
Oklahoma State University
Stillwater, Oklahoma 74074

OREGON

Don Giles
Marine Advisory Service
Oregon State University
Marine Science Center
Newport, Oregon 97365

RHODE ISLAND

Prentice Stout
Marine Advisory Service
University of Rhode Island
Narragansett, Rhode Island 02882

TEXAS

Sally Meyland
Center for Marine Resources
Texas A&M University
College Station, Texas 77843

VIRGINIA

James Lanier III
Susan Gammisch
Sea Grant Program
Virginia Institute of Marine Science
Gloucester Point, Virginia 23062

WASHINGTON

Alyn Duxbury
Division of Marine Resources
University of Washington
Seattle, Washington 98195

John Smith
Gray's Harbor College
Aberdeen, Washington 98520

MARINE TECHNOLOGY SOCIETY
COMMITTEE ON EDUCATION

Roger Anderson, Chairman.
Gulf and South Atlantic Fisheries
Development Foundation
Tampa, Florida 33622

Arie R. Korporaal, Chairman.
Office of the Los Angeles County
Superintendent of Schools
Downey, California 90241

NATIONAL MARINE
EDUCATION ASSOCIATION

Thayer Shafer, Executive Secretary,
546-B Presidio Boulevard
San Francisco, California 94129

COUNCIL ON EDUCATION,
SEA GRANT ASSOCIATION

Gerald S. Posner, Chairman.
City University of New York
New York, New York 10021

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A number of people took time to write their comments to the authors, and we acknowledge their contributions with particular thanks even though there were too many for individual acknowledgements.

Appendix Two

About Marine Careers

An obvious specialized goal of marine and aquatic education is to educate and train the variety of people needed to work at all levels in the marine and aquatic environments. The range of jobs and careers relating to the world of water is from unskilled workers to specialists with advanced university degrees.

Of the more than two million people employed in marine-related work, including vessels and shipyards on the inland waterways, only about a fourth actually work *on* the water. The rest stay ashore in marine and water-related industries. It is also pertinent that less than 20 percent of the work force is classed as professional and technical personnel.[7]

During the past decade, new courses for skilled personnel as marine technicians, fishermen, and seafood processors have been developed, primarily by the Sea Grant Program. The traditional academic programs in the sciences and engineering have been improved and augmented. Most of the available courses in colleges and community and junior colleges are listed in *University Curricula in the Marine Sciences and Related Fields.*[8]

More recently, courses have been initiated in high schools to teach skills at a somewhat lower level, but there is no current list.

For the most part, the courses (including those in two-year colleges) are offered in coastal cities.

Traditionally, marine and aquatic careers have been seen in terms of the sciences, engineering, or the skilled trades. But the changing times have brought a demand for economists, lawyers, and both business and public administrators competent to work in the appropriate fields. A number of universities in the Sea Grant program now offer courses in general marine affairs designed to provide background in marine matters to careerists whose work may somehow impinge on marine considerations but who are not primarily marine careerists. There do not appear to be comparable courses for those concerned primarily with fresh water.

There is nothing mysterious or esoteric about marine careers at any level. They follow the pattern of other professional and vocational education.[9]

Perhaps the single most urgent need in the marine career field is for improvement of career counselling at all levels from high school to graduate school. Popular media programs create false impressions and expectations which guidance counsellors must be prepared to counter with accurate information. A program of marine and aquatic education should provide such information.

Appendix Three

The following is one example of a conceptual scheme for marine and aquatic education which might be used either for course development or as an outline for development of materials and units.

A Conceptual Scheme For Studies of Aquatic Environments

by

Maura Geens Tyrrell and Robert W. Stegner

1. An Abundance of Water Makes the Earth Unique in Our Solar System
   - 1.1 Water has a unique combination of chemical and physical properties.
     - 1.11 The chemical and physical behavior of water results in part from the geometry of the water molecule.
     - 1.12 Within the range of temperatures encountered on earth, water exists in three states: solid, liquid, and gas.
     - 1.13 Water exchanges large amounts of heat as it changes in state.
   - 1.2 Water in the environment contains a variety of substances in suspension and in solution.
     - 1.21 Water is a very effective solvent.
     - 1.22 Dissolved and suspended substances affect the properties of water.
     - 1.23 Water in nature usually contains gases, organic compounds and mineral salts.
     - 1.24 Many substances dissolved or suspended in water are recycled through biological, geological, and chemical systems.
2. Aquatic Environments Interact with the Earth and Its Atmosphere
   - 2.1 Most of the earth's water is in the oceans.
     - 2.11 Oceans formed early in the history of the earth.
     - 2.12 The earth's surface water is constantly recycled through the oceans.
   - 2.2 The ocean waters are influenced by the earth's rotation, revolution, and position in the solar system.
     - 2.21 Ocean current patterns are affected by the absorption of solar energy.
     - 2.22 Ocean current patterns are affected by the earth's rotation.
     - 2.23 Tides result from gravitational forces of the earth, the moon, and the sun.
   - 2.3 Energy is transferred wherever bodies of water meet the land or atmosphere.
     - 2.31 Atmospheric movements generate waves, surface currents, and coastal winds.
     - 2.32 Moving water shapes land forms.
     - 2.33 Subsurface topography is constantly changing.
     - 2.34 Land and sea floor movements generate waves.
     - 2.35 The aquatic environment helps to stabilize the earth's climate.
   - 2.4 Materials carried from land masses influence the physical and chemical features of rivers, lakes, and coastal zones.
     - 2.41 Water, ice and wind carry minerals, nutrients, sediments and fresh water into rivers, lakes, and coastal zones.
     - 2.42 Fresh water from the land dilutes the coastal waters.

3. **Aquatic Organisms Interact in Complex Ecosystems**
   - 3.1 Life probably originated in the marine environment.
     - 3.11 Water facilitated the chemical evolution of organic compounds and coacervates.
     - 3.12 Chemical evolution resulted in heterotrophic systems.
     - 3.13 Autotrophs evolved from heterotrophs.
     - 3.14 Aquatic environments have supported the evolution of a diversity of species.
   - 3.2 Aquatic organisms are adapted to their environments in different ways.
     - 3.21 Aquatic organisms are adapted developmentally, structurally, functionally, and behaviorally to their environments.
     - 3.22 Organisms in aquatic communities interact in balance with their environment and with one another.
     - 3.23 Populations of aquatic organisms are unevenly distributed.
   - 3.3 Aquatic ecosystems depend on a constant flow of energy and the recycling of materials.
     - 3.31 Energy for the maintenance of aquatic ecosystems comes from the sun.
     - 3.32 Aquatic plants convert solar energy to food energy.
     - 3.33 Aquatic organisms transfer energy and materials through food webs.
     - 3.34 Aquatic bacteria reduce organic materials to simpler forms.
   - 3.4 The stability of aquatic ecosystems tends to be directly proportional to the diversity of its populations and the complexity of relationships among them.

4. **People Are Part of Aquatic Ecosystems**
   - 4.1 Aquatic environments have affected the course of history and the development of human cultures.
     - 4.11 Oceans, lakes, and rivers have served as routes for the dispersal of human populations and cultures and for commercial transport.
     - 4.12 Proximity to aquatic environments and the availability of aquatic resources have influenced the cultures of many societies.
   - 4.2 People's activities may alter marine ecosystems.
     - 4.21 People collect and culture aquatic resources.
     - 4.22 Exploitation of aquatic environments can cause depletion of many marine and freshwater species and the degradation of habitats.
     - 4.23 People are changing aquatic ecosystems by adding pollutants to land, to air and water.
   - 4.3 Existing technology is capable of maintaining the health and usefulness of aquatic ecosystems.
     - 4.31 The maintenance of the health and usefulness of aquatic environments depends on value judgements and ethical considerations.
     - 4.32 Regional and international agreements will be essential for the conservation of aquatic resources.

Appendix Four

Memorandum of Agreement Between The United States Office of Education and The National Oceanic and Atmospheric Administration

The purpose of the memorandum is to establish a formal cooperative relationship between the United States Office of Education and the National Oceanic and Atmospheric Administration which will result in mutually beneficial information exchange and interagency activities designed to stimulate a wide range of activities at the federal, state, regional, and local levels between marine and coastal related fields and the educational continuum and which will further the respective agencies' missions. The end purpose of these joint activities is to encourage the development of an integrated and coordinated national, state, regional and local marine environment education program.[1]

To this end, the following types of activities, arrangements, and understandings will be jointly pursued. Reimbursement as appropriate will be made when the National Oceanic and Atmospheric Administration or the United States Office of Education renders service to assist the other agency in performing its functions.

I. The United States Office of Education will assist the National Oceanic and Atmospheric Administration in the design of a national strategy for marine and coastal education. This strategy will be set forth in a concept/policy paper. The paper will contain philosophy, definitions, short- and long-range strategies and recommendations for moving marine and coastal education forward.

II. A primary purpose of this agreement will be to further the intent of both agencies to create as much involvement and interaction as possible between traditional education agencies, institutions, organizations, and existing marine and coastal oriented institutions and programs.

III. The United States Office of Education will encourage state departments of education and related educational organizations at the state and regional levels to work closely with Sea Grant institutions and those other agencies/institutional organizations concerned with marine and coastal education and related employment opportunities.

IV. When feasible, representatives of each of the agencies will accompany representatives of the other in visiting or reviewing marine and coastal educational or related education projects at organizations or institutions sponsored by either agency.

V. Proposals received by each of the agencies and relating to marine and coastal education would be referred to the other for information, comment, or review.

VI. To help carry out this agreement, each agency will designate a management coordinator.

VII. The assistance and support of the National Advisory Committee on Oceans and Atmosphere, the National Academy of Science, the National Academy of Engineering, the Council of Chief State School Officers, the National Ocean Policy Study Committee and other appropriate Congressional and Executive offices will be sought on behalf of both agencies.

Ernest Boyer
United States Commissioner
of Education

Richard A. Frank
Administrator, National
Oceanic and Atmospheric Administration

August 25, 1977

[1] The term "marine environment" means the coastal zone, as defined in Section 304 (1) of the Coastal Zone Management Act of 1972 [16 U.S.C. 1453 (1)]; the seabed, subsoil, and waters of the territorial sea of the United States; the waters of any zone over which the United States asserts exclusive fishery management authority; the waters of the high shelf [as created by Public Law 94-461, Section 203 (6) of the National Sea Grant Program Act].

Appendix Five

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Photographs:

Hank Frey
Kathi Jensen
NOAA
Al Pione
James G. Schaadt
Richard Stewart
John Taylor
University of Delaware Sea Grant