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The marine resources of Virginia, their development, use and preservation

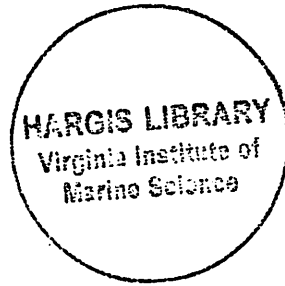
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THE MARINE RESOURCES OF VIRGINIA
THEIR DEVELOPMENT, USE
AND
PRESERVATION



An Address By
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Gloucester Point, Virginia
presented at the
Governor's Conference on Natural Resources
Hotel John Marshall
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An Abstract

Virginia's marine resources encompass all the physical, biological and aesthetic attributes of her 13,000 square miles of marine waters and bottoms and 4,000 statute miles of shoreline, beaches and marshland.

The economy of the Commonwealth is closely related to these valuable resources. Maritime Virginia, that region extending from the Continental Shelf to the fall line of the ocean's tributaries is our most populous, productive and fastest growing area. Sixty per cent of all Virginians live in one third of the counties and the population increase has been 98 per cent in twenty years. A 37 per cent increase is anticipated in the next six (6) years along the James. Seven billions of dollars change hands annually.

The combined forces of population, industrial, recreational and shipping growth along with more military activity are placing greater and greater demands on the marine environment for water, food, recreation, building sites and waste disposal. While these sociological and economic segments enjoy the blessings of Virginia's marine resources, they also degrade them, often in such a way that nature, unaided, cannot compensate.

Destructive degradation must be prevented or minimized. To do this there is need for better planning and management, for better standards. This will involve modern decision-making techniques such as operations research or resource engineering using latest methods for analysis and decision, plus more adequate planning--even zoning, plus more realistic legislative and executive and private regulation of marine resource uses and users.

All these activities require facts, knowledge about the resources, themselves, and the pressures to which they are or will be subjected. This means continuing research on marine resources and continuing evaluation of their usage and condition. Education of and cooperation between science, the public and political persons and groups is an absolute necessity.

THE MARINE RESOURCES OF VIRGINIA

THEIR DEVELOPMENT, USE

AND

PRESERVATION

Preface

THE SEA - boundless source of energy, water, food, joy and wonder; engine of weather; highway for commerce; avenue of attack; bastion of defense; receptacle of society's wastes; repository of earth's soil; theater of history; scroll of the ages; cradle of life-- It Is Important - It Must Be Known. THIS IS THE BUSINESS OF MARINE SCIENCE.

THE PAST

Virginia was colonized via the sea, her early economic, social and political development was near the shores of the sea, her connection with the mother country was through the sea, protection and severance from a wrathful and oppressive government was provided in significant measure by the sea. Virginians have been succored, amused, and terrorized by the sea and her major cities are on tidal tributaries of the sea. Despite this, Virginia's chief attention was directed landward early and this direction persisted for many years--well into the present century. Now attention is finally returning to the marine environment. It is being foreed to.

Except for casual mention of marine fishery products, when development, use and conservation of natural resources are considered, soils, forests, mineral resources, and wildlife receive the chief attention, often in that order. Though no one will deny the importance of these terrestrial resources it is necessary and timely that the

marine resources receive their portion of our attention. This need is becoming increasingly apparent. Dramatic events of recent years have demonstrated that our tidal waters are not as inexhaustible or indestructible as was once thought.

ECONOMIC ASSETS OF TIDEWATER VIRGINIA

Though aesthetically displeasing to some, it often helps to focus attention on a subject by citing its economic and social impacts.-- Dollars talk! forcefully--and sometimes crudely, roughly and thoughtlessly. For a complete breakdown of the economic assets of Maritime Virginia see Appendix I.

Tidewater or Maritime Virginia consists of those counties, cities and towns located at the fall line and eastward to the sea. Included are approximately 33 -- about a third -- of her counties and the largest cities and suburban areas. Almost 60 per cent of the people live in Tidewater, where the greatest population and industrial growth in Virginia has occurred. Almost seven billion dollars change hands in Maritime Virginia each year. Much of this commerce is directly related to activities oriented toward marine resource. The capitalized value of marine resources, whether self-renewing or depletable and of marine oriented industrial, residential and commercial activities is great, exceeding several hundred billions.

VIRGINIA'S MARINE RESOURCES

What are Virginia's marine resources? What makes Tidewater so important and enables it to make the major contribution to the economic well-being of the entire Commonwealth?

The Marine Waters

The marine waters, themselves, are important. Virginia has responsibility over or ready access to 13,000 square miles of sea water.

These waters serve as sea lanes, as highways, to float and facilitate movement of the merchant and naval fleets of the United States and half the countries of the globe. They receive, remove and purify, within limits, the wastes of these fleets. They provide water to cool the power plants and clean and succor the sailors. It is because of the importance of these waters to coastal and international commerce and communications that the major industrial units, the military bases and the major communities of eastern Virginia have arisen. Growing recreational fleets make use of these attributes.

The lovely waters of the Virginian Sea (Captain John Smith's name for the mid-Atlantic between Capes Hatteras and Cod), Chesapeake Bay and the tidal rivers stretching far inland are sources of wonderment and beauty and provide the setting for shorebound beauties or even serve as the main attraction, aesthetic value, of eastern Virginia. People are fascinated, rested and restored or rejuvenated by the ageless, limitless, inconstant face of the sea. This attribute in itself is of great, though not readily calculable value to society. Despite the difficulty of directly evaluating the dollar worth of the aesthetic features of the marine resources they do, however, engender vast economic activities and production.

The combination of sea, sand and sun is usually irresistible. Hundreds of thousands of people are attracted temporarily (tourists and vacationists) and permanently to the shorelines of the State, partially because of the water. Williamsburg, Jamestown and the towns, homes and river plantations of the James and other estuaries are made more attractive by the proximity of attractive waters and shorelines. Industrial and military recruiting in the area is made easier by their presence, though this is not an unmixed blessing.

Marine waters with their special properties support profuse and diverse forms of life which in themselves are interesting and useful resources.

The waters of the sea, especially the brackish waters of the estuaries serve as processing and, more generally, cooling waters for industry and shipping. Estuarine and marine waters also receive, to dilute, disperse and transform, it is hoped, the waste materials and water from the major cities. For example, they are used variously as primary, secondary or tertiary and final sewage treatment plants for Richmond, Petersburg, Hopewell, Newport News, Norfolk, West Point, Fredericksburg and the metropolitan Washington complex, etc. and the major industries of the State. Wastes of all types including agricultural and radioactive materials reach the estuaries and the sea. This use has saved communities and industries millions of dollars but has often been a wasteful and destructive process. We have not hesitated to put marine waters to this use--we should recognize their service in any accounting of valuable marine resources.

Because they function as an almost universal solvent, the waters of the sea receive, dissolve, hold and sometimes release, most of the important elements and compounds known. Because of this it is a rich natural nutrient for life from the lowest to the highest forms.

In addition, the waters of the sea serve as storehouses of energy, moderators of weather, determiners of climate and as the central reservoir of 90 per cent of the earth's water. The ocean is our ultimate source of water--it is our greatest water reservoir.

Marine waters, especially the less salty estuarine waters, will be increasingly used for drinking, irrigation and process water. To do this, special techniques of capturing less salty surface waters or of

desalting the marine or estuarine waters will have to be developed.

Valuable though they are, these waters also are the cause of economic loss and death. Destruction of real property by slow erosion or swift storm damage is not uncommon. Loss of life and property on land and ships and their cargoes at sea are frequent.

Increasing contamination by chemicals, sewage, radioactivity, silt, heat and multiple, sometimes destructive, use of these waters both above and below their fall lines pose serious threats to their cleanliness and utility and undoubtedly affect their habitability by marine organisms of all kinds.

Shorelines, Beaches and Bottoms

The waters of the Virginian Sea and the estuaries are bounded and contained by shorelines and bottoms which, themselves, play important roles in the ecology of the marine environment and in the economy of the Commonwealth.

There are over 4,000 statute miles of tidal shoreline in Virginia. These vary from salt marshes and muddy flats to sandy ocean and river beaches and high bluffs. Some are stable--some are not.

Shorelines are economically and aesthetically valuable. Almost everyone likes to wander along a sandy strand. This is a peaceful and healing pleasure. Many people wish to build permanent or vacation homes along ocean and bay beaches and water. Residential shoreline is extremely valuable, often costing over \$100 a linear foot, unimproved.

Pleasure beaches are particularly valuable not only in cost per linear foot but attractiveness to recreationists with money from elsewhere. So valuable are they that expensive engineering works whose sole function is to protect the beaches and resort properties and costly programs of beach replenishment are justified. To remedy damage caused

to Virginia Beach by the "Ash Wednesday (1962) Storm" cost over ten million dollars and a continuous replenishment program is underway. Because of building and replenishment programs like this, submarine sand has become a valuable resource and a search is on for sources of high quality strategically located sand for beach nourishment.

Though, perhaps, not as aesthetically pleasing as sandy shores or high bluffs, tidal marshes are nonetheless extremely valuable. Because of their high plant productivity, they supply a great deal of nutrient material to the main streams as their annual cycles of growth, death and decay continue endlessly. Many tidal flats produce as much converted energy per acre as farm land of highest productivity and they do it without any effort by man. Tidal marshes are important "respiration areas" and play significant roles in the overall circulation and energy balance of our estuaries. Salt marshes now serve as nursery areas for many species of fishes, crabs and other marine animals. In short, salt and estuarine marshes are extremely important to the marine environment and the welfare of marine organisms. Marshes also support shore and wetland birds and mammals. Hunters derive great enjoyment and spend \$603,000 each year to hunt in Virginia's tidal lowlands.

Shorelines are being occupied at increasing rate by private property owners, resort owners, communities and industries. The era of untrammled beaches is rapidly ending. Marshes are being drained and filled at an increasing rate. Virginia must be careful that wetland destruction does not destroy the useful and aesthetic attributes of our marine areas. Public beaches must be provided and "virgin" wetlands must be set aside.

Bottoms from the low water line out are obviously as extensive in area as the waters they underlie. Virginia's marine bottoms are

valuable, containing many valuable natural attributes and resources. The nearer the surface of the water they lie the more valuable they are, within limits. Natural growth and culture of valuable shellfish, such as oysters, hard clams and soft clams, makes many acres of bottoms extremely valuable. Those not preserved to the public, i.e., outside the Baylor Survey boundaries, are much sought after by private planters as oyster leases from the Commonwealth. Under lease they are nurtured, bartered and passed on as valuable land properties. Indeed, crops produced on these lands by oyster farmers can bring more money per acre than the best farm land. Properly managed, even with information now at hand, those grounds in public care can be just as productive. Perhaps the most productive oyster grounds in the world are those of the lower James estuary which have served as oyster seed beds and original sources of over 75 per cent of all oysters grown in lower Chesapeake Bay for many years.

In addition to serving as beds and sources of shelter, support and nutrients for important marine animals, Virginia's tidal bottoms contain valuable deposits of gravel which have been dredged for use in construction and commerce for sometime. Furthermore, fossil and recent, but overlain, submerged oyster shell reefs have been exploited for years, not only for oyster repletion programs, but also to manufacture lime and chicken feed and for other industrial uses. Use of this non-renewable resource for industrial purposes is rapidly increasing and a sizable shell-dredging operation has developed in Virginia waters.

Sand has long been used in construction projects. The islands of the new Chesapeake Bay Bridge-Tunnel and much other commercially valuable land has been built of submarine sand.

The bottoms also serve as substrates for many bacteria and animals and plants which may be themselves necessary to the ecological web of these marine environments or may serve as food or attractants to important fishes and crabs.

Indeed, unseen and unappreciated as they usually are, the sandy, muddy, light and dark bottoms of Virginia's estuaries, bays and sea are natural resources of great value to the Commonwealth. There bottoms can become contaminated by silt, chemical and radioactive wastes. Nursery areas and clam, oyster and crab beds can be destroyed completely. Being essentially non-renewable resources, gravel and shell can be depleted. Contamination and destruction must be prevented and over use of shell and gravel resources must not be allowed to occur. These things can be accomplished only if we understand processes and results of contamination and if we know what our usable stocks of resources are. We do not as yet.

Marine Organisms

In the past talk of Virginia's marine resources has centered around marine life, more specifically those marine organisms that could be caught, processed and marketed for a profit (see Appendix I.) We have seen above that there are useful marine resources other than the biological; however, because they are living, transient and greatly variable in quantity the fishery resources have received much attention.

Many fishes and several molluscs and the blue crab are economically valuable and are now being utilized. Others in each of these general classes of living things to which these animals belong could be utilized were markets developed or new capturing and processing techniques perfected. Still others could be utilized or utilized more efficiently were adequate cultural, aqua- or mariculture, and processing techniques developed.

Many plants and animals, though not directly useful to Virginia, are--nevertheless--necessary to the food chains (the web of life) that supports other valuable fishes and processes. Some marine animals and plants, for example, certain jelly fish, shipworms and grubs, fouling organisms, oyster drills, oyster worms, red-water organisms and parasites, are "natural resources in reverse." They disrupt man's marine-oriented activities and affect his plans and economy. Even they, however, have a place in the natural scheme of things which it may not be wise to unbalance too readily by their mass destruction.

Molluscs - oysters, hard clams, soft clams, surf clams, mussels, scallops, snails, squid

Of all the groups of marine organisms represented in the marine environment the molluscs are the most valuable. The rich, actual or potential, economic fauna includes the Atlantic oyster, hard clam, soft clam, surf clam, sea scallop, mussels, whelks and conchs and other small snails. Though used primarily as bait for sport fishermen, some squid are caught and sold for food. Almost all of these could probably stand heavier exploitation were proper methods used and markets available (see Appendix II).

The molluscs are also most likely prospects for actual farming or mariculture. It is not surprising, therefore, that oysters and hard clams are being crudely farmed and that it is on these species that actual breeding and controlled hatching and rearing work is being done by science and industry. Even under present inadequate culture methods and notwithstanding temporary short-or long-term difficulties resulting from diseases and predators, Virginia's oyster production could be doubled or tripled in a short period of time with very little effort. The technique and scientific know-how

are available. Though some of Virginia's problems in not increasing production stem from traditional social practices, some are due to an antiquated and backward outlook by the industry and some are due to poor or inappropriate private and public management practices.

As far as is known all marine animals are sensitive to the wastes of society but because they are largely fixed in position and cannot readily escape, molluscs are especially vulnerable to long-term contamination of their home waters by chemicals, heat or silt. Though small amounts of domestic sewage may be beneficial, which possibility should be considered and utilized where possible, large amounts are detrimental as are almost all industrial and radioactive wastes. Estuarine and coastal waters must remain as pollution-free as possible.

Finfishes

Many species of fishes live in Virginia waters. Many are already exploited and many more could be utilized were markets available or were the need for additional protein really great (see Appendix III). Of those now being used, only four or five are being exploited to or beyond their probable maximum capacity.

Indications are that at present levels of exploitation man's activities have little effect on population levels of most fishes. Natural factors of hydroclimatology are of greater significance. However, long-term changes in water quality or in the nursery and spawning areas may be affecting the finfisheries, especially those whose survival depends upon the availability of special, often restricted, waters and bottoms for parts of their life histories.

Crustacea

Virginia predominates in production of the blue crab. Though

the supply fluctuates, it has generally been adequate to meet demands. Delicious crab products are, or should be, well known to everyone. The population might be exploited more heavily. Lobster is also caught and other crustaceans might be used (see Appendix IV). Crustacea are susceptible to overfishing, pollution and destruction of nursery and spawning areas by siltation and engineering changes.

Other Organisms

Though not commercially exploited or perhaps even exploitable, many microscopic marine plants and invertebrates are useful as food for higher organisms. In addition, their qualitative and quantitative distribution may serve to indicate water quality. Quite often governmental and industrial groups interested in maintaining natural waters are not brought into action until some plant or animal has clearly indicated poor conditions, e.g., severe mortalities of fishes and invertebrates, plankton blooms, macroalgae destruction.

Virginia still possesses a wealth of useful marine organisms. From them she derives revenues at landing of about 22 million dollars. About 10,000 people are directly involved. At wholesale and retail the amounts of money and people involved double and triple. Seafoods have long been a part of the Virginia scene, a part worth preserving not only for the delightful variety they provide but because they will be really needed in the future.

An especial value of these resources is the fact that they are largely self-renewing. That is they replenish themselves regularly with very little capital investment from man. Were we to back calculate their capital value to Virginia at 10 per cent per annum, it is plain that an investment of \$200,000,000 dollars, a too conservative figure,

would be required as the capital investment in any manufacturing industry in order to produce such an annual sum. It is in this way that comparisons should be made when plans are being made for industrialization and development of the marine resource systems.

Sport Fishing

Marine organisms are more useful and perhaps more heavily exploited for recreational and aesthetic purposes than for commercial reasons. It is impossible to place values on the expectation and thrills of merely seeing animals and plants in the water. Though some are at times nuisances and repulsive, like jelly fish and watermilfoil, it is likely that most of the fascination inherent in estuarine and marine waters would not be there were animals and plants gone. Absent would be the lure of wading along and flushing and observing small fishes and crabs and no delightful treasures would be washed upon the beaches for amateur beachcombers to find and squirrel away. Sport fishermen are rapidly rivaling commercial exploiters as users and sources of pressure on fishing stocks. Though estimates are available for sport fishing expenditures they tell only part of the story.

Though not strictly aquatic or marine, ducks, shorebirds and certain furbearing mammals are regular inhabitants of tidal marshes. Each year 13,000 sportsmen spend over half a million dollars to enjoy these self-renewing resources of Virginia tidal marshes. Thus, not only is marshland valuable and essential as nursery areas for many marine organisms but it is also useful recreationally. Aesthetically, marine marshes are beautiful, wild often lonely places where many wonderful birds and animals can be seen, photographed, hunted and enjoyed. As mentioned above, when marshlands are destroyed not only is estuarine production of other marine animals reduced but these

marsh animals and plants, themselves, are gone forever.

It might be mentioned that the ocean of air above us is a valuable natural resource also and that an uncontaminated atmosphere is an important asset to enjoyment of marine resources. Airborne contaminants fall mostly on the sea (the sea occupies most of Earth's surface) but that is a subject as vast as the sea and will be left for some other time and person.

MARINE RESOURCE PROBLEMS

It has been shown that Virginia has a vast treasure trove of aesthetic and economic wealth in her marine waters. Indeed it is certain that a great part of Virginia's actual and potential wealth is marine oriented.

The marine environment is complex. Most of Virginia's marine resources are located within, along or under the major estuaries and the coastal lagoons or the shallow reaches of the Virginian Sea. In contrast to deeper ocean waters, these are areas where the shore and sea meet, where fresh water from upriver and from other surface and subsurface drainage meets and dilutes the salt water from the sea. Here also the shallow bottoms have their greatest effect on the currents and on the contents, chemistry and biology of the brackish and salt waters above them. These coastal waters receive soil eroded from the land with its minerals and, as a consequence, are usually richer than those of the deep oceans. Estuarine and coastal seas also receive the suspended or dissolved wastes from all cities, towns, homes and industries along all coastal rivers.

With the close and immediate interactions taking place between the land, the sea, the atmosphere, fresh and salt water and society,

coastal waters are extremely complex in nature. Many factors interact to give them their natural characteristics. Because of this inherent complexity, they are difficult to understand and manipulate intelligently.

Complex User Requirements

Because of their proximity and accessibility, the coastal waters are the most used and exploitable of all the waters of the world ocean. Many users wish to take their "cuts." Sometimes these uses are in real or apparent conflict with each other and some uses are temporarily or permanently damaging to the resources. The James and Rappahannock rivers are excellent illustrations of the innate complexities of our coastal waters. In their downriver, tidal reaches, both are stratified systems with heavier salt water from the Bay on the bottom and lighter fresh water from the upriver and shoreline drainage areas in the upper layer. The salty bottom waters flow upstream even though the fresh flow is downstream. This creates problems as in the case of the lower James where it is certain that a change in the depth of the river bottom will alter the velocity of the upstream flow, change the depth of the lower layer and allow waters of greater salinity to intrude further upriver than before. Though these changes are certain the extent is uncertain. Also unknown are the possible repercussions these physical changes, certain to occur, will have on the oyster fishery. It is known that successful larval survival and spat setting and survival depend upon the upstream current and the upstream limits of salinity. This has been the chief natural resource problem in the James River development program up until now.

Changes in the volume rate of flow in the upper, fresher layer are also important in determining success of marine organisms.

As a consequence, dams which may be operated in such a way as to change the flow may change the salinity regime and affect survival of oysters, clams and other useful invertebrates by allowing salinity-dependent predators and survivors onto productive bottoms. This prospect is being considered in the plans of the Salem Church Dam on the Rappahannock River.

Engineering Projects

Engineering projects such as channel enlargement and realignment and dam construction on our estuaries are numerous and increasing. Each year sees dozens of small and large channel projects: Over 400 small and large dams are proposed for the Potomac system alone for the next several years.

Reservoir construction and operation are not the only engineering difficulties that marine resources must face. Also involved are fill and drainage of salt marshes, filling and erosion of shorelines and waterways, bridge and island construction and siltation resulting from engineering projects. Engineering activities may pose severe threats to marine resources. Conversely, they may also be planned and operated so as to enhance those resources, e.g., reservoir operation to reduce pollution and improve water quality or actually enhance oyster and clam survival and growth, as the Institute and the Corps are attempting to do with the Salem Church project. It is possible, by proper planning to minimize adverse effects.

Contamination

Increasing populations and industrialization along our tidal rivers will be inevitably accompanied by increasing contamination-- this cannot be escaped at this time. The James and the Rappahannock are, even now, being polluted (more than necessary). The problem is

one of degree. Pollution can and must be controlled and minimized. Difficulties in setting allowable tolerances for marine water quality are encountered because we lack the detailed information concerning the physiological responses of the organisms necessary to set such limits.

Shoreline Use

Virginia's shorelines are rapidly being occupied. Potential shoreline for industrial, residential and recreational use are diminishing. In many areas the most valuable shores are already gone. It is important that those remaining be husbanded wisely. We must be especially careful that the urge to grow and industrialize does not eliminate natural areas important to the ecology of the estuaries, the survival of important organisms, the recreational activities of man and aesthetic uses. Only the bare minimum of degradation must be allowed. For this reason plans for the use of this land should and must be developed well ahead of pressures.

It is a happy characteristic of our system that enterprise is encouraged and that individuals, communities and industries and even states promote their own interests, growth and development. Unfortunately, quite often these promotions create unforeseen pressures on the natural environment. Often they create pressures that are contrary to, or augmented by, the desires of existing users. As an example, a manufacturing industry may wish to use estuarine waters to cool or in processing and to receive its wastes. These desires even within a single economic unit may conflict. The employees of that plant and the community in which it is located may use the water to swim and fish and for the disposal of wastes and the shorelines as homesites. These may also conflict with each other and the industry that they serve.

Exploitation of Marine Organisms

Destruction or degradation of the marine habitats by poorly conceived and operated engineering projects, by contaminants and siltation serve to eliminate or reduce marine organisms. Also, important are the harvesting activities of man.

As has been mentioned above (see also Appendices II, III, and IV) most commercial or sport species of finfish and molluscs in Virginia waters are not being exploited to their fullest. However, a few are and great care must be taken not to eliminate these much used forms. Furthermore, we must always be careful not to exceed that fine point beyond which rational exploitation becomes too heavy and destructive. All too often we cannot even recognize this point. Because survival and success of marine animals and plants depends upon so many factors including not only those actually or potentially destructive activities of man mentioned above but also natural catastrophies or changes, complete understanding of these factors is necessary and continuous surveillance obligatory.

In the past, heavy dependance has been placed upon regulation of fishing pressures by law. With more adequate knowledge this approach has been shown to be fruitful in only a few cases. Often the restrictions have served no useful purpose. It is especially important that laws and regulations and other management decisions and devices be based upon the resources themselves and not upon uninformed whim, opinion or pressure. To have it otherwise accomplishes nothing but wasteful restriction.

In order to successfully make use of and conserve the living marine resources, it will be necessary to learn more about their ecological requirements and their physiological responses. In addition,

a continuous and careful monitoring of the stocks of all major species is needed.

For many species, it seems unlikely that we can really do much to increase their numbers. They must, of course, be protected from over-utilization and from the problems of environmental destruction. Some species can be increased by special practices such as utilizing productivity generated by human wastes or by other environmental improvements. Especially susceptible to purposeful culture are the molluscs which probably will be hatched, reared and grown under controlled conditions to get as faraway from the vagaries of nature as possible. A substantial start has been made on this. In the meantime, we can, if we will, double production now merely by revising archaic practices and following more modern procedures.

THE FUTURE

We have seen that the Commonwealth's marine resources are very valuable and much more important to her economy than most acknowledge or even suspect. Virginia is truly a maritime state. Because of their complexity and the multiple, often conflicting demands of their users, wise use and development of these resources will require careful planning and management. Rapidly increasing population levels in the maritime ~~counties~~ and burgeoning industrialization increases the necessity for prompt action.

The marine resources now suffer from poor management practices and as pressure grows their degradation becomes more intense.

Two deficiencies are especially notable. One is antiquated or inadequate decision-making processes which operate inefficiently and in provincial or partisan manner and often not in keeping with the facts

concerning the natural resources themselves. The other is the prevailing lack of adequate information on which to base wise decisions.

(Obviously, the former depends upon the latter.)

In order to improve Virginia's chances of making optimal use of her natural resources new decision-making systems are needed. Also necessary is a more careful evaluation of goals in resource use.

We must recognize that increasing populations and industrialization entail costs--costs in environmental degradation which must be recognized and minimized, if possible. Some destruction cannot be prevented. Progress, growth and industrialization cannot be halted but they must be controlled. It is wise and businesslike to do so. The cost of failure is aesthetic and economic loss.

In planning local or statewide promotional and developmental activities, careful attention should be given to all the ramifications of any course of action. It has been shown many times that new uses of or additional pressures on the marine resources degrade those resources and are detrimental to their desirable attributes and contrary to the interests of previous users. We must be sure, for example, that increasing industrialization on an estuary will not destroy an important fishery resource or interfere with an established and important tourist or recreational industry, unless we wish to sacrifice those activities. Some uses are mutually exclusive no matter how they are planned and carried out. Others can be made compatible with careful planning. Still others are compatible from the outset. Though we may be satisfied to allow one established economic use to disappear in favor of another, we must know what we are about.

One thing is certain, progress and virgin, pristine conditions are incompatible. If Virginia has any areas which should be preserved

in this condition, they must be set aside at once.

One of the keys to better planning is an efficient, effective evaluation system. At present, we employ numerous agencies, regular (VALC) and special appointive commissions or boards, and various executive and legislative groups to evaluate natural resource problems. In general, these have been somewhat effective but in really complex problems they often bog down in spiralling rounds of ineffectual investigation and reporting. They must be assisted. One ready way is for these bodies to make more use of the scientific or technical agencies or bodies and advice now available to them. Not infrequently, plans and management decisions are made and laws and regulations framed and even passed that have no real bearing on improvement of the resource ~~other~~ than intent. Quite often special study groups are established by legislative resolution to answer resource questions that one or more state agencies are actively at work on and can already answer.

Resource Engineering

Because of the increasing complexity, urgency and magnitude of these resource management problems, it would be wise to bring such techniques as Operations Research, using high speed digital and analogue computers to consider the variables and evaluate the possibilities and present a rated list of most likely decisions for further consideration by human decision groups.

Through the use of all adequate modern techniques, it should be possible to improve the results of and shorten the time for decision making. This might be called Resource Engineering.

Resource Planning and Zoning

In these times when a project to benefit one area along a

tributary might adversely affect other economic interests, often some distance away, it is important that official bodies and plans concerned with evaluation of an entire river system be developed. One technique is establishment of effective and responsible regional authorities with legal authority to, and responsibility for, zoning along an entire system. Such a group should determine well in advance what marshlands can be sacrificed, what amounts and types of wastes can be tolerated, which areas are to be preserved inviolate for historical or aesthetic reasons, where residential areas can be located, where industrial development can be encouraged and other such matters. The most critical areas for this type of activity are the James River system--and the Potomac River system estuaries in Virginia under greatest pressure.

Knowledge

To solve present and future problems, maintain and improve the marine resources, permit better planning for development and use--no matter what the mechanism for decision making--it will be necessary to have accurate and complete information about the resources. While Virginia's scientists and others have made a good start on acquiring this information and we know much more than when effective work was begun less than twenty years ago, it is apparent that we must learn more. Present knowledge is inadequate because the phenomena under study were vast and complex to begin with, as mentioned above, and because our efforts at research have been limited in scope. Furthermore, the frame of reference for our studies and decisions have changed drastically in the last twenty years and new variables are being constantly introduced by man himself. Because of these things and the urgent need to prevent

irreparable damage it is essential that information be developed at a much more effective rate than that of the present. This will require an enlarged, improved and continued research effort. It must be realized that just as society changes nature itself is not static. Increasing interaction between the two constantly causes changes in the systems science must study.

Continuing research, improved decision making and planning, in that order, are necessary to the wise use of Virginia's marine resources. Also important will be continuous efforts toward improvement in the regulations and enforcement operations of the various state management agencies involved and toward system zoning.

Education of the citizenry and public officials and development of replacement scientists and new techniques are vital.

APPENDIX I
OUTLINE OF STATISTICS
ON THE
MARINE RESOURCES OF VIRGINIA
AND
ASSOCIATED ECONOMIC ACTIVITIES

(These data from the 1962 publication entitled "Maritime Virginia" issued by the Virginia Institute of Marine Science, formerly the Virginia Fisheries Laboratory, have been revised where necessary and possible by information from a similar study now underway. Though precise figures are often difficult to obtain, this information can be considered as reasonably accurate.)

I. POPULATION OF MARITIME VIRGINIA - 1960

Total Population of Virginia	3,966,949
(Now over 4,000,000 as indicated by 1963 statistics of the U.S. Census Bureau.)	
Population of Maritime Virginia	2,282,191
Percentage of Total in Maritime Virginia	57.53%
20-Year Increase for Virginia	48.1 %
20-Year Increase for Maritime Virginia	97.8 %
20-Year Increase for Rest of Virginia	11.1 %
Land Area in Maritime Virginia	11,559
Percentage State's Land Area in Maritime Area	29%
Number of Towns and Cities on Shoreline	109
Total Shoreline Communities' Populations	1,562,898

Over 57% of all Virginians live in the Maritime Area!

More than 39% of all Virginians live in Waterfront Communities!

According to predictions from reliable sources the tidal James River will experience a 37% growth in population by 1970 (500,000 people).

II. SEAFOOD INDUSTRY

Number of Employees in 1960	9,599
Est. Value of Capital Equipment	\$200,000,000
1962 Poundage Caught	453,900,000
Value of 1962 Catch	\$ 21,300,000
30-Year Average Annual Catch in Pounds	293,602,000
30-Year Average Annual Value of Catch	.\$ 12,888,000

Commercial Fishing in 1960 was 24.9% greater than the past 30-year average, and 62.4% more valuable!

III. VALUE OF SALT-WATER SPORT FISHING

1960 Estimated Value	\$31,500,000
1955 Estimated Value	\$24,601,500
5-Year Increase	6,898,500 or 28%

Virginia is famous for its salt-water sport fishing, a form of recreation that has increased by an estimated 28% in the past 5 years.

IV. SHIPPING IN VIRGINIA - 1962

1962 Totals and Values - Virginia

Total Tons Shipped (Short Tons - 2000 lbs.)	65,569,255 tons
Total Foreign Shipments	34,016,596 tons
Value of Foreign Cargoes	\$1,099,066,514
Percentage of Nation's Total Foreign Shipping by Virginia in 1962	9.88%
Total Domestic Shipping	31,552,659 tons
PERCENTAGE INCREASE ALL SHIPPING, 1953-1962	60.4%
PERCENTAGE INCREASE FOREIGN SHIPPING, 1953-1962	107.1%

Rank Among East Coast (U.S.A.) Ports 2nd

Virginia Ports out rank all other major ports of the United States in current growth.

V. VALUE OF SHORE-BASED INDUSTRIES

Number of Shore-Based Industries - 1960	931
Number of Maritime Virginia Industrial Employees	128,463
Increase in Shore-Based Industries; 1950-1960	33.6%
Increase in Industrial Employees; 1950-1960	25.9%
Estimated Gross Product Value of Maritime Virginia Manufacturing - 1960	\$4,072,255,000

Maritime Virginia, with 931 industries employing 128,463 employees, has, in the past ten years, realized a 33.6% growth in number of industries, and 25.9% in industrial employment.

VI. ESTIMATED VALUE OF MARITIME VIRGINIA REAL ESTATE - 1960

Value of Privately Owned Land and Buildings in Maritime Virginia	\$10,045,000,000
Number of Building Permits	40,000
Value of New Construction	\$ 380,000,000

Privately-Owned property in Maritime Virginia is worth over \$10-billion - not including government-owned properties - and construction in 1960 was valued at \$380-million.

VII. VALUE OF THE MILITARY TO MARITIME VIRGINIA

Number of Installations	11
Employees - Military and Civilian	127,900
Fleet-Based Navy Personnel	65,000

Annual Spending by Naval Installations for Payroll, Goods and Services in the Maritime Area	\$1,500,000,000
Estimated Annual Spending by Military for Payroll, Goods and Services in the Maritime Area	\$2,300,000,000

Maritime Virginia harbors one of the greatest concentrations of military power in the world, and the military is important to the economy of Virginia, bringing over \$2.3 billion annually into this area.

VIII. ESTIMATED VALUE OF TOURIST TRADE TO MARITIME VIRGINIA - 1960

Number of Out-Of-State Tourists to Maritime Virginia	20,000,000
Tourist Spending in Maritime Virginia	\$400,000,000
Number of Businesses in Maritime Area Partially or Wholly Dependent Upon Tourist Trade	16,000

Maritime Virginia is one of the most visited sections of our nation. Approximately 20,000,000 out-of-state tourists annually spend about \$400,000,000, supporting an estimated 16,000 businesses here.

IX. VALUE OF WETLAND HUNTING IN MARITIME VIRGINIA - 1960

Waterfowl Hunters	13,180
1960 Values	\$602,853
Average Annual Hunter Expenditure (per person)	\$ 45.74

Waterfowl hunting is a popular recreation in Maritime Virginia, with 13,180 participants spending approximately \$602,853 in the bay area in 1960.

X. VALUE OF BOATING IN MARITIME VIRGINIA - 1960

Estimated Number of Boats in Maritime area	37,205
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Approximately 37,205 boat owners in Maritime Virginia partake in the number one outdoor family sport of boating - whether pleasure-riding, water skiing, sailing or fishing.

APPENDIX II

USEFUL AND POTENTIALLY USEFUL MARINE MOLLUSCS

<u>Species</u>	<u>Actually Used</u>		<u>Potentially Useful</u>
	<u>Overused</u>	<u>Underused</u>	
<u>C. virginica</u>	x		
<u>V. mercenaria</u> (hard clam)		x	
<u>Mya arenaria</u> (soft clam)		x	
<u>Mytilus edulis</u> (blue mussel)			x
<u>Modilus demissus</u> (ribbed mussel)			x
<u>Spisula solidissima</u> (surf clam)		x	
<u>Rangia cuneata</u> (marsh clam)			x
<u>Placopecten magollaritus</u> (sea scallop)		x	
<u>Aequipecten irradians</u> (bay scallop)*			x
<u>Busycon canaliculatum</u>		x	
<u>Busycon carica</u> (knobbed)		x	
Squid			x

Sea scallops - limited numbers off coast, some have been landed at Hampton.

Busycon - shipped cooked to New York City by some dealers

*Bay scallop - (might be reintroduced)

Rangia - thousands of bushels now around Jamestown.

M. demissus - animal food

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APPENDIX III

MARINE AND ESTUARINE FISHES OF COMMERCIAL OR SPORT IMPORTANCE

<u>SPECIES</u>		Commercial Importance	Sport Importance	Level of Exploitation
Scientific Name	Common Name			
<u>Carcharhinus milberti</u>	Sand bar shark	Minor	None	Probably underexploited
<u>Megalops atlantica</u>	Tarpon	None	Minor	Stocks unknown
<u>Alosa aestivalis</u>	Blueback or glut herring	Major	None	Underexploited
<u>Alosa mediocris</u>	Hickory shad	Minor	Minor	Underexploited
<u>Alosa pseudoharengus</u>	Alewife	Major	None	Underexploited
<u>Alosa sapidissima</u>	American shad	Major	Moderate	Adequate, perhaps near maximum
<u>Brevoortia tyrannus</u>	Menhaden	Major	None	Near maximum level
<u>Gadus morhua</u>	Cod	Minor	Minor	Virginia stocks perhaps tempo:
<u>Urophycis regius</u>	Spotted hake	Minor	None	Underexploited
<u>Urophycis chuss</u>	Squirrel hake	Minor	None	Stock not known
<u>Merluccius bilinearis</u>	Silver hake	Minor	None	Probably underexploited
<u>Anguilla rostrata</u>	American eel	Minor	None	Underexploited
<u>Mugil cephalus</u>	Mullet	Minor	None	Stock minor in area
<u>Centropristes striatus</u>	Black sea bass	Major	Moderate	Exploitation moderate, not ma

<u>SPECIES</u>		Commercial Importance	Sport Importance	Level of Exploitation
<u>Scientific Name</u>	<u>Common Name</u>			
<u>Roccus americanus</u>	White perch	Minor	Moderate	Underexploited
<u>Roccus saxatilis</u>	Striped bass	Major	Major	Exploitation adequate - near m
<u>Pomatomus saltatrix</u>	Bluefish	Moderate	Major	Moderate, not overexploited
<u>Rachycentron canadum</u>	Cobia	Minor	Major	Exploitation adequate
<u>Seriola spp.</u>	Amberjacks	None	Minor	Underexploited
<u>Coryphaena hippurus</u>	Dolphin	None	Moderate	Underexploited
<u>Orthopristis chrysopterus</u>	Pigfish	Minor	Minor	Probably underexploited
<u>Bairdiella chrysura</u>	Silver perch	None	Minor	Underexploited
<u>Cynoscion nebulosus</u>	Spotted weakfish	Minor	Moderate	Stocks minor
<u>Cynoscion regalis</u>	Gray weakfish	Major	Major	Exploitation adequate
<u>Leiostomus xanthurus</u>	Spot	Major	Major	Exploitation moderate, not ma
<u>Menticirrhus saxatilis</u>	Northern whiting	Moderate	Moderate	Probably underexploited
<u>Pogonias cromis</u>	Black drum	Moderate	Major	Exploitation adequate
<u>Sciaenops ocellata</u>	Red drum	Minor	Major	Exploitation adequate
<u>Micropogon undulatus</u>	Atlantic croaker	Major	Major	Stock temporarily lost
<u>Stenotomus chrysops</u>	Scup	Major	Minor	Exploitation moderate, not necessarily maximum
<u>Chaetodipterus faber</u>	Atlantic spadefish	Minor	Minor	Stock rather limited

SPECIES

<u>Scientific Name</u>	<u>Common Name</u>	<u>Commercial Importance</u>	<u>Sport Importance</u>	<u>Level of Exploitation</u>
<u>Tautoga onitis</u>	Tautog	Minor	Minor	Probably underexploited
<u>Euthynnus alletteratus</u>	Little tuna	None	Moderate	Underexploited
<u>Sarda sarda</u>	Atlantic bonita	None	Minor	Underexploited
<u>Euthynnus pelamis</u>	Oceanic bonita	None	Minor	Underexploited
<u>Scomberomorus cavalla</u>	King mackerel	Minor	Minor	Stock rather limited
<u>Scomberomorus maculatus</u>	Spanish mackerel	Moderate	Minor	Stock probably underexploited
<u>Scomber scombrus</u>	Atlantic mackerel	Moderate	Minor	Exploitation adequate at present stock level
<u>Thunnus thynnus</u>	Bluefin tuna	Minor	Minor	Stocksize unknown in local waters
<u>Xiphias gladius</u>	Swordfish	Major	None	Stocks probably underexploited
<u>Makaira albida</u>	White marlin	None	Major	Stock probably underfished
<u>Peprilus alepidotus</u>	Harvestfish	Moderate	None	Probably underexploited
<u>Poronotus triacanthus</u>	Butterfish	Major	None	Exploitation adequate
<u>Paralichthys dentatus</u>	Summer flounder	Major	Major	Exploitation moderate, but not maximum
<u>Pseudopleuronectes americanus</u>	Winter flounder	Minor	Minor	Local stock small but expanding
<u>Sphaeroides maculatus</u>	Northern puffer	Minor	Moderate	Stock underexploited

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APPENDIX IV

CRUSTACEANS OF ECONOMIC VALUE IN THE CHESAPEAKE BAY
AND THE ADJACENT CONTINENTAL SHELF WATERS

I. Species actively exploited

1. Blue crab, Callinectes sapidus. In all saline and brackish waters of Maryland, Virginia, and in inshore waters of the shelf; exploited as hard crabs, soft crabs and peelers (for bait), and crab meal from the picking residues.

II. Species giving substantial financial return, but fishing is incidental to other fishing operations.

1. Northern lobster, Homarus americanus. On the continental shelf.

III. Species which do not contribute significantly to the economy, because catch is small, local and seasonal. These species are economically valuable in other areas of the U. S.

1. Edible shrimp (3 species), Penaeus setiferus, P. duorarum, P. aztecus. Caught in fish pound nets, by hand dipnet, and small seine, at mouths of Virginia rivers.
2. Rock crab, Cancer irroratus. Caught incidentally in deep waters of the Bay and on the conti shelf. Cooked for crab meat extraction.

IV. Species which are abundant and are exploited, but do not contribute significantly to the economy here or elsewhere.

1. Grass (glass) shrimp, Palaemonetes sp (3 species). Found in the Chesapeake area; used as chum (bait) in fishing.

V. Species which are relatively abundant, and not presently exploited in the Bay area. Other, similar species are exploited in other areas of the U. S.

1. Sand shrimp, Crangon septemspinosa. Small-sized shrimp, 1-2 inches, most numerous near mouths of Virginia rivers, in fall, winter and spring. Used in other areas of U.S. as bait and for shrimp meal (seasoning).
2. Fiddler crabs, Uca sp. There are three species abundant in marshes throughout the Bay area. Used in other areas as bait for tautog.

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