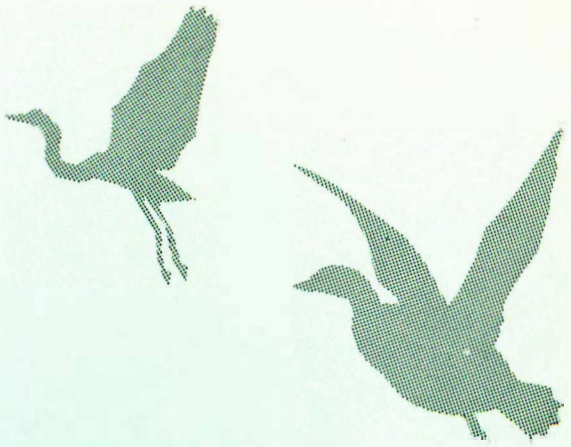

THE IMPORTANCE OF MAINTAINING QUALITY AND AVAILABILITY IN THE MARINE ENVIRONMENT

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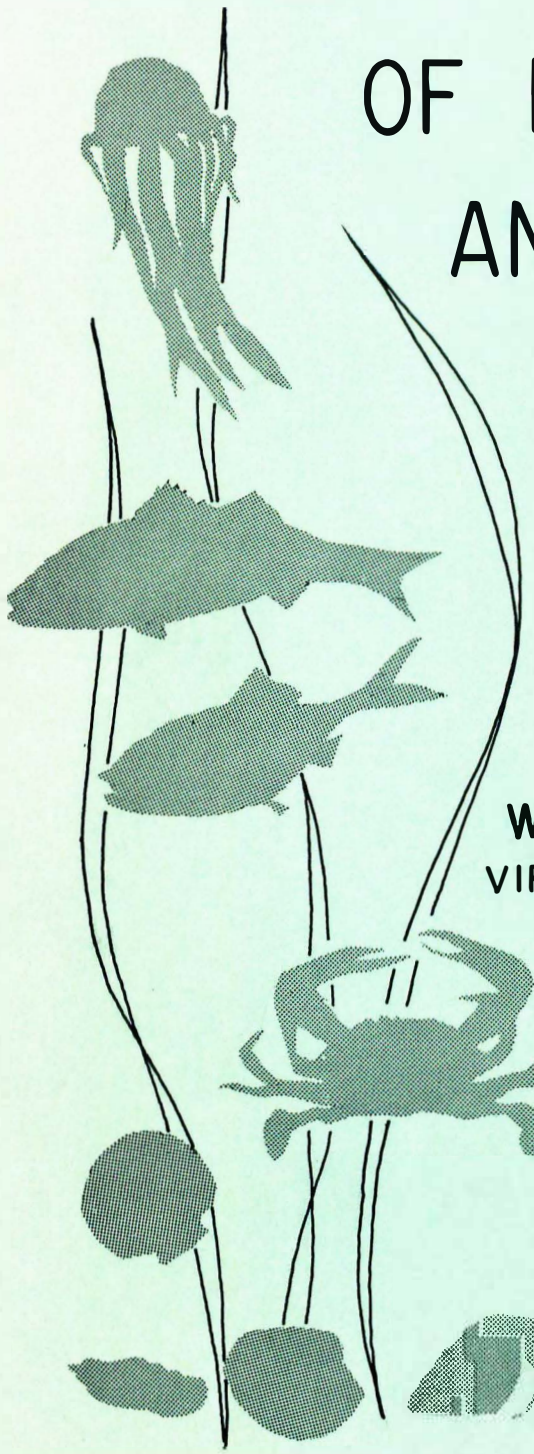

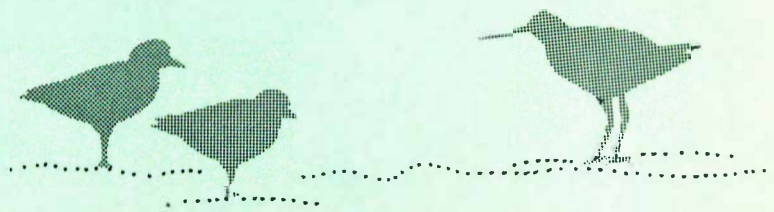

THE IMPORTANCE OF MAINTAINING QUALITY AND AVAILABLILTY IN THE MARINE ENVIRONMENT

Introduction

It is no secret that growing populations and increasing demands on natural resources are causing environmental stress in many places on "Spaceship Earth." No secret either the fact that the "Life Support Systems" of Earth have, at any point in historical and technological time, their own inherent requirements and limitations. They can support only so much human life and social activity and still provide the quantity necessary for present and future needs of man and, equally important, of other species. Quantities of certain important natural resources are limited. Even renewables like water and biological productivity are not unlimited.

Quality of resources and environment is an even more limited and fragile, nonetheless essential feature. Diminished quality limits diversity and versatility which in turn controls utility (hence useful quantity).

Simple accessibility or availability of resources to actual or prospective user groups is also a factor which must be added to the equation.

Maintenance of resources and environments in the quantity, quality and availability required for reasonable present and future uses is one of the most important tasks facing societies and their action agents--governments.

We can actually measure, or at least estimate, quantity, i.e. miles of shoreline, acres of salt marsh, bushels of available sub-bottom oyster shell, numbers of fish or crabs, and so forth. (Appendices I, II and III)

Much more difficult is the task of evaluating quality or the need for quality. Even this is not too formidable if there are acceptable standards, or even criteria on which to base standards. Were these difficulties eliminated or even reduced, government could plan and manage much more effectively. To assist government, scientists and engineers must develop ability to establish resource and environmental needs of the public in quality as well as quantity and to develop realistic criteria and establish reasonable standards of quality.

An essential requirement in this vital activity is ability to discern present and future needs in objective and reasonable fashion. But this is not an easy task! We have not yet learned to identify all real environmental needs of human individuals and their societies, nor do we know enough about the resources and environments to engineer (plan and manage) carefully. Thus, we must be extremely conservative until these requirements are better understood and closer design and operation becomes possible. We must protect our "Spaceship" and its "Life Support Systems" to maintain the crew (Earth's population) at reasonable levels. The crew must, of course, be kept healthy, organized, stable and hopeful.

The marine environment and its resources are major components of Earth. Having contributed much in the past they will be even more important to future societies. As with other resource systems, it is necessary that they be used, developed and preserved carefully.

Virginia - The Maritime State

Unquestionably, Virginia is a maritime state whose balance and economic life is closely tied to the ocean and to the bay and its tidal tributaries. The resources and attributes of many thousands of square miles of tidal waters and bottoms are accessible and useful to Virginians and visitors alike. Sixty percent of all our citizens live in the thirty-

odd Tidewater counties which constitute one-third of the counties and even less (twenty-nine percent) of the total land mass. The capitalized value of marine resources, self-renewing and depletable, and of marine-oriented industrial, residential and commercial activities is great, undoubtedly exceeding several hundred billions. Appendix I includes a recent revision of the outline of general statistics on the marine-related resources of Virginia first begun in 1962 by Mr. Fred C. Biggs and myself.

Virginia, herself, is a national natural resource system. As has been forecast and subsequently demonstrated by time, the north-east and mid-Atlantic urban sprawl zone is growing, spreading and coalescing, leaving maritime Virginia one of the last great coastal systems in a state of reasonable quality. It is essential that we decide what we want to do with our marine environment and plan for achievement of the resultant goals.

Virginia's Marine Resources

What makes the Commonwealth a principal Maritime State? What are Virginia's marine resources?

The Marine Waters

The marine waters, themselves, are important. Virginia has responsibility for or ready access to over 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 engines and clean and succor the crews. It is because of the importance of ocean 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 their attributes.

The lovely waters of the Virginian Sea (Captain John Smith's name for that vast sweep of the mid-Atlantic shelf extending 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 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 waters, and their 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 vactioners) and permanently (residents) 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 enticing 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.

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 waters from the major cities. For example, they are used variously as primary (too often), secondary or tertiary and final sewage treatment plants for Richmond, Petersburg, Hopewell, Newport News, Norfolk, Chesapeake, Portsmouth, West Point, Fredericksburg, Virginia Beach and

the metropolitan Washington complex and other adjacent municipalities, counties or developments, and by the nearby industries of the State. Wastes of all types including agricultural and radioactive material reach the estuaries and the sea. This use for waste disposal has saved communities and industries millions of dollars but has usually been a wasteful process by causing environmental destruction and/or reduction of quality and utility. Unfortunately, we have not hesitated to put marine waters to this use; therefore, we should recognize this 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. They are rich liquid culture medium for life from the lowest to the highest forms. They also absorb, dilute and transport semi-toxic and toxic materials which may damage or destroy marine life.

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

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 percent 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 waters of upper tidal tributaries, are increasingly used for drinking, irrigation and industrial process water. Later, ocean waters will serve these purposes more.

Increasing contamination by chemicals, sewage, radioactivity, silt and heat, as well as 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 organ-

isms of all kinds.

Wetlands, Shorelines, Shallows 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 5,432 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. Growing numbers of 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 local and visiting recreationists.

Though, to some, not as aesthetically pleasing as sandy shores, wooded banks or high bluffs, Virginia's tidal wetlands (393,262 acres) are nonetheless extremely valuable. Because of their generally high plant productivity, they supply a great deal of nutrient material to the main tidal tributaries and estuaries as their annual cycles of growth, death and decay continue endlessly. Many tidal marshes produce as much converted energy per acre as farm land of highest productivity and they do it without any effort by man. Tidal flats, some 80,000 acres, are also highly productive as are adjacent subtidal bottoms. All three categories of wetlands and shallows are important "respiration areas" and play significant roles in the overall circulation and energy balance of estuaries. Tidal wetlands serve as nursery areas for many species of fishes, crabs and other marine animals. Inshore, 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 $1,423,650 each year to hunt in Virginia's tidal lowlands.

Shorelines are being occupied at increasing rate by private land owners, resort owners, communities and industries. Consequently, availability is decreasing. The era of untrammeled beaches is rapidly ending. The public has increasing difficulty in finding accessible beaches. 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" or high priority wetlands must be set aside. Otherwise, the essential criterion of availability will be violated.

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. Like marshes, tidal flats provide much basic productivity. Natural growth and culture of valuable shellfish, such as oysters, hard clams and soft clams, makes many acres of bottoms extremely productive and valuable.

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 many years. Furthermore, fossil and recent, but overlain, submerged oyster shell reefs have been exploited, not only for oyster repletion programs, but also to manufacture lime and chicken feed and for other industrial and agricultural uses. Use of these non-renewable resources for industrial purposes is increasing. Furtunately, when a shell dredging operation sought access to shells in recent deposits rather than the older

ones they had begun with, to maintain economic productivity, the state (Marine Resources Commission) declined permission.

Sand has long been used in construction projects. The islands of the Chesapeake Bay Bridge-Tunnel and much other commercially valuable land has been built of submarine sand. The projected second Hampton Roads Bridge-Tunnel crossing will use much sand. Sand is useful to nourish valuable beaches and to offset erosion.

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, lighted and dark bottoms of Virginia's estuaries, bays and the Virginian Sea are natural resources of great value to the Commonwealth. These bottoms can become contaminated by silt, sewage, sludge, chemicals 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, most considerations of Virginia's marine resources have 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 living things provide food and because they move, are transient and greatly variable in quantity and quality, fishery

resources have received much attention.

Many fishes and several molluscs and the blue crab are economically and socially valuable and are now being utilized (Appendix I). 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, aqui- or mariculture, and processing techniques developed. Such improvements are not possible without waters and bottoms of suitable quality, quantity and availablility.

Many plants and animals, though not directly useful to Virginia, are, nevertheless, necessary to the food chains (the "webs of life") that supports other valuable fishes and processes. Some marine animals and plants, for example, certain jellyfish, 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 shellfish could probably stand heavier use were proper methods used and markets available.

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.

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. 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, subtle 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 biological and economic production of the blue crab. Though the supply fluctuates, it has generally been adequate to meet demands. Lobster is also caught and these and other crustaceans might be more heavily used. 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 can 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 commercial fishing 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 in local, regional or national menus but because they will be really

needed in the future to feed the growing populations of the state, nation and world.

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 value to Virginia at 10 percent per annum, it is plain that an investment of some 200 millon dollars, a too-conservative figure, would be required as the capital investment in any manufacturing industry in order to produce such an annual sum.

Sport Fishing

Marine organisms are as useful and perhaps more heavily employed for recreational and aesthetic purposes than for commercial reasons. Present fishery statistics are inadequate to allow a more positive statement. It is impossible to place values on the expectation and thrills experienced in children and adults merely seeing animals and plants in the water. While some are at times nuisances and repulsive, like jellyfish and water milfoil, 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. Likely, sport fishermen are rapidly rivaling commercial harvesters as users and sources of pressure on fishing stocks. Though estimates are available for sport fishing expenditures (Appendix I) 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 19,000 sportsmen spend almost two 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 resident marsh animals and plants are eliminated forever from the local scene.

Quality and Availability

Marine environments and their resources are valuable. They are in places, diminishing in quantity, quality and availability. There is need for reasonable concern.

We must recognize that increasing populations and industrialization entail costs--costs in environmental degradation which must be reckoned and minimized, if possible. Some destruction or degradation cannot be prevented. It may not be possible for some time to slow population growth and industrialization in the Commonwealth, but eventually--soon, they must be controlled. It is wise and businesslike to do so. The costs of failure are aesthetic and economic loss. The costs of failure are environmental degradation and reduction of quality of the "good life" in Virginia.

Marine environments and resources now suffer from poor management practices (in part due to inadequate scientific understanding and technological ability--but only in part) and as pressure grows their degradation becomes intensified.

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 carefully 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.

Of a certainty, "progress" and maintenance of virgin, pristine conditions are incompatible. If Virginia has any areas which should be preserved in this condition, they must be identified and set aside at once.

To allow continuation of the essential processes of marine and estuarine ecosystems; to maintain or improve biological productivity and support the dependent sport and commercial fisheries; to permit continued aesthetic enjoyment of sea-and shore-scapes; and, to make it possible for other essential economic activities to prosper and grow reasonably, it will be necessary for Virginia, and nearby states, to use their marine resources wisely. They must plan and manage for continued public and private vailability.

The essential key in this great task will be maintenance of the balance and condition of the marine environment. On good quality waters depend most of the other features and utilities. Maintenance of shorelines, shallows, beaches and bottoms is also vital. Utility involves availability, amount and quality. Biological productivity is related to quantity and quality of waters and bottoms. Preservation or development of quality requires establishment of reasonable use plans and quality standards and enforcement thereof. This is no easy task.

Continuing research, improved decision making and planning

carried out together, 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 local, state and national management agencies involved and toward system zoning.

Education of the citizenry and public officials and development or replacement scientists and new techniques are necessary. Public participation is important. None of these activities are possible in chaotic, disordered society. None can be sustained on ephemeral evangelistic fervor. Only organized, determined and continued enthusiasm and application of scientific knowledge and full employment of all technology and reason will allow the continuing tasks of maintaining quality of the marine environment and availability of marine resources.

A final caution, we must not rely too heavily on science and technology to keep the "Spacecraft" in trim. Despite much opinion to the contrary, science and technology are not, in themselves, enough. They must be applied or utilized in a balanced, reasonable manner by governments, industries and people who understand the human condition and what is required to keep human populations and the environment in balance. They must be managed and applied with reason. They cannot be expected to overcome disastrous effects of ill-considered resource use activities.

Significant gaps remain in our knowledge and understanding of environments and resources. Engineering ability is limited. Resource and environmental management systems are imperfect. Because of these things,etc., we must be conservative in undertaking potentially damaging activity. For safety--"overdesign" and continuing concern and vigilance are needed. Science and technology can and must assist to make the resources of the seas available to feed, clothe, protect, carry and renew people, but without adequate control of population and demand by the public for maintenance of quality and diversity, scientists and engineers can

only delay or ameliorate a worsening destruction of quality. The people and their governments acting together in organized and reasonable fashion must decide what sort of environments are to be maintained and what the rates of resource-use will be. Population and resource management will have to go hand-in-hand.

SOME ASPECTS OF THE ECONOMIC IMPACT OF THE SEA AND ITS RESOURCES ON THE VIRGINIA ECONOMY

I. Population of Maritime Virginia - 1969

Total population of Virginia (EST.)	4,781,175
Population of Maritime Virginia (EST.)	2,706,865
Per Cent of Total in Maritime Area	58.5%
Per Cent of Virginia Territory in Maritime Area	29%
1960-69 Population Increase for Virginia (EST.)	20.9%
1960-69 Population Increase for Maritime Area (EST.)	27.6%
1960-69 Population Increase for Remainder of Virginia (EST.)	12.5%
Per Cent of 1960-69 Total Virginia Population Growth Occurring in Maritime Area	73.3%

Source: ESTIMATES OF THE POPULATION OF VIRGINIA COUNTIES AND CITIES:

July 1, 1969...A report from the Bureau of Population and Economic Research, University of Virginia

II. SEAFOOD INDUSTRY IN VIRGINIA - 1968

Estimated number of employees	9,600
Pounds landed	382,021,263 lbs.
Catch Value at Landing	$ 20,539,775
Value of Processed Fishery Products	$ 28,755,685
Net Economic Impact on the Virginia Economy	$ 61,619,325
20-Year Average Annual Catch (1949-1968)	379,477,000 lbs.
20-Year Average Annual Catch Value (1949-1968)	$ 20,496,000

Source: U.S. Fish and Wildlife Statistical Report for 1965 and 1966.

III. VALUE OF SALTWATER SPORT FISHING - 1968

1968 Estimated Expenditures on Saltwater Sport Fishing in Maritime Virginia	$ 40,199,900
Estimated number of Fishermen	480,688
Annual Expenditure Average of Each	$ 83.63
Estimated Number of Recreation Days	6,431,984
Expenditure Per Fisherman Per Recreation Day	$ 6.25

Sources: 1965 National Survey of Fishing and Hunting, U.S. Fish and Wildlife Service Resource Publication 27. This basic document was up dated to 1968 using population estimates as cited in sources for the first section on population in this document, coupled with rising costs of living as published by Consumer Price Index.

IV. *1966 IMPACT OF VIRGINIA PORTS ON THE VIRGINIA ECONOMY

	Employes	Wages
TOTAL IMPACT OF SHIPPING	225,000	$ 1,500,000,000
TOTAL PORT-RELATED IMPACT	27,320	168,010,000
HARBOR-ORIENTED ACTIVITIES	66,790	460,570,000
TOTAL INDIRECT IMPACT	130,890	871,420,000

Source: The Contributions of the Ports of Virginia to the Economy of the Commonwealth, the Bureau of Population and Economic Research, University of Virginia October, 1968

V. IMPACT OF MILITARY ON MARITIME VIRGINIA ECONOMY - 1969

Estimated No. Employees, Military and Civilian	200,000
Estimated Annual Spending for Military Payroll, goods and Services in Maritime Area	$ 1,700,000,000

Source: Conferences with various Military officials

VI. ESTIMATED VALUE OF TOURIST TRADE - 1969

Estimated Number Out-of-State Tourists to Maritime Virginia	$ 27,300,000
Amount Spent by Out-of-State Tourists in Maritime Virginia	$ 318,500,000
Amount Spent by Virginian Tourists in Maritime Virginia	$ 208,000,000
Total Spent by Tourists in Maritime Virginia	$ 526,500,000

Source: VIRGINIA TRAVEL STUDY, 1968, Department of Conservation and Economic Development of Virginia

VII. ESTIMATED VALUE OF MARITIME VIRGINIA WETLAND HUNTING - 1968

Number of Waterfowl Hunters	18,982
Estimated Expenditures for Wetland Hunting	1,423,650

Source: 1965 National Survey of Fishing and Hunting, U.S. Fish and Wildlife Resource Publication 27; 1968 Report on the Number of Duck Stamps sold in Maritime Virginia; cost factors updated using recent Consumer Price Index Statistics.

VIII. VALUE SHORE-BASED INDUSTRIES 1968

Estimated Number Industries, Maritime Area	1,200
Estimated Number Industrial Employees, Maritime Area	190,000
Estimated Average Annual Wages Per Employee	$ 5,850
Estimated Annual Wages Production Workers	$ 1,200,000,000
Estimated Value Added by Manufacture in Maritime Area	$ 2,500,000,000

Source: 1968 SURVEY OF MANUFACTURERS, Virginia Department of Labor and Industry

* 1966 is the latest report year by the Ports Authority from which the above statistics are taken.

TABLE 2

Miles of Tidal Shoreline in Virginia*

	Developed	Marsh	Sand	Dry
Potomac River	38	20		94
Potomac Creeks	34	130		327
Rappahannock River	23	66	3	153
Rappahannock Creeks	15	148		194
Piankatank River	8	8		32
Ware River	5	13		21
Severn River	6	16		28
Mattaponi River		72		51
Pamunkey River		85		52
York River	16	29		30
York Creeks	20	84		73
Chickahominy River		40		26
Chickahominy Creeks		54		26
James River	43	73	12	158
James Creeks	72	339		116
Ches. Bay E. Shore	1	78		28
Ches. Bay Mainland	20	26	36	18
Ches. Bay Creeks	123	71	1	227
Back Bay Creeks	8	200	21	17
E. Shore Bayside Creeks	28	273		220
E. Shore Seaside Creeks	12	800	43	88
Blackwater River		38		30
Nottoway River		46		36
Atlantic Ocean		10	80	
Totals	472	2,719	196	2,045

2719
4764
196
4960

4960
972
5932

*The 24 areas listed above are reasonably distinct. All smaller creeks emptying directly into the Bay are included under Chesapeake Bay. Topographic maps produced by the U. S. Geological Survey or the Coast and Geodetic Survey were the bases for this survey. Since some of these maps were over 20 years old, it is likely that the amounts of shoreline in each category now differ from those given. "Developed shoreline" refers to shore which has homes or other structures spaced less than one-fourth mile apart. "Dry" shoreline is agricultural or wooded shore which would generally be fringed by marsh grass but is above tideline.

From "Coastal Wetlands of Virginia, Interim Report" by M. L. Wass and T. D. Wright, VIMS, 1969.

TABLE 1

Tidal Wetland Acreage by Geographic Areas*

	Temporary Lakes	Wooded Marsh	Marsh	Open Creeks	Wood-land	Tidal Flats	Sand	Ponds	Dredged Areas	Totals
Potomac River	0	1,790	8,835	6,601	0	1,123	0	659	0	19,008
Rappahannock River	0	6,689	15,496	10,785	100	722	96	924	11	34,823
York River	0	3,083	23,482	5,939	1,134	3,131	169	1,418	0	38,356
James River	0	17,676	18,164	7,604	763	3,784	40	638	70	48,739
Chesapeake Bay	0	8,681	14,210	12,013	503	3,657	1,524	397	22	41,007
Eastern Shore, Bayside	0	139	17,706	12,681	0	440	9	151	0	31,126
Eastern Shore, Seaside	389	150	66,435	3,698	66	66,560	4,177	276	0	141,751
Southeastern Virginia	374	21,920	12,745	1,597	62	0	1,622	132	0	38,452
Total Acres	763	60,128	177,073	60,918	2,628	79,417	7,637	4,595	103	393,262

* Only wetlands presumed to be tidal are considered in this survey. Virginia has large tracts of coastal wetlands which are not tidal.

From "Coastal Wetlands of Virginia, Interim Report" by M. L. Wass and T. D. Wright, VIMS, 1969.