



EXPLORATION AND RESEARCH IN CHESAPEAKE BAY:

Being a Brief History of the Development of Knowledge
of the
Bay of Santa Maria *

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** This paper was the basis for the luncheon address by Dr. Hargis, one of the Founders and then Chairman of the Board of Trustees of the Chesapeake Research Consortium, Inc. on the occasion of the Bi-State Conference on Chesapeake Bay, held at Patuxent Naval Air Station, Lexington Park, Maryland, April 1977.

VIMS Contribution No. 837

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INTRODUCTION

Much has happened in Chesapeake Bay country, "the countrie so Faire", since the Bay first began--millions of years ago. Twenty thousand years ago, more or less--probably more, the Bay area was occupied only by the animals and plants then indigenous to its lands and waters. There were no humans. The forces affecting the Bay were entirely natural. This is not to say that there was no contamination, no erosion, no sedimentation, because for eons and millenia prior to the coming of man such things undoubtedly took place. The same forces of nature as are active today were at work. Certain historical records refer to crystal clear or sky-blue waters filled with fish literally jumping out of the water due to crowding, and other probably aberrant observations. Undoubtedly, the waters were generally clearer than they are now, but not crystal clear, except for certain times of special calm and cold temperature. Like all such estuaries the Bay has received sediment from upstream and from local scouring and erosion since its physical beginnings. Peneplanation of mountains and erosion of uplands and shorelines are forces which have been active for millions of years in the region. Undoubtedly, fish and shellfish were more abundant in pre-human times. There was no fishing pressure and no human-caused contamination to reduce their numbers. But, the concept of

estuaries being chock-a-block with fish (except at run or spawning times) is not a sound one even for pre-human or pre-European times. Nature's balancing forces do not work so.

Man is a relative newcomer to the Bay. His deleterious impacts on the land and waters of the Bay region are even more recent. According to archaeological evidence the exploration and invasion of North America by humans from eastern Asia began more than 20,000 years ago. In the millenia to follow, these first "redmen", later to become "the natives", expanded into all of North and South America and in some places developed highly sophisticated and materially wealthy societies. Not so in the mid-Atlantic region where largely Stone-age technology and simple hunting, fishing and farming tribal groups persisted into the age of European exploration described below.

Descendents of these first human explorers and colonists of North America entered the Chesapeake Bay country, probably from the north and west, long before the dawn of written history, but long after establishment of their initial beachhead in that area of North America now known as Alaska. The journeys of this group of wanderers had begun thousands of years before, somewhere in Asia, extended across the Bering Island chain (the "northeast passage" of Asiatic explorers and settlers so to speak) and did not end until they reached the

shores of the North Atlantic. Archaeological remains are the only record of early Atlantic coastal Indians and their societies, habitations, wanderings and travails -- until the writings and drawings of European explorers and settlers began to appear in the 15th century A.D.¹

Nothing is known of the numbers in which the first family groups or tribes of human settlers arrived to attempt colonization. It seems likely that immigration proceeded in waves with one group after another moving eastward, now in long moves accomplished in a short time, now in slow and imperceptible progression over generations, centuries and millenia. The movement was ultimately successful. Indians reached the Chesapeake.² Evidence indicates that the first of

¹ Records of contacts with aborigines in the northern latitudes of the North American coast date to the "Viking" explorations of the period around 1,000 A.D.

² The absence of man on the Chesapeake prior to the appearance of early Asian-derived settlers does not mean that the land was not inhabited by other animal species. Archaeological evidence indicates occupancy over preceding millenia by large groups of aquatic and terrestrial vertebrates of all kinds from sharks to snakes and mice to mastodons. The Indian invaders did not merely walk into uninhabited land but had to kill, subjugate, drive away or accommodate to earlier vertebrate inhabitants. Prior to that, microbes, plants and invertebrates abounded before and during the developing vertebrate ascendance. Predominant plant and animal populations of various groups have been in the region for eons, man is merely the most recent of the lot.

the "redmen" from the west may not have been the lineal ancestors of those encountered by the first white explorers and settlers. The Chesapeake region was occupied by several different groups.

The natives the first Europeans encountered may not even have been the original human occupants and owners of the Chesapeake area. Invasions took place and battles were fought and possession of land was disputed, lost and won. Powhatan's Confederacy of tribes of Algonkian stock was under pressures from northern, southern and western tribes when the "white" man came and began a new occupation. Hence, displacement of the redmen by the English colonists was probably merely the latest in a series of such displacements.

Historians estimate that there were about 750,000 Indians in all of North America in the period when white man arrived. Those in eastern Maryland, Virginia and North Carolina were not the most advanced or warlike and were about to be squeezed to extinction between the white invaders, newly arrived on the coast, and their more aggressive red brothers to the west and north who continually sought to invade their territories, kill rivals and take hostages.

It is estimated that about 20,000 Indians constituted the empire of Powhatan, which largely coincided with present-day

Tidewater Virginia and perhaps some parts of Tidewater Maryland. Though the total number living in the entire Chesapeake region at the beginning of the European colonial ventures is not known to the writer, it is sufficient to say that it was not great--perhaps 40 or 50,000.

Development of Early Knowledge of the Bay Region

Aboriginal men probed as curiosity and other pressures pulled and/or drove them overland to the shores of the seas and to the islands beyond. In so doing new knowledge was gained about the region and its natural history and geography and was passed from individual to individual, group to group and period to period via direct instruction and lore, but there is no written evidence of this knowledge except that which European man has recorded.

The aborigines put little pressure on the resources of the Chesapeake and its tributaries--as far as we can tell, though the estuarine system was of great value to them in providing food, currency, avenues of communications and trade, and other resources. Their knowledge of the Bay and its processes, primitive by present-day standards, was evidently adequate to their social and economic needs. They were "children of nature", hunters and small farmers, and accommodated well without a great deal of specialized knowledge or technological

help. We cannot do so in these times.

Knowledge of the Chesapeake and its systems has increased markedly since the beginning of European exploration in the late 15th Century but not sufficiently to arrest the gradual disruption of proper functioning of its processes, environments and resources. Certainly more must be known before man and Bay are again in harmony as they were when only the "redman" was here--if indeed that is possible.

However, it is not the purpose of this paper to examine the continuing overuse of certain fishery resources, the ever-increasing rates of sedimentation due to human activity, the growing discharge of sewage and chemical wastes of all kinds, the increasing impacts of new and ever more toxic chemical species reaching the system, the solid waste disposal challenge or the battles and wars against them all. Instead, the purpose is to outline the growth of knowledge of the region and of the chemical, physical, biological, geological and some of the sociological processes that have taken place in, on, and around the waters, bottoms and shores of the Chesapeake and its tributaries. This brief report spans the time from more than 20,000 years B.C. to 1978 A.D., with special attention to the 500-year period encompassing the late 15th to the 20th centuries. It covers those reported explorations and

scientific activities which seem, from this vantage-point, to constitute milestones in the development of knowledge of the system and evolution of the organizational and intellectual capabilities which were necessary to produce and develop that knowledge. Hopefully it will be informative and useful.

The sources utilized are mostly secondary, though copies of a number of original reports have been examined. Many of the secondary documents, however, are themselves based upon exhaustive and scholarly examination of the manuscripts, logs, diaries and other primary records and first-hand reports and maps developed during or soon after the explorations which produced them and may generally be relied upon.³

Because most of the explorers and scientists of the early period worked under great hardship and stress both in the field and at home, accurate record keeping was often neglected.

Then, as now, most of their supporters probably cared less for knowledge and truth than for useful artifacts, products and reports which would encourage further exploration, settlement, development and profit. Sir Walter Raleigh, who sent scientists and scholars along on some of the voyages he

³ Citations provided as necessary.

sponsored, seems to have been an exception.⁴

Also, many of the mariners and explorers involved in the early days seem to have possessed limited abilities at reporting and were not inclined toward scholarly efforts. Usually they were too busy fighting the elements, hostiles--white and red, and seeking to satisfy their employers to record their thoughts and findings. Also, there was a great tendency toward secrecy. Logs and journals based upon experiences and reliable (and sometimes unreliable) hearsay were valuable, saleable commodities to the navigators, captains and other venturers of the times. Hence, records of these beginnings were naturally few to begin with and even when they were made, a number were short-lived. Lines of communications with the sponsors in the mother country were lengthy and hazardous and many of the records that were made were lost in transit. Though others eventually reached home, most were never published and were eventually lost. Very few were preserved and survive in primary form.

Secondary records of original reports of voyages and explorations are more numerous. Like many of the records of

⁴ Though he may have merely preceded modern profitmakers who also perceive the importance of detailed knowledge to successful economic ventures.

antiquity, verbal reports and original manuscripts owe their continued existence to chroniclers who were not present at the time of first findings or even of first reporting but made their records at a later time. Undoubtedly, much original information was lost or transformed in the retelling. Nonetheless, sufficient records remain to permit development of a reasonably accurate chronology and facilitate judicious surmise as to the likely course of events between documented happenings. From such stuff comes the information presented herein.⁵

THE DEVELOPMENT OF RECORDED KNOWLEDGE OF

THE CHESAPEAKE SYSTEM

The development of recorded knowledge of the Chesapeake region (Fig. 1) spans about five centuries. It began slowly at first as European explorers only lightly touched the

⁵ Unfortunately, recent records of the historical aspects of scientific organizations and of contributing personalities are frequently little better than those of early times despite modern recording techniques because the prime developers of recent scientific and organizational history have made little effort to record their own travails and accomplishments. Frequently, they have been so busy developing, explaining, raising funds, justifying and defending their actions from critics and competitors alike that they have had little time to record historical developments for which they were largely responsible. It is my hope that this brief historical treatment will help reverse this trend.

FIGURE 1. Outline map of Chesapeake Bay region showing most places and institutions mentioned in text.

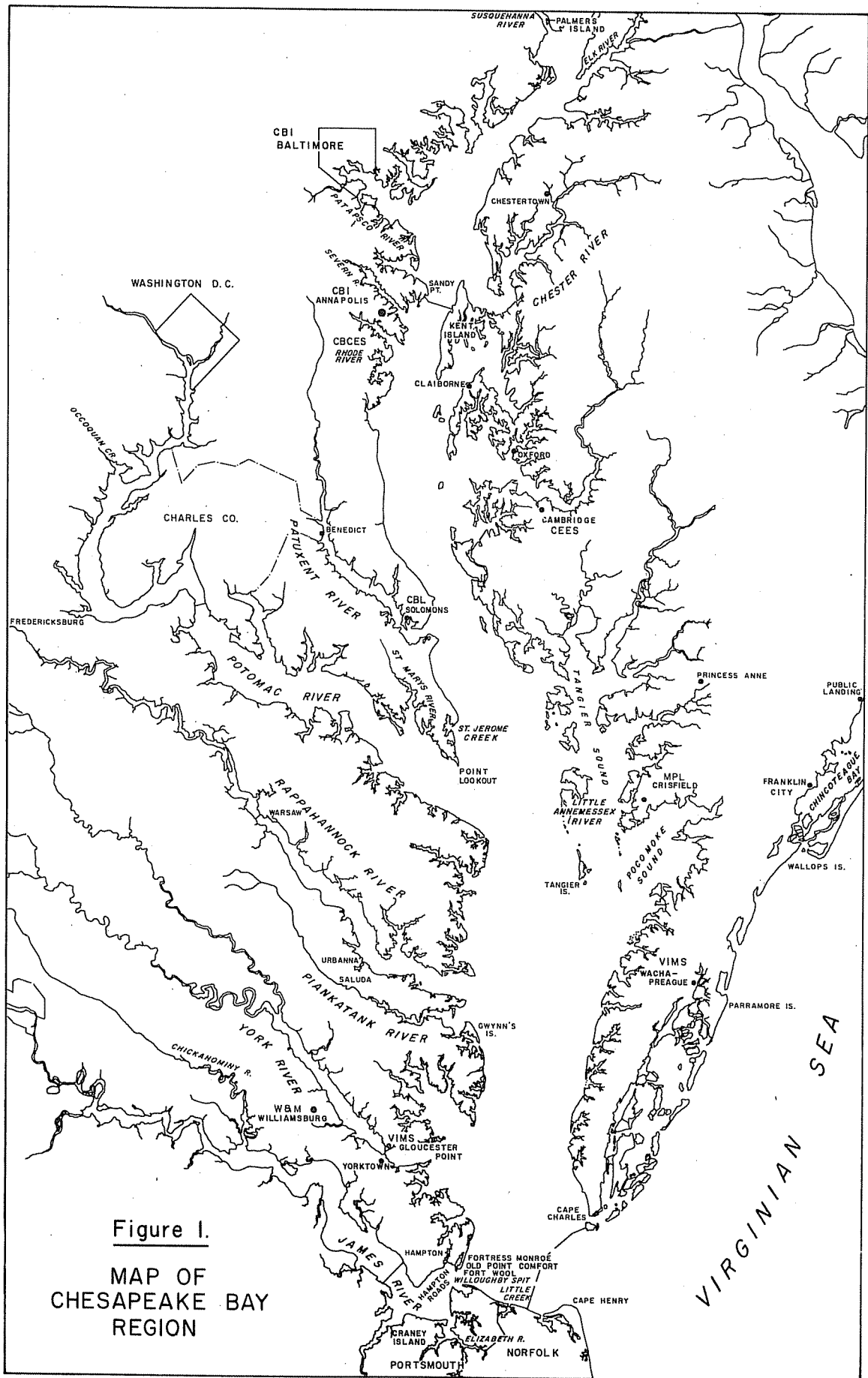


Figure 1.
 MAP OF
 CHESAPEAKE BAY
 REGION

mid-Atlantic coast; took its first "quantum jump" in early Colonial times (about 1600 to 1700); developed slowly until the late 1800's; increased more rapidly from about 1870 to 1930 or so and then took its second quantum jump after World War II.

Early on, most knowledge was gained by navigators, explorers, commercial tradesmen and settlers. Sprinkled amongst this multitude of non-scientists (or untrained scientists) were a few scholars. Together they produced a massive amount of new and valuable information about the Chesapeake in early and mid-Colonial times. Because it saw this first great expansion of knowledge, I have chosen to call the period from about 1600 to 1700 or so the First Quantum Period in the development of knowledge of the bay.

The civil storms which separated the colonies from England -- the Revolution, and, to a lesser extent the War of 1812, each produced gaps in orderly development of knowledge of natural history and other scholarly matters requiring time, money and coordinated observation, thought and communication.

Always closely attuned to major sociological events such as economic and military upheavals, carefully organized and truly scientific efforts at accumulation of knowledge and understanding of the Chesapeake began around 1885-1890, after

the exhaustion of the War Between the States⁶ (the last military action in which the federal system and the independence of states was tested) and developed slowly until the 1930's. Of course World War I intervened. World War II produced another hiatus in progress, but after 1946 knowledge truly burgeoned. Most of the scientific knowledge extant about the Chesapeake has been acquired since then. This is true of scientific and engineering developments in other geographical regions and fields of knowledge as well. The period from 1946 to the present is the Second Quantum Period or phase in the growth of knowledge of the Bay.

During this span of five hundred years, knowledge developed in the familiar saltatorial pattern of large and astounding, in retrospect, but generalized leaps: with large discoveries such as the finding and mapping of the Bay itself or the discovery of the broad outlines of the general phenomena related to circulation patterns or to the composition and migrations of fish populations, being made as science first turned its attention to each new area of interest. After the

⁶ Wars make convenient markers despite the fact that they are not the manifestations of the best tendencies of society. Many people know of them and their approximate dates. Usually they constitute breaks between periods, closing out old ones, ushering in new ones. Often they bring new technological and scientific needs and developments.

generalized and startling new findings were accomplished and the "surface" had been skimmed, the more tedious but no less important activity of filling in details began. This is usually the way scientific knowledge develops: early, generally inexpensive cream skimming and later, more expensive filling in. We are now engaged in the latter pursuit, the filling in of ever-increasing details of the natural and human systems involved. Detailed knowledge is vital in these days of conflict over and decision on allocation of resources. Detail is usually hard to come by and much more costly of acquisition than new or generalized information.

Despite my notion that there were really two major knowledge-producing eras, the several lesser periods in the evolution of knowledge of the Chesapeake system cannot be ignored and all require treatment.

The Pre-Colonial Period

A one-hundred-year-long period of exploration preceded the actual attempt at implantation of European colonies on the Chesapeake and several plantings were to be attempted before success occurred. During this pre-Colonial period history records, with varying degrees of clarity, a long list of explorers, commercial entrepreneurs, adventurers, warriors and sea captains (a single capable man such as the redoubtable

Captain John Smith could be all of these in one) who sailed along the coast in that part of the Atlantic Ocean later named the Virginian Sea by Smith. Some of them actually put into the Bay and sailed its waters. For the present there is time only for the most noteworthy of these forays; more exhaustive treatment will have to wait.

John Cabot (Giovanni Gaboto) -- In the spring of 1497, some five years after the discovery of America by Columbus, John Cabot, a Venetian merchant under patent from King Henry VII of England, began explorations along the east coast of North America, financed in part at least from his own resources. It has been stated by certain writers that this group, under his son Sebastian, reached the coast of Maryland and Virginia by coasting southward from Canadian latitudes. Some have even said that this expedition sailed as far south as the Carolinas and even Georgia and Florida before returning to Bristol, sighting land in the vicinity of the Bay.⁷

Other historians, notably the careful and reliable Samuel Eliot Morison (1971), indicated that neither of the Cabots' reached the Chesapeake region and branded Sebastian as an

⁷ There is uncertainty as to details of the Cabot expeditions--some say they sailed too far out to sea to have sighted land at all. Others say they did not come so far south. These points cannot be settled here.

accomplished liar. Whether or not the Cabots actually sailed this far South, they did reach Newfoundland, claimed it for the English King and established the basis for later English claims to North America. There was no immediate follow-up of any of the North American discoveries and claims the Cabots may have made because Henry VII was preparing for war with Scotland when Cabot and company returned.

Amerigo Vespucci-- The Italian navigator Vespucci sailed north along the coast in 1498, and likely reached the latitude of Chesapeake Bay since some authorities of maritime history have it that he reached the latitude of what is now called the Gulf of Saint Lawrence far to the north. It is even conjectured that Vespucci sailed into Chesapeake Bay. But as Wilstach (1929), who sought to determine exactly who should be credited with first entry of Chesapeake Bay, said "....conjecture is too poor a peg on which to hang certainty." Explorations apparently languished at this point. The record is silent for over a quarter of a century.

Giovanni de Verrazano -- A Florentine in the employ of Francis the First of France is recorded as having seen the majestic waters of the Chesapeake in 1524 after an overland trip across the Eastern Shore. He is also recorded as having drawn an ill-conceived map in which was lain (or reinforced)

the erroneous documentary foundation of the belief that the Western Sea or Western Ocean (the Mare de Verrazana) was only a few leagues across low-lying land from the Atlantic Ocean (Wise, 1967). The Florentine navigator is said to have landed on what is now Parramore Island, the highest and most heavily wooded of Virginia's barrier island chain. Actually Giovanni's brother, Hyeronimus de Verrazano, drew the map (Fite and Freeman, 1969). Others have said that this misapprehension, a misconception that was to cost succeeding explorers so much time, gold, and blood, was developed -- not at the Chesapeake, but near Cape Hatteras where Verrazano was supposed to have crossed the Outer Banks and gazed upon the broad waters of the Carolina sound system, which he then construed as the fabled Western Ocean. Both stories seem suitable to the basic facts. Of course the fact that the Eastern Shore is generally wider than the islands of the Outer Banks and matches Verrazano's "few leagues" better, would seem to lend most credence to Wise's contention. Samuel Eliot Morison (1971) has concluded that Verrazano must, instead have landed at or near Kitty Hawk, North Carolina, and that the Western Sea he saw was the Sound behind that island.

Regardless of where Verrazano's landing occurred, his "discovery" of the western ocean had a marked impact on the future. In his conclusion of the nearness of the Western Sea

and a possible route thereon to the fabled riches of the Orient, Verrazano was propelled by legends and stories of such a route from other sources dating back decades. In making this erroneous "discovery" he merely found, as have so many before and since, what he planned or hoped (or both) to find!⁸

Many have concluded that Verrazano's misconception was deleterious to the course of exploration: That this mistake caused delays of serious colonization attempts which were interrupted for the continual searches for the fabled "Northwest Passage" and for the gold and jewels of the Far East. I think not! Certainly, it reinforced the lust for quick profit-producing activities. However, I do not believe that it was bad for the course of civilization, or for the development of geographical knowledge and natural history, or for global economics and governmental experimentation, or for development of knowledge of unknown areas of the Earth and of natural history. Without the lust for wealth and empire, understanding and development would have proceeded much more slowly. Even a mistake such as Verrazano's would have kept alive the possibility for eventual discovery of the riches of Cathay and investors would continue to anticipate profits and

⁸ Many scientists, politicians and others do this even today--seek to develop data to support preconceived notions whether erroneous or not.

in doing so sponsor further explorations.

In those early days of western exploration and colonization the legitimate urge for profits--as well as cupidity and greed, were usually the prime movers, as they are now. Without the anticipation of quick discovery and great profit, it is doubtful that monarchs or merchants would have made the initial and follow-up investments or that colonists would have faced the rigors and hazards of the long voyage west and the invasion and occupation of hostile lands. All maritime nations of the time, French, English, Dutch and others, hoped to find Cathay, or gold, jewel and spice-rich areas of the new World (as the Spaniards did in Central and Western South America), make a quick-killing and return home wealthy. Encouragement of adventurers and settlers was one way to enable such development. Later, encouragement of migration and colonization was a way to relieve certain social pressures in the mother country and at the same time expand opportunity and empire inexpensively. Nobles, government officials and merchants alike were not reluctant to seek either objective.

Most early English settlers, too, probably had this vision since many in the first ships were gentlemen adventurers. Had the quest for eventual quick and huge profits, which enabled the entrepreneurs, explorers and settlers alike to overlook the

hardships of voyage, settlement and occupation and repeated failures, not continued until the true riches (the fisheries, soil, forests, fur-bearers, minerals and other natural resources) and potential of North America were recognized and markets developed in Europe, it is likely that the discovery and development of the New World would have lagged considerably.

This phenomenon has its parallel in modern times. Were it not for the promise of advantage, i.e. either commercial gain or solution of increasingly costly or intolerable problems, the search for knowledge by scientists and scholars of the Chesapeake Region (or of any other area) would have been much less vigorous than it has been! And it has been laggardly enough! Industry and governments would not have invested the money necessary to support explorations, research and development. Disabusal of the prospect of rapid riches, or of the promise of solutions, in modern times is the quickest way to assure withdrawal of support; so is achievement of complete and final solutions.

So much for motivational analysis. If Giovanni de Verrazano actually did see or even enter Chesapeake it was to be two years before another European did so.

Lucas Vasquez de Ayllon, a Spaniard in the employ of King

Charles V of Spain entered the Capes of Virginia in search of the (northwest-sic) passage "in 1526" (Wise, 1967). He did not, of course, find the Western Ocean but was forced to settle for building a town called San Miguel de Guadalupe.

There is argument over the site of San Miguel. According to some San Miguel was on the banks of the James or at the site of Jamestown (Fig. 1). Others place it elsewhere in the Chesapeake region. Morrison (1971), on the other hand, identifies the landing site of Ayllon's expedition as the Cape Fear River (N.C.) and says that the Carolina coast expert Henry Harrisse placed the site of San Miguel de Guadalupe as being somewhere on the banks of the Cape Fear River below Wilmington.

Though the exact location of San Miguel may never be known, dissension and disease (and an insurrection of Negro slaves--slaves even then!) nearly wiped out the settlement. The same three forces, only with Indians instead of slaves, almost had the same effect in English Jamestown eighty-one years later. The survivors at St. Miguel fled for home. The English survivors remained and the colony, after many travails, seated itself and eventually prospered.

Mendenez de Aviles -- The Spanish explorer and colonizer who established Saint Augustine in Florida, de Aviles, sent another expedition up the coast in 1566 (probably following an

earlier northward voyage involving Dominican friars), to enter what they called St. Mary's Bay -- Bahia de Santa Maria.⁹ The Dominicans referred to above had acquired an Indian identified by them as an Axacan who accompanied this second Spanish expedition to the Bay. It is certain that from this time on the Chesapeake was known to the European explorers and promoters (Wilstach, 1929)!

Considering the dispute over the location of San Miguel de Guadalupe it seems likely that the first definitely positioned European attempt at settlement in the Chesapeake region took place on the York River in what is now Virginia in 1570. Byron (1960) reports that a group of Spanish Jesuits from Havana, Cuba established a mission there. It lasted only a few months until local Indians killed all but one member, a boy named Alonso.

Other Spanish Forays -- Spaniards evidently came to the Bay again in 1570, 1571, 1572, 1573 and 1588. In 1572 a priest, Brother Carrera, recorded what is possibly the first description of the Chesapeake. He noted that the Spaniards, who forced the release of Alonso from captivity, disembarked in

⁹ Seventy-five years later they were calling the Chesapeake Bahia del Xacan (Axacan Bay), presumably based upon the land of origin of the Dominican's Indian.

a body of water of which he said,

"...in a great and beautiful port and men who have sailed a great deal and have seen it say it is the best and largest in the world. So...the pilot remarked to me. It is called the Bay of the Mother of God, and in it there are many deepwater ports, each better than the next...It was about three leagues [nine miles] in the mouth and in length and breadth it was close to thirty [ninety miles]. They say that at the end of water sea begins."¹⁰ (Byron 1960)

The length and breadth figures are interesting and, of course, wrong. This is not too disturbing since it is unlikely that the Spanish sailed very far into the Bay. Despite these discrepancies Carerras' description is, most likely, of the Chesapeake.

Captain Barcia -- The Spanish voyage in 1573 was conducted by a Captain Barcia, who sailed to the Chesapeake (St. Mary's Bay) at 37 and one-half degrees North Latitude, entered and

¹⁰ Gilbert Byron (1960) indicated that in 1573 Pedro Mendenez de Marques entered the mouth of the Chesapeake, which he too referred to as the Bahia de Santa Maria. Whether this is the same voyage as that of Barcia is not known to me.

wrote:

"It is three leagues wide and you enter it N.N.W.; within there are many rivers and harbors on both sides, where a vessel can enter; at the mouth, near the land, on the southern shore, there is nine to thirteen fathoms water; and on the north five to seven; two leagues at sea, the depth on the north and south is the same as inside, with more sand; following the channel nine to thirteen; inside the port, by fifteen or sixteen fathoms, he found spots where the lead did not touch bottom."

This description is clearer than that of Carrera. The latitude recorded serves to definitely fix the location of this voyage as having been to, within and up the Chesapeake.¹⁰ A decade later and sixty years after the first English voyages to the region came another Englishman, Lane, who "rediscovered" the Bay and caused it to be depicted on a map.

Governor Ralph Lane -- One of Sir Walter Raleigh's Roanoke colonists, who in several groups at separate times attempted to

¹⁰ Gilbert Byron (1960) indicated that in 1573 Pedro Mendenez de Marques entered the mouth of the Chesapeake, which he too referred to as the Bahia de Santa Maria. Whether this is the same voyage as that of Barcia is not known to me.

FIGURE 2. Map of that part of the Virginia Colony (or patent to Sir Walter Raleigh, which then encompassed North Carolina) including the North Carolina Sound System and the lower part of Chesapeake Bay (called Chesepiooc Sinus). This map drawn around 1585 is the earliest showing part of the Chesapeake.

establish themselves in that part of old Virginia or "South Virginia" now called North Carolina, Ralph Lane actually sailed into the Chesapeake in 1585 and "discovered" it, at least from the English point of view, for the first Queen Elizabeth (Howe, 1969). It is reported that Lane's men entered the Elizabeth River ("the country of the Chesepiooks" whose name was later applied to the Bay).

Recorded knowledge of the southern part of Virginia and the lower Chesapeake (Chesepiook Sinus) made a significant stride with Raleigh's colonizing attempts. The first surviving English map which showed any part of the Chesapeake resulted from one of these voyages (Fig. 2). Not only did Captain Ralph Lane actually sail into the Bay, but John White, the recording artist of the first abortive colonizing attempt in 1585, prepared, along with the map mentioned above several drawings and reports which imparted much knowledge of the lower Chesapeake, the adjacent coast around the outer banks and the sound region of North Carolina and the people there.

Governor John White¹¹--White's observing eye and careful pen recorded for posterity the natives, their costumes and

¹¹ It is of interest to note that Raleigh had directed that the settlement that was the birthplace of Virginia Dare (the first English child born in the New World) was to have been built on (Footnote continued on next page)

the shores of the "magnificent Chesapeake". Despite Raleigh's directives the officer commanding the colonization fleet disobeyed his orders and sailed south to the Caribbean to raid and trade after abandoning John White and his colonists on Roanoke Island.

White later left for a sojourn to England to secure aid. His daughter and grandchild, Virginia Dare, did not return with him. On his return to Roanoke White sailed to the south to secure a little profit. This privateering side venture by White ended in disaster and he was forced to return to England again. The Spanish Armada interrupted another planned trurn to Roanoke. By the time a relief ship arrived all of the colonists including Governor White's family had disappeared with the rest of the Lost Colony. White was unable to find them. This sad and well-known story ended with more search expeditions after which Raleigh was able to venture no more to the New World.

customs and the resources and activities upon which they depended for sustenance. A learned man named Richard Hakluyt also contributed. The records of some of the discoveries of White and Hakluyt survive, in part, in the writings of Thomas Harriot, also a colonist, published some five years later in 1590 (Harriot, 1972). Though White and Hakluyt provided the only surviving records of the scientific findings of these expeditions, it is recorded that other scholars had been recruited by Raleigh for his voyages of discovery and colonization.

Captain Bartholomew Gilbert -- While searching for survivors of the lost colony, Gilbert sailed his small boat, the ELIZABETH, into and up the Chesapeake in 1603. During an attempt to renew their fresh water supply on an island in Tangier Sound, the captain and one of his men were killed (Fig. 1). The others fled to their vessel to return to England (Byron, 1960).

English interests in the region continued, as did those of Spain. As late as 1609 the King of Spain sent scouts from his colonies in Florida and the Caribbean to the 37th parallel.

Captain Franscisco de Ecija -- On one such mission the Spaniard, de Ecija, came north in his ship, ASUNCION DE CHRISTO, under orders to explore the coast to 44°30' north

latitude (the latitude of Maine about the level of Grand Manan Island) to

"find out if there are on said coast ports, settlements of people of different nationalities who may have occupied such places without any authority, only wishing to take possession of them and there exercise their piracy; so that we may take steps to avoid the many troubles there-from likely to arise to the great injury of God our Lord, and of his Majesty the King".

On July 24th of 1609 Captain Ecija came to the "Bay of Axacan".¹² His lookout spied a ship at anchor in the Chesapeake. The Spaniards anchored outside for the night but the alien ship was still there when they awoke in the morning. This confirmed earlier reports from the natives of an English settlement (that at Jamestown) established two years earlier. Discouraged by this knowledge and the sighting of the confirmatory English ship, the Spanish coasted back to Florida.

The Spanish had settled central and northern South America some years earlier and occupied the shores of the Caribbean,

¹² Recall the Indian from Axacan from a spanish venture of half-century before? This was one name the spaniards evidently applied to the Chesapeake, or a part of it.

including Florida. They constantly attempted to subvert English ventures by overt and covert efforts in the court of St. James as well as in the field. One early map of Virginia, including the Chesapeake and North Carolina sound regions was stolen by Ambassador Don Alonso de Velasco, and was not discovered in the Spanish archives at Simancas until much later. Because of this history, this 1610 map, which may have preceded that of Smith in publication, had no influence on later English explorations. The preparer of this map may have been Robert Tindall, a surveyer and military engineer-gunner who prepared an earlier map of the James-York River area of the Chesapeake (Sanchez-Saavedra 1975). These Spanish intrigues produced many problems but did not prevail.

The Early Colonial Period

Until the establishment of the first continuous settlement in Virginia, the discovery and scrutiny of the Chesapeake were based upon sporadic enterings and a few landings of lesser or greater duration of the Pre-Colonial period. This period, which lasted almost 115 years or about 5 generations, saw development of the first brief descriptions and partial maps of the Chesapeake region described above. These records were based upon landfalls or sightings as well as incursions and excursions of some length and substance.

By the substantial findings of Raleigh's English colonists and explorers and of the Spanish under Barcia, especially the former, the stage was set for what can be characterized as the First Quantum Jump Period in knowledge of the Bay (c.f. above and below). It was begun by the Englishmen of the Virginia Company's expeditions to their new land holdings¹³ in North America, who -- shortly after their arrival in the lower Chesapeake in April of 1607, set about a series of explorations which were to provide a vastly greater amount of new and more accurate information than had theretofore been obtained and were to establish the first really sound basis for the geographical discoveries and scientific investigations of later periods. It is this period in the development of recorded human knowledge of the Bay that I have chosen to call the First Quantum Jump Period (ca. 1600-1700).

Captain Christopher Newport -- To open this great period of information development, Captain Newport with Captains Anthony Gosnold and John Smith and eighteen others of the aspiring Jamestown settlement sailed up the James River (then called Powhatan's River), which ran by it, in 1607 "in order to determine how far the James was navigable or if it offered

¹³ Granted originally by James I, King of England who succeeded Elizabeth, Raleigh's benefactress and malefactress.

passage to the other sea" and to obtain information "on the land and its people". The sea that they sought was called the East India Sea--the Western Ocean (McCary, 1957). Actually, this cruise was the second voyage westward up the James. The first took place earlier when the full company was still on the three ships and looking for a favorable place to land.

The celerity with which these leaders of the infant colony took off on such a voyage of exploration -- even before a suitably housed and fortified settlement had been established and their charges settled in, supports the conclusion that the riches of the Orient were their primary objective. Such a rapid departure concerned certain of Captain Newport's colleagues. Some of the colonists openly objected to his haste in this business but undoubtedly he had been strongly urged toward action by Company directives. The motive of this stock-company was profit and its members surely wanted profits to be quick and large. After this voyage Captain Newport sailed for England leaving the further business of settlement and exploration to others.

Captain John Smith -- From mid-1607 until his disastrous experience with gunpowder exploding in his pouch or powder-horn, the intrepid Captain Smith was organizer and director of the most productive explorations and

investigations, both by land and sea, accomplished during this period.¹⁴ One of his most informative excursions was the journey all through Powhatan's kingdom from the James to the Potomac as a prisoner. Smith was captured by Indians who attacked and routed his small band on the banks of the Chickahominy River (Fig. 1). The doughty Captain was overpowered in the marshes. From the Chickahominy he was taken on display to many Indian villages. During this long trip he observed Indian ways and learned the countryside. As all school children know, or used to, it was on this trip that Pocahontas is reported to have saved Captain Smith from the vengeance of her father Powhatan, the Indian Emperor and head of Powhatan's Confederacy. Following this experience Smith returned to Jamestown to resume his presidential (gubernatorial) duties there.

In June 1608, with 14 men in an open barge, Smith set out to explore the Chesapeake, returning after a few days spent in exploring the lower Chesapeake and its tributaries. Later in

¹⁴ Scholars have argued over whether Smith deserved as much credit as early historians gave to him and he to himself. The majority seem to agree that he did. Most recent scholars concur. Smith's drive, determination and leadership were prime reason for the survival of Jamestown in its first two years. I am convinced that he deserves most of the kudos and few of the brickbats. He held the weakling colony together in its most trying time and at the same time drove it forward. Smith was evidently quite a man.

the summer they departed Jamestown again and ventured all the way to the Susquehanna River (Fig. 1), arriving home in early September.

These two voyages of discovery conducted by a few men in an open boat of "three tuns burthen" and powered by oar and sail occupied nearly three months and encompassed a navigation of some three thousand miles. The last voyage was a feat of major proportions, the accomplishment of which opened the Chesapeake region for further development by the English. It added vastly to knowledge of the Chesapeake because by the time of their return in September of 1608, Smith and his men had explored both sides of the Chesapeake as far as its head, and many of its inlets, creeks and rivers as far as their fall lines. In doing so they braved the unknown, suffered violent Bay storms (noteworthy for their suddenness and viciousness) and numerous other natural dangers, and established relations with a number of native tribes, fighting and frightening some and charming and bribing others. They observed the customs of the natives encountered and saw and undoubtedly recorded and probably collected many new animals and plants. They also made measurements, sightings, soundings, notes and sketches, thus accumulating invaluable contributions to geography, cartography, ethnology and natural history and laying the foundation for future development and commerce.

Later in 1608, based upon careful observations and records of these voyages, Captain Smith prepared an "astonishingly accurate" map (Fig. 3) and a report which were sent to the Virginia Company at home.

In the winter of 1608-09, Smith's explorations and observations were continued. After a severe injury by exploding gunpowder during his last voyage, Smith returned to England for treatment where he prepared a book on his findings. It was published in 1612 and included his amazing "mappe" (Fig. 3). Because of its accuracy and utility, this careful depiction of the nature of the Chesapeake Bay and its environs (later to be subdivided to allow the development of the Calvert fiefdom of Maryland) was the best for 100 years and firmly established Captain John Smith as a great explorer, observer and map maker (McCary, 1957 and others).

Other Early Colonial Explorers--Others carried forward the task of learning and conquering the Chesapeake, including Sir Henry Spelman, who was captured by Powhatan's people, lived with them, learned their ways and interpreted for the English. He was later killed by Indians in a bit of treachery on the Potomac in 1623. Samuel Argall (who kidnapped Pocahontas in another act of chicanery) and Henry Fleet were two others.

In 1627 King Charles I of England gave explicit

FIGURE 3. Captain John Smith's map of Virginia resulting from Smith's voyages of 1607-1609. This document, remarkable in its accuracy considering the times and circumstances in which it was made, was a mainstay for Chesapeake travelers for many years.

instructions to Virginia's Royal Governor to secure for him exact information of the bays and rivers around the settlement on the James. The Secretary of the Virginia Colony, William Claiborne, was given a gubernatorial commission to explore the Chesapeake Bay and its tributaries. In doing so Claiborne also traded with the Indians of the middle and upper Bay and established trading posts on Kentish Isle, now Kent Island, on the Eastern Shore, and Palmers Island (Fig. 1) at the mouth of the Susquenanna (Earle and Skirven, 1916). The Kent settlement, now part of Maryland, was later represented in the House of Burgesses at Jamestown.

That first period of development of new knowledge of the Chesapeake, herein identified as the First Quantum Jump Period, reached its peak in these early efforts at colonial exploration. Other explorations followed during the early and mid-Colonial period, expeditions pushed inland, and surveys were made as lands were patented, parcelled out and transferred. Frequent sailings were made and traders established themselves among the distant Indian tribes. Trappers and hunters roamed the woods. The Powhatan Confederacy was eventually crushed and its survivors dispersed, domesticated or severely contained.

It is certain that more could be learned about the

discovery of new knowledge of and greater detail of the Bay in this period with more complete research but it is not my purpose here to exhaustively review the detailed history of exploration of the region but to point out that the process of learning about the Bay and its tributaries; the deep bottoms, shallows, shorelines and wetlands; the biota, including humans; and, the habitats in which they were found began a long time ago. It is also my purpose to acknowledge the work of these early explorers, yes -- scientists, and our indebtedness to them.

The results of these early investigations were developed into reports, journals, memoirs and charts, most of which have long since disappeared. Some have survived to help lay the foundations upon which explorers, scientists, scholars and engineers of later periods have built. Just as today, much of this early investigation was carried on by men of great curiosity. Just as today, information was sought by its supporters primarily for its usefulness in enabling further realization of the purposes of society as expressed by those in command at the time.

The Mid- and Late Colonial Periods

As we have seen, the early exploration and observation promoted by the Virginia Company was devoted primarily to the

search for the Orient and riches. The frenzies of these "get-rich-quick" activities gave way later in the Colonial period to development of the fisheries, the land, the forests and the other resources which were available in great quantity and were the true riches--the economic foundations of our country.

As the 17th Century progressed, commerce to Europe, chiefly with Great Britain, because of the English origins and restrictions imposed from home, increased. Navigation across the broad Atlantic Ocean through the Virginian Sea (the mid-Atlantic Bight) into the Chesapeake system grew.

A new province, the Colony or Palatinate of Maryland, was carved from Virginia by act of King Charles in 1632 and navigation increased¹⁵. With greater navigation came new exploration, new soundings, new charts, logs and reports and new information.

¹⁵ Who granted Calvert Lord Baltimore part of Newfoundland, then portions of Virginia and North Carolina below the James and finally, since these had already been granted and their occupants strongly resisted Calvert and his claim, then settled upon a gift of the Potomac and the land from its southern shore north to Pennsylvania.

That Charles granted the river Potomac is, in itself, significant and showed that he or Calvert, who evidently wrote the patent, was well aware of the value of such estuarine water courses and their resources, amenities, and opportunities.

Knowledge of the Chesapeake and its tributaries and their resources slowly but steadily grew. However, for the most part, the most startling new geographical studies of this period in Colonial development were accomplished during land explorations to, along and from the Western frontier. Infant America was turning its attention westward and inland. Part of this westward focus was due to the continued search for a quick way to the Cathay. The chimaera of the Western Ocean and an easy Northwest Passage to that mythical nearby sea died slowly! Increasingly, however, the purposes were discovery of the continent, reconnaissance of its resources and the search for new land and developmental opportunities. As a result attention was drawn away from the coastal areas, the Bay and the sea by the hinterlands.

The thrust up the rivers of tidewater, and settlement and clearing of the land on the coastal plain and piedmont required much time and energy. As the invasion of the highlands went forward, the explorations down the great valleys of Pennsylvania, Maryland and Virginia and through the mountain passes, (called gaps), into western Virginia, (now West Virginia), Kentucky, southern Ohio, Indiana and Illinois, and other states continued.

Subjugation of the natives in Tidewater, which brought

peace, development of familiarity and accommodation to the conditions imposed by their new homeland, coupled with economic development, allowed the settlers greater leisure in which to devote increased attention to cultural activities.

Educated Marylanders and Virginians became interested in the natural history of the region, as had foreign naturalists much earlier, and in the development and application of science and technology in the New World. Personal libraries grew. New institutions of learning were developed. To the north at Boston in the Massachusetts Colony (once part of Northern Virginia) Harvard University was founded about 1691. William and Mary was established in Williamsburg in 1693 by Royal Charter. Debating and scientific societies developed in Williamsburg, Annapolis, Philadelphia, Boston and elsewhere. These and other formal cultural and educational advancements eventually came, but took almost 100 hard years from Jamestown to become established.

With this period of military calm (except for incursions and depredations of the Dutch and pirates) the development of important families and wealth took place on the Tidewater of Chesapeake. Indians, wolves, panthers and bears alike were gone from the coast. The "Golden Age of Colonial Culture" had begun (Wertenbaker, 1967). An important milestone in

development of the Golden Age in Virginia was the founding and development of the College of William and Mary in Virginia, which for decades stood alone in the Chesapeake region.

In Gloucester County, just across the York River from Williamsburg, John Page of Rosewell studied astronomy and made some of the first recorded meteorological observations conducted in the New World. These observations related to Page's agricultural activities and his native curiosity.

John Clayton -- The second John Clayton¹⁶ came to Virginia in 1705 and settled in Gloucester for the remainder of a long and productive life, and was probably the foremost Virginia scientist of the 18th century. Throughout a lengthy career as a civil servant to the county, he devoted much time to studies of the flora of the Chesapeake region and the rest of Virginia. His Flora Virginica was published in Europe by Professor Gronovius, but several other manuscripts which he had prepared

¹⁶ Confusion occurs over the exact identity of the two Claytons mentioned in the early history of Virginia. The Clayton Family apparently had a habit of naming first male children John. There were two scholarly Claytons in Colonial Virginia. The first was a minister who came to Williamsburg and returned to England. This John Clayton observed and commented on nearly all aspects of Virginia's natural science including observations of air, weather, soil and plants and descriptions of the James, York, Rappahannock and Potomac Rivers. He must have been extremely busy for he was only here a short time, returning to England in 1685 after a stay of from one to two years.

were destroyed during the Revolutionary War. His herbarium exists today in the National Herbarium in England. Both were scientific milestones which are still useful.

John Banister, a minister of Appomattox, studied the insects and other plant and animal species of the region and saw them published in Ray's Historia Plantarum and in the Philosophical Transactions of the Royal Society.

John Mitchell, a medical doctor of Urbanna, also studied various aspects of nature and, being active in cartography, prepared a map of British America which incorporated a more accurate picture of the Chesapeake system than earlier maps. It was used considerably, well into the 19th Century.

The Society for the Advancement of Useful Knowledge -- A group which emulated the Royal Society and devoted itself to the stimulation of the arts, manufacture and science, was formed in Williamsburg on the eve of the Revolution. It was sponsored by scholarly Governor Francis Fauquier.¹⁷ John Clayton and John Page of Gloucester were the first president and vice-president, respectively, and a number of other scholars and scientists were members (Wertenbaker, 1967). It

¹⁷ One authority lists the sponsor as Lord Dunmore, last Colonial governor of Virginia. The question of who really was the initial sponsor must be examined more carefully later.

is not known to me whether Thomas Jefferson, foremost scholar and scientist of Virginia in his later years, was a member but he frequented Williamsburg and knew its members and is known to have joined Governor Fauquier for dinner, serious discussion and musicales at the Palace.

The Virginia society no longer exists but to the north in Philadelphia, Benjamin Franklin--America's greatest Colonial scientist,¹⁸ organized a similar society, the Junto, which in 1769 merged with a rival group to form the American Philosophical Society. John Clayton and John Mitchell of Virginia were its first non-Pennsylvania members.

The American Philosophical Society survives to this day. Franklin, its first president, was interested in many scientific subjects including meteorology and oceanography. His studies of the Gulf Stream contributed to the development of the science of the sea in America. Unfortunately, we have found no record showing that Franklin's marine studies extended

¹⁸ My estimate of Franklin's supremacy in American science is challenged by Dr. Carl N. Shuster (personal communication 6 January 1978) who says that David Rittenhouse, Second President of the American Philosophical Society, was a "peer if not better scientist than Franklin". He further asserts that Rittenhouse was "the premier mathematician and astronomer of the Colonies". "His surveys and observations were used in the sponsorship of river diversion, such as the Susquehanna and Schuylkill Canal." I am indebted to my long-time friend, Dr. Shuster, for his intelligence.

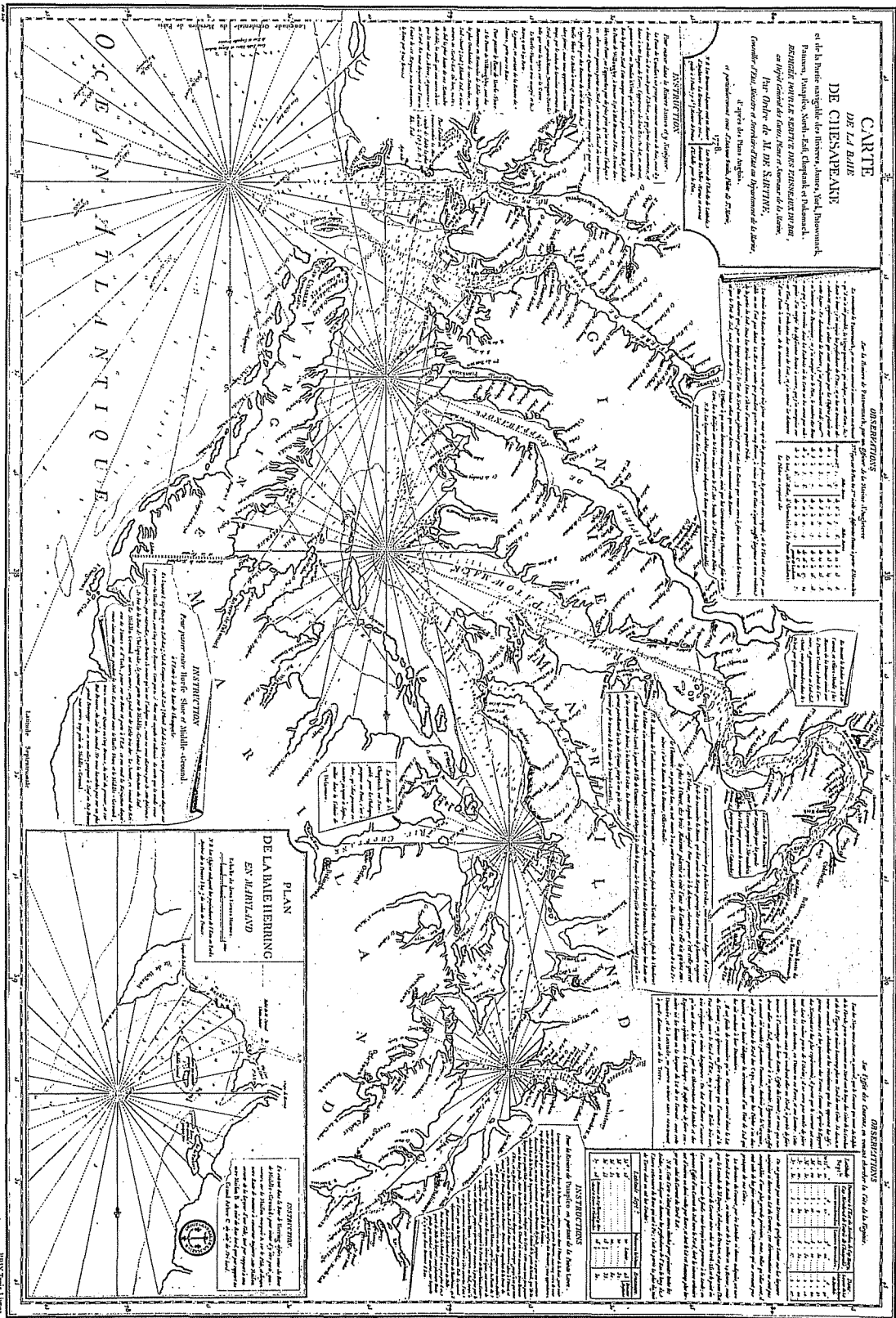
to the Chesapeake system though they contributed to understanding of the outer edge of the Chesapeake Bight (of the Virginian Sea) whence come the salt waters of the lower and middle Bay and its estuarine tributaries.

Marine Research Abroad -- In several truly scientific voyages, from 1769 to 1779 in the ENDEAVOUR, the Englishmen, Captain James Cook made major advances in knowledge of the oceans, contributing vastly to the beginnings of oceanography but nothing to knowledge of the Chesapeake. Nonetheless, the work done by this doughty Captain and his scientists, namely Sir Joseph Banks, helped lay the groundwork for growth of the science of the sea in ensuing centuries and indirectly aided later work on the Chesapeake.

The Revolution -- The War for American Independence ending the Colonial Period began in 1775. It lasted until 1783, two years after Yorktown. As with later American conflicts it generally interrupted the orderly development of knowledge of the Chesapeake area--except that associated with military action. During this period a navigational chart which included a number of soundings and other hydrographically significant features was drawn to aid French naval activities in the Bay (Fig. 4).

The Chesapeake was not to escape the War even though the

FIGURE 4. 1778 French naval charts of the Chesapeake. Containing numerous surroundings, it succeeded Barler hydrographic charts drawn by Captain Walter Hoxton in 1735 and by Captain Anthony Smith's 1776 revision of Hoxton's effort.



CARTE
DE LA BAIE
DE CHESAPEAKE

et de la Baie voisine de la Rivière James, York, Potomack, Pamunkey, South-kill, Clappan et Patuxent.
REDIGÉE SUR LES MESURES DES RUSSELS ET DE LA
ANCIENNE CARTE DE LA BAIE DE CHESAPEAKE
Par Othobon de M. DE SARTIN.
Gouvier, Chef de la Baie de Chesapeake, et de la Rivière de la Baie.
Il a été dressée par le Capitaine de la Baie de Chesapeake, et de la Rivière de la Baie.
Il a été dressée par le Capitaine de la Baie de Chesapeake, et de la Rivière de la Baie.

INSTRUCTIONS

Il est à remarquer que la Baie de Chesapeake est une Baie d'Asie, et non d'Amérique.
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OBSERVATIONS

Sur la Baie de Chesapeake, le 10 Mars 1763.

Heure	Latitude	Longitude	Direction du Vent	Force du Vent	Direction du Courant	Force du Courant
10	38° 30'	76° 30'	N	1	N	1
11	38° 30'	76° 30'	N	1	N	1
12	38° 30'	76° 30'	N	1	N	1
13	38° 30'	76° 30'	N	1	N	1
14	38° 30'	76° 30'	N	1	N	1
15	38° 30'	76° 30'	N	1	N	1
16	38° 30'	76° 30'	N	1	N	1
17	38° 30'	76° 30'	N	1	N	1
18	38° 30'	76° 30'	N	1	N	1
19	38° 30'	76° 30'	N	1	N	1
20	38° 30'	76° 30'	N	1	N	1
21	38° 30'	76° 30'	N	1	N	1
22	38° 30'	76° 30'	N	1	N	1
23	38° 30'	76° 30'	N	1	N	1
24	38° 30'	76° 30'	N	1	N	1

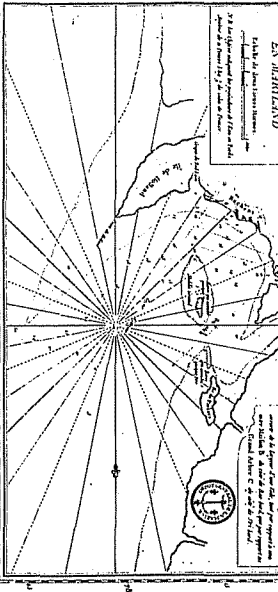
OBSERVATIONS

Sur la Baie de Chesapeake, le 10 Mars 1763.

Heure	Latitude	Longitude	Direction du Vent	Force du Vent	Direction du Courant	Force du Courant
10	38° 30'	76° 30'	N	1	N	1
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13	38° 30'	76° 30'	N	1	N	1
14	38° 30'	76° 30'	N	1	N	1
15	38° 30'	76° 30'	N	1	N	1
16	38° 30'	76° 30'	N	1	N	1
17	38° 30'	76° 30'	N	1	N	1
18	38° 30'	76° 30'	N	1	N	1
19	38° 30'	76° 30'	N	1	N	1
20	38° 30'	76° 30'	N	1	N	1
21	38° 30'	76° 30'	N	1	N	1
22	38° 30'	76° 30'	N	1	N	1
23	38° 30'	76° 30'	N	1	N	1
24	38° 30'	76° 30'	N	1	N	1

PLAN

DE LA BAIER HERRING
EN MARYLAND



INSTRUCTIONS

Il est à remarquer que la Baie de Chesapeake est une Baie d'Asie, et non d'Amérique.
Il est à remarquer que la Baie de Chesapeake est une Baie d'Asie, et non d'Amérique.
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first action began several hundred miles to the north in Massachusetts. In 1776 Lord Dunmore, the last Colonial governor of Virginia, was driven from the Bay after battles at Norfolk, Portsmouth, and Gwynns Island (Fig. 1). In 1777 the mainstem of the Bay and the Elk River (Fig. 1) supplied the watery avenue for Sir John Clinton's invasion of Pennsylvania which ended with the capture of Philadelphia, the Capitol, by Great Britain and the retreat of American forces into the long winter of Valley Forge. Four years later in 1781 the main military action ending the Revolutionary War closed on the lower Chesapeake with the naval battle off of the Virginia Capes, followed by the amphibious battle between Washington and his French allies and Lord Cornwallis over the fortified harbor of the lower York River between Gloucester Point and Yorktown, otherwise known as the battle of Yorktown. Surveys and soundings made for military purposes during the latter stages of the War added somewhat to the knowledge of the Bay.

European Scientists--Learned men of Europe had been interested in the New World since the first announcements of its discovery. Specimens of plants and animals were exported from America to the collections of many scholars, universities and museums. For example, as indicated above, John Clayton's herbarium of Virginia plants found its way to the National Herbarium in England. This interest of European scientists

spanned the Colonial period and survived the eight-year long, arduous first War for American Independence and the much shorter Second War of the Revolution (popularly known as the War of 1812), conducted by George III who undoubtedly wanted his "British subjects and possessions" back.¹⁹

The Post-Colonial Period

Undoubtedly the years immediately following the Revolution saw further exploration of the geographical features, the resources and the natural history of the Chesapeake. Understanding of the Bay, its bottoms, coasts and processes steadily but slowly improved as agricultural, commercial, military and academic pursuits were furthered throughout the entire region, but primary attention of the most vigorous forces in Maryland and Virginia continued to be directed toward the westward-moving frontier. This western focus had, as noted

¹⁹ Incidentally, this war began with a sea-borne invasion where the first had ended, in the Chesapeake. It almost foundered, or at least faltered, with the defeat of Admiral Sir John Warren's forces at Craney Island, near Norfolk in the Elizabeth River. It was almost victorious on the Patuxent not too far from Solomon's Island and again at Washington on the Potomac where the first permanent marine laboratory on the Bay was built. The battle at Fort McHenry in the port of Baltimore (the Patapsco River) almost put the finishing touches on this last British War Against the Chesapeake Bay colonies and the fledgling United States. The Chesapeake was heavily involved, in War of 1812! Of course the Battle of New Orleans took place in another estuarine marine area the mouth of the Mississippi and the nearby Gulf of Mexico.

above, begun well before the Revolution. Its movement and vigour slowed during that eight-year-long conflict but as soon as the War was over the movement renewed itself. The War of 1812 had little effect. From then on until the late 19th Century it gathered momentum and became the dominant force of national life, of exploration and of science. Noteworthy examples are many, beginning with the Lewis and Clark expedition to the great Northwest in 1804 during the presidency of Thomas Jefferson. Even the disastrous and all-consuming Civil War only slowed the westward march for a while.

This resulted in a comparative waning of interest in the ocean and its resources--and of interest in the Chesapeake. The frontier of the sea, once the greatest challenge (of the pre-Colonial and early Colonial periods) faded before the lure of the wilderness. This is not to say that there was no interest in the sea, its environment and resources. On the contrary, some of the same problems which plague man today such as offshore fisheries rights, international sea boundaries, and freedom of navigation on the high seas bothered early American functionaries. Thomas Jefferson, himself, as Secretary of State, reported on fishing rights and worked on the international boundaries of the seas. But this was byplay--backing and filling. "Westward Ho!" was America's cry. It was, in fact, the driving force in America until early in

the present century. Only recently have we begun to look again seaward.

To be sure, knowledge of Chesapeake Bay country, its various environments and their resources and other natural phenomena continued to increase. Botanists, ornithologists and other naturalists added information on the flora and fauna of the land and of adjacent tidal waters and geologists spurred the search for economic minerals and new concepts.

The interests of European scientists and explorers in the phenomena and places of the New World, which had begun with the first speculations and voyages of discovery in the 15th and 16th Centuries, flourished during the 17th and 18th Centuries. They persisted and some flowered anew after the Revolution and the War of 1812. New collections made all over the country by Americans and visitors alike found their way to Europe. One relatively unknown visitor was the French scientist, Plee.

Auguste Plee -- arrived in Hampton Roads aboard the French frigate JUNO in the spring of 1821. He explored, collected and sketched around the lower Chesapeake and up the James and York Rivers before moving on to Philadelphia, New York State and Canada.

Plee's journals were withdrawn from the Paris museum after

his death and have never been seen since, but many of his sketches are available in the Paris Museum of Natural History. Among them is a sketch showing Gloucester Point, the site of the Virginia Institute of Marine Science since 1950-51.

Plee's whirlwind 3-month tour of the mid-Atlantic, the East and Canada ended with his departure to the Caribbean where he died in 1825, never having reached home (Rouse, 1972).

Other Efforts -- As far as has been detected from the records thus far, little new or noteworthy major exploration or scientific study of the Chesapeake took place during the early and middle part of the nineteenth Century. Navigation, commerce and fisheries continued and charts and maps of the Bay and adjacent land masses were under almost constant revision. More adequate coastline surveys and soundings of bottom topography, so important to commercial navigation and military activities at sea, were made and maps were revised to include the new data. Soundings and shoreline surveys of the mid- and late 1800's have been useful in studies of geomorphology, shoreline erosion and changes in bottom topography to scientists of the Bay in very recent times.²⁰

²⁰ This period should be investigated further. More may have occurred than appears at this point.

Further Developments in Oceanography Abroad -- In Europe considerable interest began to develop in scientific study of the oceans. Numerous voyages of science and exploration were dispatched. Among these noteworthy voyages of science were those of 1) the BEAGLE with Charles Darwin as naturalist 1831-1836, 2) PORPOISE in 1839-42 with J.D. Dana, 3) RATTLESNAKE with T.H. Huxley in 1846-50, and 4) BULLDOG in 1860 with G.C. Wallich as scientist. The American Civil War seems to have caused a pause since the British apparently did not resume the work until 1868 with the Wyville Thompson cruises. Earlier, however, Edwin Forbes had done considerable oceanographic research around the British Isles and Herdman (1923) credits him with being one of the founders of oceanography. Governments were involved primarily through their navies. Hydrographic offices were established and strengthened to allow observations related to support of naval and commercial operations of the several sea powers.

In the United States our Navy responded and sponsored the United States Exploring Expedition to the Pacific under Lt. Charles Wilkes, an astronomer who headed the Navy's Department of Charts and Instruments. The Expedition marshalled in and departed from Hampton Roads just off the lower Chesapeake in 1838. The ships employed were the sloop of war VINCENNES, the brig PEACOCK, the store ship RELIEF and two tenders, the GULL

and the FLYING FISH (Jahns 1961). It also established a Naval Observatory at Washington.

The U.S. Coast Survey had been established earlier. Its second head, Alexander Dallas Bache, a grandson of Benjamin Franklin, continued his grandfather's interest in the Gulf Stream. He also encouraged Louis Agassiz to use Coast Survey vessels in his oceanographic research. Not known at this point is whether the Agassiz-Coast Survey combination accomplished anything on the Chesapeake. Bache also helped bring his friend Joseph Henry to the new Smithsonian Institution in Washington on the Potomac.²¹

Other Advances -- Great advances had been and were still being made in the understanding of gravity, of astronomy and of the relationships between the movements of moon and tides and wind and water. Inventions such as the steam engine and its application to steamboats promised to revolutionize the developing science of the sea as it did to travel and commerce, on land and at sea. Auguste Plee had travelled in the north by steamboat as early as 1821 but wind in sail remained the

²¹ The United States Coast Survey and its successor the Coast and Geodetic Survey undoubtedly conducted many operations in the Chesapeake Region following their establishment. Time has not permitted a review of these works in detail. Hopefully opportunity to do so will present itself later.

principal motive power at sea for some time.

The science of hydrography advanced in Europe and was being practiced around the world by the navies of the advanced nations and some of the merchant companies.

Matthew Fontaine Maury, born at Fredericksburg on the Rappahannock tributary of the Bay, applied his fertile and productive mind to the problems of mariners, of farmers, and of whale fishermen. He developed a plan for meteorological observations at sea and across the land to aid agriculture and developed charts of winds and currents with sailing instructions and whale tracks for whalers, and became America's foremost scientist of the sea.

The U.S. Naval Observatory, established on high ground near the head of tide on the Potomac, was the seat of much oceanographic work. Its first superintendent was Maury (Corbin, 1888).

Though many hydrographic works had been done on its banks at Washington and on several expeditions such as the Wilkes Expedition to the Pacific and the Antarctic Ocean, little seems to have been done to elucidate details of the Chesapeake. The attention of the Navy and of American commerce were on the World Ocean. There was an effort by the U.S. Navy to chart the

sounds, estuaries, harbors and coastal waters of the South--later to become useful in the Civil War, but no published record of such work on the Chesapeake during this period has been unearthed during this study.

The Post-Civil War Period: Prelude to the Modern Era

The Civil War (from 1861 to 1865), which opened with a preliminary military action on another estuary off Charleston in far away South Carolina, started in earnest on a tributary of the Potomac (Occoquan Creek-Bull Run) and raged around the shores of Chesapeake until the very end (Fig. 1). Many fierce battles, in this our most costly conflict, were preceded by waterborne troop and supply movements from the Potomac to the James and the York and then to the Rappahannock, Potomac and back to the James. All major waterways of the Chesapeake were involved. A number of the engagements involved naval and amphibious operations. New soundings and surveys preceded and accompanied these movements and improvements in navigational records and charts were possible.

Apparently, the first "remote sensing" from the air of land and water-borne military facilities (but mainly troops) in the United States began on the Chesapeake. Aerial observation of topographic features and water bodies began on the James and York with the observations of hydrogen balloonists of the North

and South. Some balloons were supported and flown from especially equipped vessels. The revolution in naval warfare brought about by the engagement of the first steam-powered ironclads VIRGINIA (MERRIMAC) and MONITOR in Hampton Roads were another technological milestone first put into practice in the struggle for control of the Chesapeake. Though worthy of note as additions to marine military technology these engineering achievements added little to knowledge of the Chesapeake.

The period between the Revolution and the Civil War saw development of many governmental and private institutions concerned with science. As has been noted, the U.S. Coast Survey, the Naval Observatory and the Smithsonian Institution had been established in Washington prior to the Civil War. The Navy Hydrographic Office was founded just after the War. William and Mary was joined by other colleges and universities around the Chesapeake. Among them were Washington College in Chestertown, Maryland (1782), St. Johns in Annapolis (1784), and Georgetown University in Washington (1789) (Fig. 1).

Industry grew and the seacoast and beaches became popular vacation spots. Maritime commerce increased and fishing became big business. Fisheries began to experience difficulties. Nonetheless, organized scientific efforts to increase knowledge of the biological, chemical, geological and physical phenomena,

including the fisheries, of the tidal waters of Maryland and Virginia did not really begin to develop until around 1870. To be sure, as in the preceding period mentioned above, individual observations and small surveys occurred (or continued) but they were mostly directed at terrestrial populations and processes. Little was done on marine subjects.

Studies of Natural Resources - the Fisheries--In the beginning knowledge was obtained by fishermen through the increasingly successful pursuit of those species which were readily available and well-liked by consumers. Shellfish, finfish and crabs, captured and treated by methods used in their own homelands and by their Indian teachers, had been used from the Colonial beginnings. Later fishery scientists were to be involved in the gathering of knowledge of fishery resources.

The development of fishery science and mariculture began in Europe long before it did in the United States. That it did so is of no great surprise considering the longer history and greater sophistication of the Continent.

In the United States governmental authorities were becoming worried over effective management of the fisheries and use of fishery resources, but fishery science had not yet emerged on the Chesapeake. Science is usually not "called in" until problems develop (and often not until they have become

overwhelming) and the fishery resources of the United States and especially the Chesapeake seemed unlimited in those days. Concern did not materialize to the degree necessary for action until after the War Between the States as far as we can tell.

With increasing harvest of coastal species, problems began to develop. Those readily accessible, long-lived, sedentary and easily-harvested molluscs, the ubiquitous oysters, exhibited signs of distress. First, harvests dropped in the northern waters of New England, New York and upper New Jersey. Pressure moved south into Delaware Bay and the Chesapeake as populations of humans to the north increased and fishery populations waned. Oyster production soon diminished there too. Fishing practices and pollution were becoming suspect as probable causes. Science began to be seriously considered as a possible tool for solution of these difficulties.

Early Fisheries Investigations--In 1865 C. S. Maltby made a careful computation of the oyster business for the whole Bay for the year and found that 6,954,500 bushels had been harvested. Ten years later 17,000,000 bushels were taken and the amount continued to increase until 1885 when the harvest began to shrink. Shrinkage continues. This decline in productivity caused severe worries in both ends of the Chesapeake and in Washington (Brooks, 1891).

Around 1870, after the Civil War ended, the fisheries management agencies of Virginia and Maryland and the Federal government undertook studies of the fisheries of the Chesapeake and, more importantly for our purposes, of the biological resources on which they were based. At about this time the U. S. Coast Survey undertook a number of studies of oyster bars in the Chesapeake as well as elsewhere in the mid-Atlantic and Northeast. These important joint state-federal activities relating to improved management of the coastal fisheries have continued until the present day.

Prior to the publication of Fishes of the Chesapeake Bay by Hildebrand and Schroeder of the U. S. Bureau of Fisheries in 1928, the most comprehensive work on fishes of the Bay was the List of Fish of Maryland by Uhler and Lugger (1876). This work, which could have been titled A Catalogue of the Fishes of Maryland and Virginia (Hildebrand and Schroeder 1928), was published by the Maryland Fish Commission in 1876 in the report of the Commissioner of Fisheries. It was supplemented in 1877 and in 1878 by Lugger who added 29 and 10 species respectively.

According to Hildebrand and Schroeder (1928) many other now famous scientists contributed to organized knowledge of the fish and fisheries of the Bay during this same period. For example, Tarleton H. Bean, Barton A. Bean, Hugh M. Smith, and

Barton W. Evermann published papers relevant to Chesapeake fish in the late 1800's.

Biology by the Coast Survey and the Navy -- Acting under the direction of the Superintendent of the United States Coast Survey, Lieutenant Francis Winslow, USN, in 1878 and 1879 surveyed the oyster beds and studied oyster populations of Tangier Sound. Working especially in the little Annemessex River (Fig. 1), he conducted experiments with different spat collectors. This work with artificial collectors is the first recorded for the Chesapeake region. The busy Lt. Winslow also worked on oysters in North Carolina waters, laying the groundwork for subsequent scientific oyster investigations there.

Lieutenant James B. Baylor, believed to have been a naval officer working for the U.S. Coast and Geodetic Survey, conducted a survey of all of the known oyster-producing rocks of Virginia, including formerly productive ones, in 1894. Done at the request of the Virginia government (the old Board of Fisheries or its predecessor organization if there was one) the work resulted in the delineation of those oyster grounds in Virginia which were legally established as the public grounds of the Commonwealth on the basis of Baylor's findings and delineations.²²

The cooperation of these federal officers in technical programs related to the welfare of Chesapeake Bay fisheries in both states set the pattern for later state-federal cooperation on the problems of the Bay system.

Advancements in Europe -- As indicated above, developments in many areas of science in the infant and adolescent years of the United States followed some years behind those in Europe. The pattern continued in marine science until some years after the Civil War. In England ocean research increased as the work

²² Open to all Virginia citizens these grounds within Lt. Baylor's survey boundaries have been regarded as "sacrosanct" and not available for lease or other uses until very recently. Even now action by the General Assembly is required to change the boundaries to allow uses of any sort by anyone other than "the public".

of Sir Wyville Thompson and his illustrious cohorts, begun in the ship LIGHTENING in 1868 and culminated in the remarkable voyages of the CHALLENGER in 1872-76, established models for most of the world (Herdman, 1923).

Development of Oceanographic Institutions -- The early days of oceanography were oriented around ships, the precursors of the noted marine biological stations. The great oceanographic institutions did not develop until the 1870's (Herdman, 1923). Among the earliest was the Stazione Zoologica, the Zoological Station at Naples, established at about the same time in 1873 as the privately supported marine laboratory (The Anderson School of Natural History) of Louis Agassiz in Buzzards Bay. This, the first such station in the United States was on Penikese Island, Massachusetts. Later the U.S. biological research station (now NMFS Northeast Center) was developed, becoming the first of the research stations at Woods Hole. Others followed soon after in Europe and the United States, including Chesapeake Bay.

Interestingly Agassiz was the academic "father and grandfather" of many of the marine scientists of the United States such as Drs. Brooks and Dr. Truitt who established some of the institutions mentioned here.

In the late 1800's and around the turn of the century the

federal government began to establish fishery and biological research laboratories in coastal locations or to allow others to do so on federal property.

Fort Wool -- Just as the federal fortification at Dry Tortugas was employed at one time as a marine research station, so was Fort Wool at the mouth of the James in Hampton Roads (Fig. 1). In 1878 this island installation was used as a biological field station by a group from Johns Hopkins University under the direction of Professor W.K. Brooks.²³

The Beginning of the 20th Century

Federally-Funded Science -- As many in the late 1800's had done, scientists from the federal government made significant contributions to knowledge of fishery resources and the fisheries of the Bay immediately prior to and after World War I. In 1912 Lewis Radcliffe and William W. Welsh began detailed studies of finfisheries of the Bay, probably because of continuing shad and herring declines. In the winter of 1914-15 the work was enlarged to include a general biological and physical examination of the Chesapeake under the supervision of

²³ The results of the efforts at Fort Wool there were accumulated and published by Johns Hopkins University in a report entitled Chesapeake Zoological Laboratory in 1878 which I have not reviewed as yet.

Radcliffe. The fisheries steamer FISH HAWK was assigned to this effort.

Following interruption by the First World War, Dr. R.P. Cowles of Johns Hopkins University supervised the general biological and physical research resumed in 1920. Cowles' efforts, which were the first of significance on biology and hydrography of the Chesapeake itself, were reported in 1930. This work (Cowles, 1930) was intended as a baseline against which changes in the conditions of the Bay, as determined by subsequent surveys, could be gauged.²⁴

In 1921 Hildebrand and Schroeder undertook a special investigation of the Chesapeake and the fisheries and fishes dependent thereon. It continued until the fall of 1922 when all field operations were halted and analyses of the data were undertaken. Cowles' publication, one outcome of these combined federal studies, has been mentioned. The efforts of Hildebrand and Schroeder culminated in their now classic monograph on the Fishes of Chesapeake Bay published in 1928. Though a great amount of ichthyological research has been accomplished since 1928, "Hildebrand and Schroeder" stands alone even now, fifty years later. It was reprinted in 1972 by the Smithsonian

²⁴ Baselines, even then!

Institution to meet continuing demand.

Mr. James B. Engle (personal communication) relates that there was a federal operation on St. Jerome's Creek just above Point Lookout on the Potomac around 1920 (Fig. 1). Evidently its purposes were investigations of oyster culture. Apparently its success was limited and it was discontinued.

Academic institutions became more strongly involved and organizations were established in which and from which more thorough and regular marine researches could be conducted, thus ushering in the great expansion of science in the Chesapeake that was to take place during and after the mid-1900's.

The Beginnings of Academic Laboratories on the Bay--While records have thus far proven elusive, it is known that the first university-sponsored (and supported) marine laboratory was established around 1878. After its short-lived operations at Fort Wool the Chesapeake Zoological Laboratory (CZL), associated with the Johns Hopkins University, was evidently located at a place called the Cove on the waterfront at Crisfield, Maryland (Fig. 1). It seems to have been primarily a summer operation conducted by Dr. W.K. Brooks, probably with colleagues. This organization is cited on the title page of Brooks' 1891 book entitled The Oyster. The location, not noted in that publication, was supplied by Dr. R.V. Truitt in a

telephone communication in the spring of 1977.²⁵

Dr. Brooks, a seasoned member of the Hopkins faculty, had begun his important work on the oyster even before 1878 and later served as an oyster commissioner for the Maryland government in 1883.

There was a connection between Lt. Winslow's work on the Tangier Sound and in the Little Annemessex and Dr. Brooks' Chesapeake Zoological Laboratory (CZL) at Crisfield. Lt. Winslow visited Dr. Brooks frequently and learned his methods. Winslow had been detailed by the federal government to work on oyster problems in 1878-1879. The CZL station was nearby and available and was evidently established around that time.

Having called for help from the federal government and from the universities,²⁶ state governments obviously did not have or feel they had²⁷ sufficient funds to support the

²⁵ As will be noted later Dr. Truitt, himself, has contributed mightily to the development of scientific organizations and to understanding the Chesapeake.

²⁶ Brooks is reported to have been supported by Johns Hopkins while serving the state and Lieutenants Winslow and Baylor were probably paid by their service, the Navy, or by the coast Survey.

²⁷ Which are two different things that amount to the same as far as support of science is concerned-or any other activity of importance to states.

Chesapeake Bay research that they patently needed at the time. Academic institutions were evidently no better off.

Though money to finance marine research outside of the federal government was sparse and there was precious little for inside efforts, scientists from academic programs persisted in their efforts to secure support and establish programs. Eventually, research and teaching institutions under state or private control, with fixed facilities and regular personnel supported by state and federal funds were established in both ends of the Chesapeake. Federal facilities also developed in Maryland and Virginia. Some survive today in the upper Bay though those in Virginia were disbanded prior to World War II.

Beginnings of the Recent Era -- The Chesapeake Zoological Laboratory of Dr. Brooks did not survive and there are no other hold-over organizations from the 1800's. Whether they were lost before or during World War I or disappeared with the deaths of their originators and mentors as has often been the case is not known, but it remained for the post-World War I period to see the beginnings and development of the organizations which have contributed to the second great period of discovery in the Chesapeake--the Second Quantum Jump Period in the development of knowledge of the Bay which took place after 1945.

Following the scientific bridgeheads developed by state fisheries bodies, academicians and the United States government, the period between 1916 and 1940 saw establishment of more regular efforts.

In 1916 Mr. W.H. Killian, Secretary of the Conservation Commission of Maryland, proposed that an investigator be employed to study the scientific aspects of the Bay's resources. The Department of Entomology and Zoology of the Maryland Agriculture College, agreed to employ a zoologist properly trained for this work and secured the services of R.V. Truitt in 1919 as Assistant Zoologist and lecturer in "aquiculture". In the first year the Department organized what may have been the first course on Bay conservation to be given in the state. Of course, World War I likely was responsible for delaying Killian's project but it resumed soon after.

After World War I

The Chesapeake Biological Laboratory -- The first institution to persist, the Chesapeake Biological Laboratory (CBL) at Solomons (Fig. 1), grew out of the laboratory begun around 1919 by Dr. Reginald V. Truitt. Truitt established and conducted summer operations at Solomons and, secondarily, at Crisfield on the Eastern Shore in the tradition of Brooks. He called the first laboratory the Solomons Biological Laboratory,

a name which lasted until 1924 when it was renamed the Chesapeake Biological Laboratory (CBL).²⁸

Though CBL was established in 1919 it was not until 1932 that its first permanent building was opened. Its land holdings, buildings and personnel have continued to grow since. Recently a new Controlled Environmental Laboratory, named after Dr. Truitt, was dedicated. World War II saw a pause in the development of CBL.

Federal Efforts--The federal government was active in this period in several places on the Chesapeake. If memory serves correctly, sometime during the 1920's or the 1930's, research on certain parasites of fishes was conducted from the old maritime hospital at Claiborne on the northern end of Tilghman Island (Fig. 1). A number of reports and scientific papers involving parasites, especially protozoans, of fishes were published as a result of this effort.

The Public Health Service--The United States became involved

²⁸ In a personal communication, 14 October 1977, Dr. R.V. Truitt said, "In 1919 I did divide my time between the two places (author's note--Solomons and Crisfield) but at the latter place I merely checked local waters for oyster larvae abundance, and while I had space through the interest of an oyster packer, my center of operations was a Solomons in a fishing shack where I tested the efficiency of various materials as cultch."

again with research on the southern end of the Chesapeake. A laboratory for research into basic problems of shellfish bacteriology was established at Craney Island in the mouth of the Elizabeth River near Portsmouth and operated under the successive direction of Drs. Hasseltine and Walker and Mr. Ralph E. Tarkett. It was eventually discontinued in 1928.

As part of this PHS effort in Shellfish sanitation research the Service also developed a floating laboratory, the vessel SHEARWATER, for special field studies of oyster-growing areas. The Service later curtailed its marine operations but shellfish problems persisted, and in 1934 an important field survey was made in Hampton Roads in cooperation with the State of Virginia.

Another laboratory to investigate some of the basic problems of shellfish bacteriology was organized at Craney Island in 1940 (Fig. 1). Dr. Leslie A. Sandholzer was in charge of this program which ended in 1942 because of World War II. As far as can be determined the Craney Island laboratory was never reopened.

The U.S. Bureau of Fisheries at Yorktown -- The Bureau of Fisheries (now the National Marine Fisheries Service) conducted research on a severe oyster mortality in 1928. And later, in October of 1935, a federal laboratory was established at

Yorktown, Virginia, supported by a special allotment of \$20,000 from the Public Works Administration. After a time, funds were added by the State. The program included a study of the failure of oyster culture in the York River, allegedly as a result of discharges from a paper mill²⁹ in West Point, which had been operating there since about 1913. After the initial allotment expired the laboratory was continued with support from the U.S. Bureau of Fisheries and the Commonwealth through the College of William and Mary and the Virginia Commission of Fisheries. Its work persisted through 1938.

The research done at the laboratory involved a "complete" program of investigative studies of the biological effects of pulp mill wastes on oyster production as well as a "complete program of description of the hydrographic conditions in the York and Piankatank Rivers". Dr. Paul S. Galtsoff was the Director. Much of the analyses and experimental work was carried out by Dr. Walter A. Chipman, Jr., and Dr. Arthur D. Hasler. Certain joint operating agreements were held with the

²⁹ Chesapeake Corporation, the paper mill, conducted its own studies of oyster culture in the York. In so doing the Corporation's separate oyster company developed rack culture to a fairly sophisticated and productive level. Considerable handling was required. The effort was discontinued later, reportedly due to diminishing economic returns resulting from increasing labor costs. The SeaRac method involved considerable movement and human manipulation of the oysters.

College of William and Mary in nearby Williamsburg.

This laboratory was closed out when the Federal Government decided to discontinue the operation. The spaces and some of the equipment and work it vacated were taken over by the Commonwealth of Virginia in 1940 when it established the Virginia Fisheries Laboratory, later to become the Virginia Institute of Marine Science (VIMS).

Virginia's Early State-Supported Marine Research

Efforts--Perhaps the beginning of sustained state-supported efforts by the government of Virginia began in 1931 with the hiring of a fisheries biologist, Victor A. Loosanoff. Dr. Loosanoff was to study problems related to oyster fisheries and pollution and perhaps other fisheries in certain Virginia waters, primarily the James and York Rivers. He was quartered in a building on the old ferry pier at Old Point Comfort near Fortress Monroe and the Hotel Chamberlin (Fig. 1).

In discussing this period in his professional life with me some years ago, Dr. Loosanoff, who came to Virginia from Washington state, related a number of anecdotes, including one concerning the great difficulty he had in securing a microscope to aid his work. Another one, with which we all have had experience, was the apparent belief by his non-scientific superiors and backers that all he had to do was "snoop around"

a bit with tongs, dredges and a hand-lens (and perhaps a pipe and a fore-and-aft cap like Sherlock Holmes) and solutions would be forthcoming quickly. Unfortunately it was not to be that way. Despite his best efforts and some quite productive work, considering the state of the art at the time and the equipment at his disposal, many of the problems Dr. Loosanoff was employed to solve remained unsolved when he left. A number are only imperfectly understood today -- 47 years later.

Dr. Loosanoff's state-supported operation on Hampton Roads along with the jointly-financed Federal operation at Yorktown were the precursors of the state-supported laboratory, the Virginia Fisheries Laboratory, which was established at Yorktown in the facilities vacated by the Bureau of Fisheries when Dr. Galtsoff and his cohorts left.

The Virginia Institute of Marine Science (formerly Virginia Fisheries Laboratory)--Shortly after the establishment of the Chesapeake Biological Laboratory in Maryland in 1925, Dr. Donald W. Davis, Professor of Biology at the College of William and Mary began a campaign for establishment of a marine program in Tidewater Virginia which was to culminate with the establishment in 1940 of the Virginia Fisheries Laboratory with

facilities at Yorktown and at the College (Fig. 1).³⁰ Interestingly, despite all of Dr. Davis' and William and Mary's efforts, it has been reported that two other institutions of higher education--the University of Virginia and Virginia Polytechnic Institute and State University), were asked if they wanted to operate or be involved in the new marine laboratory. Both declined in favor of the nearer, and then, more popular freshwater stations (around Mountain Lake, Virginia) and William and Mary was finally given responsibility for Dr. Davis' marine program. Rivalries and ambitions of state institutions intervened even then!

The College had to share the management and expenses of the new marine laboratory equally with the Virginia Commission of Fisheries. Dr. Curtis L. Newcomb was appointed its first Director in 1940. Several now-noted marine scientists, for example, Drs. Sewell H. Hopkins, J.G. Mackin and R. Winston Menzel, were among the first professionals and technicians in the employ of the laboratory.

A branch laboratory established at Wachapreague on Seaside of the Eastern Shore in Accomac County closed later as World

³⁰ The Microbiology-Pathology Laboratory at VIMS is called Donald W. Davis Hall after this determined advocate of Marine Science.

War II developed (Fig. 1). The War also affected the main laboratory at Yorktown and the campus of the College and research and educational efforts waned. Both the Seaside and the Yorktown centers were to be reactivated at War's end, but that at Wachapreague was not revived until Dr. Hargis became Director and did so early in the 1960's.

Baywide Cooperative Efforts--No cooperative efforts begun before World War II survive, unless one regards VIMS as the offspring of consortial activities between Maryland (Dr. Truitt) and Virginia. Interesting, however, is the attempt in early 1941 by Dr. Ivey L. Lewis of the University of Virginia to bring Virginia and Maryland interests together in planning, conservation, control and utilization programs for the Chesapeake Bay fisheries. Dr. Lewis proposed to pull together representatives of William and Mary, the University of Virginia, University of Maryland and Johns Hopkins. The organization evidently eventually came into being as the Chesapeake Bay Fisheries Commission. At a meeting of that body in November 1941, Dr. Truitt presented a proposed program which involved an examination of the socioeconomic aspects of fisheries and fishermen. Dr. Lewis served as Chairman. Numerous now well-known personages were sought for the directorship of the study outlined by Truitt. These included Dr. Leslie A. Stauber, Dr. Daniel Merriman, Dr. Herbert F.

Prytherch and others. The Commission lasted until 1944. It, too, likely became a victim of the war.

The Recent Period -- Post World War II

World War II involved vast operations over, on the surface of, and under almost all of the waters of earth. Amphibious movements across the coastal zone, the sea-land interface, were particularly touchy operations requiring much advanced hydrographic and terrestrial information for proper planning and execution. Oceanography and ocean engineering were called into action as never before in history. Most marine scientists and scientific institutions were pressed into service by the Navy. After the war oceanography developed even further, preparing the way for accumulation of knowledge in all fields of ocean science on a scale far greater and in detail far more intricate than ever before. Naturally, the Navy was a leader in this development.

Growing interest in the sciences of the sea and their applications plus an increasing awareness of the finite nature of marine resources and the easily degraded quality of the environments of the Chesapeake and nearby coastal and shelf water were the precursors of the second renaissance of science of the Chesapeake--the Second Quantum Jump Period in knowledge of the Bay. During the next thirty-odd years the majority of

information about the Chesapeake and its tributaries to be obtained since the beginnings of recorded knowledge was to be gathered. But first the organizations which were to make this growth possible had to be revived. Later, additional ones were added.

The Chesapeake Biological Laboratory (now part of the Center for Environmental and Estuarine Studies--CEES.) The Maryland marine research program at Solomons and its satellite base at Crisfield picked up steam as World War II ended. The hiatus which affected the Virginia Fisheries Laboratory toward the latter part of the War seems to have been less pronounced in the Maryland Laboratory (CBL), though both were slowed. The perambulations and permutations which led to the evolution of the Chesapeake Biological Laboratory into the Center for Environmental and Estuarine Studies are of interest.

From 1925 until today the Chesapeake Biological Laboratory has undergone several changes in organizational affiliation. At first a separate state-supported research institution, it became part of the Maryland Department of Research and Education, managed by the Commission on Research and Education of the State of Maryland, in 1941. It then was made part of the National Resources Institute (NRI) as it was taken into the

University of Maryland in 1961.³¹ It is of special interest to note that CBL established a seaside branch at Public Landing in Chincoteague Bay, which operated from 1951 to 1964 (Truitt, personal communication) (Fig. 1).

Since 1973 both CBL and NRI and the Crisfield laboratory have been part of the Center for Environmental and Estuarine Studies (CEES) of the University of Maryland under Dr. Peter Wagner. Today the headquarters of the organization is near Cambridge, Maryland on the former DuPont estate at Horn Point in Dorchester County on the Eastern Shore (Fig. 1).

The Marine Products Laboratory -- In 1957, the Department of Zoology of the University of Maryland established a seafood processing laboratory in Crisfield. Permanent laboratory facilities for marine and seafood-related research were established on the waterfront there. In addition to seafood technology, certain projects in marine science were conducted from time to time. In 1961 the seafood laboratory was merged into the Natural Resources Institute of the University along

³¹ The Final Report of the Maryland Commission on Research and Education 1941-1961 was issued on 31 May 1961. It noted especially that House Bill No. 739 of the 1961 General Assembly of Maryland transferred the functions, staff and physical assets of the Commission and Departments to the University of Maryland in the form of the newly created Natural Resources Institute.

with the Chesapeake Biological Laboratory. Recently its name was changed to the Marine Products Laboratory of the Center for Environmental and Estuarine Studies, as was shown above. Its work, mostly as a seafood technology laboratory, persists today.

The Virginia Institute of Marine Science (VIMS) -- The marine science program in Virginia was separated financially from the College of William and Mary and the Virginia Fisheries Commission, though remaining under the managerial co-chairmanship of the President of the College and the Commissioner of Fisheries. A number of young scientists, most of whom are still on the professional staff of the Institute were employed in 1946 and the program picked up headway. Personnel from the College were involved in the work of the marine laboratory and in the beginning facilities at Williamsburg were used by Institute scientists. For example, Dr. Alfred R. Armstrong of the Department of Chemistry participated in a number of studies of estuarine chemical processes.

Dr. Nelson Marshall, the second full-time³² Director (from

³² Dr. Donald W. Davis served as Acting-Director from fall of 1946 to mid-1947. Essentially therefore he was the second Director, though he was evidently not full-time.

1947 to 1951) was succeeded by Dr. J.L. McHugh who accepted the assistant directorship of the Bureau of Commercial Fisheries and left Virginia. Dr. W. J. Hargis, Jr., current director, assumed the office in early 1959.

The Institute is now the largest marine research, development and educational program on the Chesapeake Bay, with over 525 employees in peak employment times. Supported by state and federal funds it operates in all fields of marine sciences, ocean engineering and marine affairs. It is also the principal marine and advisory services activity for the Commonwealth. Its academic program, carried on under the aegis of the College of William and Mary, as it has been for almost 40 years,³³ now involves almost 70 faculty members and 110 students. Alumni of the VIMS/William and Mary program are active in many scientific areas and geographical locations. The educational program in marine science is operated as the School of Marine Science, a joint venture of the College of William and Mary and the Institute. Alumni of the School hold positions in many governmental and academic organizations.

³³ In 1964 the University of Virginia was involved when the doctoral program in marine science at VIMS was offered as part of the University's curriculum. It will continue until the last students are finished, when it will be cancelled as required by the State Council of Higher Education. The operational unit is the Department of Marine Science of the University.

The Chesapeake Bay Institute (CBI) -- The Maryland and Virginia laboratories were primarily oriented toward biological oceanography and marine biology in their early years. They had worked in other areas of oceanography, especially chemical. However, greater knowledge of the physical and geological status and processes of the Bay and its tributaries was needed thus requiring more scientific attention. Neither institution felt able to muster the funds necessary to do this on its own.³⁴

In 1948 the Chesapeake Biological Laboratory and the Virginia Institute of Marine Science agreed with the United States Office of Naval Research (U.S. Navy) to jointly sponsor, establish, aid and support a separate institution called the Chesapeake Bay Institute (CBI) for carrying out this work.³⁵ Management was to be by a Board involving members from all three of the funding organizations and CBI, itself. Thus was established the Chesapeake Bay Institute. The joint management Board did not survive long but CBI did. It remains active.

The Johns Hopkins University agreed to host the Chesapeake Bay Institute, which was first located on St. Paul street in

³⁴ Though oceanography was soon to come into a period of growth in the post-War Era, that phase had not yet arrived and funds in Virginia and Maryland for marine research, and elsewhere for (Footnote continued on next page)

that matter, were very sparse.

35 Concerning the origin of the Chesapeake Bay Institute there is confusion, indicates Dr. R.V. Truitt (personal communication of 14 October 1977) who said, "The VIMS and CBL did not agree with the U.S. Office of Naval Research to establish, etc. and carry out the work assigned to CBI upon its inception. At Solomons two years before World War II a program, Hydrography of Chesapeake Bay was instituted and continued until the war took its able leader, Dr. Robney Olson and his assistant, Harry Stern, thus for the duration, the work was closed down. Thereafter, with my Commission's enthusiastic approval, I visited Dr. Revelle at his Scripps Laboratory for a full consideration of reviewing our Baywide program expanded to oceanography. He not only recognized the need of such work but offered his full assistance to establish it, short of cash. He felt, and I readily agreed, that Dr. Marshall (Dr. Nelson Marshall, then Director of VIMS predecessor organization VFL - author's note) and his staff should be a part of the projected development. A conference with Marshall was a radiant one and our cause became a common and cordial one."

"I invited Dr. Revelle to visit us at Solomons to further discuss the matter and, possibly draw-up plans to start a broad attack on the problem. He accepted and at a crab feast of moment he urged, especially that partnership be established with the Naval Research Office. Here there was money appropriate for such work (about which I had theretofore no knowledge). It was Revelle's opinion that \$100,000 would be needed to establish a going program, a figure that scared Nelson (Dr. Marshall - author's note) and me, with our small budgets, funds being hard to come by at the time. But, we agreed that a "selling push" just could put it across. Starting with the two governors (of Virginia and Maryland - author's note), and an acceptance of the project took place. It must be admitted that we needed art in salesmanship such as "if Virginia can do it, so can we in Maryland" and vice versa. Our Commissioners, all important as they were, backed the movement cordially."

"The question that remained, with the money, \$90,000 equally shared by Virginia, Maryland and the Naval Office, was which institution should be selected to sponsor the office and program being created. The University of Maryland had not appropriated any money at all for the CBL operations. The University of Virginia had shown little if any interest in the Bay, while the arts college, William and Mary, now better (Footnote continued on next)

financed, had neither demonstrated major research potential nor had immediately available housing space (for the new oceanographic program - author's note). The Hopkins, noted for its research in several areas, was suggested and by acclaim was chosen to head up the program. I was named to interview its President, Dr. Isiah Bowman, a distinguished geographer, who cordially welcomed the thought and after surveying his campus and consulting his advisors, accepted the sponsorship of the programs at a high level of approval. The following fiscal year the Chesapeake Bay Institute, with as indicated heretofore, Dr. Donald Pritchard as its Director was established."

"Dr. Charles E. Renn was Acting Director during organization of CBI according to Dr. L.E. Cronin (personal communication)."

Baltimore in 1948 and then in an estate northeastward from Annapolis on Rideout Creek. After successful operations near Annapolis for several years, the main base for CBI was moved by the University to its Homewood Campus in Baltimore. Field operations continued on Back Creek below Annapolis until 1975 when they moved to the Trumpy boatyard across Spa Creek from the old harbor on the Severn River (Fig. 1).

Dr. Donald W. Pritchard, the first permanent director, and the staff of the Institute made major contributions to knowledge of the Chesapeake Bay and to understanding of estuarine processes everywhere. Its alumni are active in many areas. Dr. M. Grant Gross is now Director.

With establishment of this joint effort between Chesapeake Biological Laboratory (Maryland), Virginia Institute of Marine Science (Virginia), and Office of Naval Research (United States), the academic grouping of three major institutions that has undoubtedly contributed most to development of knowledge of the Chesapeake was completed and in place before 1950, twenty-seven years ago.

Other Academic Organizations (For the institutions and/or places mentioned here and later see Fig. 1) -- In more recent times other academic organizations have become directly involved in research on the Chesapeake. One such is Old

Dominion University, a Commonwealth-supported urban university in Norfolk, which established a marine biology program under Dr. Jacques Zaneveld in the old Ferry Terminal at Willoughby Spit at Norfolk in 1960, even before this former branch college became separated from the College of William and Mary. The organization was eventually named the Institute of Oceanography. Operations began at Willoughby Spit. Later, field activities were transferred to temporary quarters at Little Creek. Old Dominion University currently supports an Institute of Oceanography (currently directed by Dr. John Ludwick) on its own campus at Norfolk with a base for vessel operations in nearby Little Creek.

Certain members of the Department of Biology at the College of William and Mary and of other units of the College are also involved in projects related to estuarine and marine biota, and to resource economics, sociology, and law. A number of faculty members in these and other disciplines are involved in estuarine-related research and education with VIMS and the School of Marine Science and on their own. Less intense activities related to phenomena of the Chesapeake and coastal waters in the region are carried out by members of the developing Department of Environmental Science at the University of Virginia in Charlottesville. The Virginia Polytechnic Institute and State University (VPI and SU) at

Blacksburg maintains a field seafood station at Hampton. The Water Resources Research Center, operating out of VPI and SU supports some Chesapeake Bay research and there are other strong signs of more diverse marine interests developing in that institution. Mary Washington College at Fredericksburg on the Rappahannock has been interested in marine studies and education.

Several units of the Virginia Community College system, for example Thomas Nelson Community College at Hampton and Rappahannock Community College at Warsaw (Northern Neck branch) and at Glenss near Saluda (Middle Peninsula branch), are involved in teaching marine subjects but apparently do little research. Individual scientists in a number of other institutions, such as George Mason University in northern Virginia, do engage in marine research, but this involvement is relatively recent and usually small. It may increase.

In Maryland a similar situation exists. Some branches of the University of Maryland, for example the University of Maryland, Eastern Shore at Princess Anne, have attempted to encourage interest in Chesapeake science and a few individuals have been active as have several from St. Mary's College on the St. Mary's River in southern Maryland just off of the Potomac estuary. Individual faculty members from Hood College, Goucher

College and Washington College have also participated. Several Maryland community colleges, such as Anne Arundel Community College below Annapolis, Chesapeake Community College on the Eastern Shore in Queen Anne County and Charles County Community College on the western shore (Potomac River) have had involvements similar to those of their counterparts in Virginia.³⁶

As yet because of their recency and/or the small size and sporadic nature of their efforts, these academic programs have contributed relatively little as compared with those of VIMS, CBL (CEES) and CBI to knowledge of the Chesapeake Bay. Provided state and federal support for marine activities does not wane, one can probably expect more from them in the future.

State Agencies -- In Maryland, at least one of the secretarial departments (the Department of Natural Resources) maintains a staff of scientists, technicians, and engineers, with boats,

³⁶ In his personal communication of 14 October 1977 Dr. Tuitt notes, "You have paid tribute to faculty members of educational institutions for their contribution on seas and estuaries. I'd like to suggest that same be amplified somewhat. You will recall that professors usually were paid by the year, but typically, with their summers off for study and professional improvement. On that basis, mainly the Woods Hole Biological Laboratory (the Marine Biological Laboratory at Woods Hole - author's note) and the Bermuda Biological Laboratory became famous and a "summer resort" for those seriously interested in biology, especially marine life, the starting point of it all. (Footnote continued on next page.)

Dr. Herrick's (Western Reserve University) master piece, The American Lobster (we should have a like one on the blue crab) is one of hundreds that can be cited. Dr. Brooks, Hopkins, gave many summers to oyster study. Goucher, Washington, Hopkins, St. Johns and Western Maryland College each provided a faculty member annual for the Solomons work while I presumed to represent the University of Maryland. In case a faculty member at an (that-sic) institution was not available. \$100 was made available to support a visiting professor from elsewhere. I'd recall that in the 30's our students and staff paid only \$1 a day for board. Dr. Kudo of Illinois, Dr. Raymond Osborne, Ohio State, Bryozoa specialist of world note, Dr. Marcus Old, Dean at Hofstra University who did the Bay's boring sponge study and several other known specialists spent summers with us from the faculties of Columbia, Harvard, Rochester, Dartmouth, La. State, Vanderbilt, etc. Not all of them furthered their research but, instead, taught classes in the marine field courses limited to 5-6 students at the graduate and upper under-graduate levels. I go into this aspect of our work to recall that able college workers have played a worthwhile part in the accumulation of Bay knowledge."

"Perhaps I should stop there, but, I must say I feel that certain of the Commissioners of Fisheries, especially Armstrong and Lankford of Virginia, and Killian and Warfield of Maryland earn high praise, not political wise, in that they insisted on facts to guide them in policy making and they urged public support of research. As you know, in general those offices have been political plums."

which are active in the Chesapeake. It also sponsors research by academic and industrial laboratories partially from funds generated by Maryland's forward-looking power plant siting program. Other state agencies around the Upper Bay may be probably also involved, certainly the Maryland health agency makes observations.

The Virginia Marine Resources Commission encourages and supports studies in areas related to its responsibilities. Many of the funds so employed are federally derived. Additional Virginia state agencies such as the State Water Control Board and the State Department of Health are involved in supporting outside research and in doing monitoring and enforcement-level studies related to management of pollution of all types and to health-related aspects of water quality. These contribute to knowledge, understanding and management of the Bay. After all, man-induced changes are now almost as important as natural ones in the increasingly heavily populated and pressured Chesapeake region. Their importance is growing. As a consequence they must be studied and monitored even more carefully than natural changes if we are to truly understand the Chesapeake.

Interstate Agencies -- At least one multistate agency, the Interstate Commission on the Potomac River Basin, has been

active in planning and management on the Potomac for a number of years. It has not only prompted management interest in that important part of the Chesapeake System, but, also has encouraged the development of knowledge of the Potomac and the Bay into which it empties.

Recent Federal Activities -- Past contributions of federal installations and programs were discussed briefly above. Little has been said of those currently active.

The National Marine Fisheries Service Laboratory (of the National Oceanic and Atmospheric Administration) was built in 1959-60 on land donated by Mr. Johnson Grymes at the lovely town of Oxford on the Tred Avon River, a branch of the Choptank, on the Eastern Shore of Maryland (Fig. 1). It was dedicated and occupied in 1960. Primarily involved in shellfisheries and marine disease-related research, it succeeded a laboratory with similar functions which had operated from 1944 to 1960 at Annapolis. Once autonomous under Mr. James B. Engle, the first Director, and Dr. Carl Sindermann, the second Director, it has become a satellite of the northeastern laboratory complex controlled out of the National Marine Fisheries Laboratory at Woods Hole directed by

Dr. Robert L. Edwards.³⁷ Dr. Arthur Merrill was in charge after Dr. Sindermann and now Dr. Aaron Rosenfield is resident Director.

The Oxford laboratory maintains a field station at Franklin City, Virginia (Fig. 1).

The Environmental Protection Agency established a water quality laboratory at Annapolis in the fall of 1964. Working under or in conjunction with the regional office at Philadelphia it seems about to enlarge its Bay-related activities.

The Chesapeake Bay Center for Environmental Studies of the Smithsonian Institution (CBCES) -- This Center of the Smithsonian on the Rhode River in Anne Arundel County, Maryland

³⁷ Such are the vagaries of reorganization in the federal establishment, as in other governments, all of which seem to have penchant for frequent re-organization these days -- an activity which oft-times leads to more confusion than clarity and retrogression rather than progress.

That reorganization is not a new problem or a real or imagined solution is attested by the following quote from Petronius Arbiter recorded as having been set down in 67 A.D.

"We trained hard..but it seemed that every time we were beginning to form up into teams, we would be reorganized. I was to learn later in life that we tend to meet any new situation by reorganizing and a wonderful method it can be for creating the illusion of progress while producing confusion, inefficiency and demoralization."

(Fig. 1) has been active since 1965. The Center was operated with the advice of a scientific Advisory Committee comprised of persons from the Hopkins, University of Maryland and the Smithsonian which met until about 1974, but is now defunct. The Center, itself, is now making significant contributions to Bay science especially to understanding small tributary systems and certain basic phenomena. Dr. Kevin Sullivan is Director.

Among the other federal organizations which have contributed to understanding of the Chesapeake Region are the Baltimore and Norfolk District Offices of the Corps of Engineers.

Corps of Engineers, Baltimore District -- The Baltimore Office has been responsible for the Corps' continuing Chesapeake Bay cooperative study which was begun in 1967³⁸ and for construction of the Chesapeake Bay Hydraulic Model on Kent Island, just below the Eastern Shore terminus of the Chesapeake Bay Bridge. It also supported the Corps' study of the effects of Hurricane Agnes on Chesapeake Bay. Statesmen, politicians and scientists from both Maryland and Virginia, especially those from VIMS, CBL and CBI played major roles in justifying, establishing and conducting all of these activities, including

³⁸ The study had been authorized earlier in the Rivers and Harbors Act of 1965, but was not funded until 1967.

design, construction and verification of the Chesapeake Bay Model.

Corps of Engineers, Norfolk District -- The Norfolk District of the Corps has supported a number of scientific studies of the lower Bay and its tributaries and their problems. It continues to support efforts related to its basic responsibilities. With the Commonwealth of Virginia (the Marine Resources Commission and VIMS), the Norfolk District financed the design, construction and verification of the James River Hydraulic model at the Waterways Experiment Station at Vicksburg, Mississippi. The Norfolk office earlier had been involved in construction and operation of a model of the mouth of the Lynnhaven River system.

The Geological Survey -- The U.S. Geological Survey has been involved in certain estuarine studies on the Patuxent for some time and has embarked on a study of the Potomac River. Of course, its long-term hydrological recordings have provided data extremely important to development of understanding of estuarine circulation.

The National Oceanic and Atmospheric Administration--The

National Ocean Survey (NOS)³⁹ and the National Weather Service of the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce with their sounding, surveying and nautical charting work, their long-term tidal datum measurements and studies of tidal mechanics, their wind, rainfall and solar measurements have been essential to development of understanding of the physical processes of the Chesapeake system. The Survey's Atlantic Marine Center is located on the Elizabeth River in Norfolk.

The National Aeronautics and Space Administration has also supported research, not only in remote sensing applications, but other technological developments, on Chesapeake Bay. Several units have been involved. The NASA Langley Research Center in Hampton and the NASA Wallops Station at Wallops Island on the Eastern Shore seem to have contributed most, though NASA Greenbelt is also active.

Other federal organizations have been directly involved from time to time in conduct or (more often) sponsorship of research and engineering efforts on the Bay, but those cited

³⁹ There is undoubtedly an interesting story in the efforts of NOAA, the U.S. Coast and Geodetic Survey and the Coast Survey on the Chesapeake. All of these related organizations have worked on the Chesapeake. It must, unfortunately, be left to a later time.

above seem to have been the "major players in the game" to date.

Industry -- Industrial organizations such as Virginia Electric and Power Company, Potomac Electric and Power Company, the Baltimore Gas and Electric Company, AMOCO Yorktown and Dow Chemical Company have sponsored research, mostly in relation to their own needs and programs. Some call industry-sponsored environmental work "snake-killing" but where it has been done responsibly it, too, has added significantly to our understanding of the Bay.

The Philadelphia Academy of Science, working mostly on industry-related problems and with its sponsorship have operated on the Bay and its tributaries for over 20 years. It has done site-related studies on the James, the York, the Potomac and the in the Bay itself, and elsewhere. Dr. Ruth Patrick directed the early operations of the Academy's Division of Ecology and Limnology. A field station, the Benedict Estuarine Research Laboratory, is maintained on the middle Patuxent River (Fig. 1).

The Oceanic Division of Westinghouse Corporation -- The Division established a marine laboratory on the Chesapeake Bay at Sandy Point near Annapolis in 1967 (Fig. 1). Though a good deal of its efforts have been devoted to research and

engineering in ocean waters and on problems little related to estuarine processes, it has done estuarine-related research. Recently it conducted a study of the Chester River and the Upper Bay on Maryland's Eastern Shore under funding from the Maryland Department of Natural Resources.

Nothing has been mentioned of the contributions of the scores of scientific and environmental consulting firms which have worked on the Chesapeake, some of whose efforts have added to understanding of the system. I would like to be able to do so; however, time constraints do not allow an exhaustive report at this time.

Recent Cooperative Efforts -- Conflict between Maryland and Virginia over fishery management, especially rights over access to and method of harvest of shellfish in the Potomac, Tangier and Pocomoke Sound and other border waters, are storied. Even today long after the "major" skirmishes⁴⁰ of the "oyster wars", books and newspaper accounts are likely to stress and sensationalize division and struggle. Almost unnoticed is over ten years of reasonable and fairly successful cooperation in fishery management brought about by passage of the Potomac River Fisheries Compact with establishment of the Potomac River

⁴⁰ Never really "major".

Fisheries Commission, a fishery management organization. With relatively little in the way of financial resources to work with and hampered by certain legal and political differences between the two states, the Commission has done a reasonably good job, though the lack of money is beginning to tell. Equally unnoticed is the cooperation between scientific institutions of the two states and between the states and the federal government that dates back almost a century to the post-Civil War period.

Discussion of cooperation in science, not management is our objective here. The telling of a complete story of the bi-state efforts in improving the fisheries of the Potomac will have to await another time, but a note on cooperative scientific services is possible.

The Potomac River Fisheries Commission has no money of its own for research and advisory services. These services are provided virtually free of charge by the Virginia Institute of Marine Science and the Chesapeake Biological Laboratory (CEES) of the University of Maryland.

As noted several times above, cooperation between state science organizations in Virginia and Maryland has existed since the beginning of the recent era. In fact Dr. Truitt, first Director of the Chesapeake Biological Laboratory, was

active in selling development of marine and fisheries science to the involved people and government of Virginia. Also, it has been shown that the Federal government and the two states have cooperated in investigations of the Bay, its problems and phenomena since late in the last century. Beginning with relatively loose "lend-lease" and mutual encouragement types of federal-state efforts in the late 1800's and the early part of this century, the movement for cooperation in science has progressed through state-federal maintenance of the Yorktown Laboratory to the joint bistate-federal development of the Chesapeake Bay Institute and further.

The Chesapeake Research Council (from 1964 to about 1972) -- The Council was established by a memorandum of understanding between the Directors of the Chesapeake Bay Institute, the Chesapeake Biological Laboratory and the Virginia Institute of Marine Science signed in Annapolis in the early summer of 1964.⁴¹ The earlier compact of joint contribution to the coffers and control over the affairs of the Chesapeake Bay Institute had fallen into disuse by then as the CBI developed its own finances and independent control mechanisms and as CBL and VIMS found it necessary to do more of their own work in the physical, chemical and geological areas of marine science in

⁴¹ Drs. Cronin, Hargis and Pritchard

order to supply the needs of their clients and themselves.

Under this memorandum of agreement between the Directors of the three institutions, several joint proposals for facilities and research projects were prepared. As a result, a major cooperative program to gather prototype data for the design of the Chesapeake Bay Hydraulic Model was conceived, agreed to by the Baltimore District of the Corps and carried forward.

Even before this project was completed Hurricane Agnes struck North America at the Gulf Coast and roared north into the highlands of Virginia, Maryland and Pennsylvania, whence flow the great rivers of the Chesapeake, producing a massive influx of fresh water into the Bay system. These same three organizations took the lead in a major study of the effects of the storm on the environments and resources of the Bay.

As a result of early efforts by these three institutions and others a great amount of baseline, or "before", data is available. Coupled with data gathered during the height of Agnes and afterwards, this scientific examination of a great natural catastrophe and its immediate impacts and aftereffects on a major estuarine system is the first of its kind for the Chesapeake and one of the first on a major estuary anywhere, as far as I am aware. Undoubtedly, this multi-disciplinary,

multi-institutional program conceived by Drs. Cronin, Hargis, and Pritchard, and set in motion even while Agnes battered and flooded the mountains and valleys of Virginia and Maryland, which poured millions of gallons of fresh water loaded with sediments, nutrients, toxins and debris into the Bay, will turn out to be a classic.

The Chesapeake Research Consortium -- A series of exhaustive discussions of the environmental and resource problems of the Bay beginning in mid- or late 1969 and of gaps in the then-current scientific knowledge of the system by scientists from Johns Hopkins University, Smithsonian Institution, University of Maryland and Virginia Institute of Marine Science supported by the institutions, and the National Science Foundation⁴² led to establishment of a new multi-institutional consortial arrangement. Dean Robert H. Roy of the Hopkins served as first Director, to be succeeded By Dr. Theodore Chamberlain and later by Dr. Henry R. Frey. Dr. L.E. Cronin, on leave from the Univ. of Md., is current director.

The Chesapeake Research Consortium, Inc., first agreed to by VIMS, the Hopkins and the University of Maryland and later

⁴² And encouraged by Dr. William McElroy, former Professor in the Hopkins and then Director of NSF.

joined by the Smithsonian was established in 1971-72.⁴³ A few years after formation of the Consortium, the older Chesapeake Research Council ceased to do business as did the Smithsonian Center's advisory group mentioned briefly above. However, the Council continued long enough to complete the sampling for the hydraulic model (supported by the Baltimore District of the Corps of Engineers) and the Agnes research program (financed by many state and federal agencies and a great deal of "blind faith").⁴⁴

Under initial support from the Research Applied to National Needs Program (RANN), and later from the Environmental Protection Agency, of the National Science Foundation and Environment Protection Agency, the Consortium has approached a number of important joint programs related to water quality, wetlands and shorelines and other problems and resources of the Chesapeake. The Consortium continues active and is looking for additional sources of funding and new scientific worlds to conquer.

As a consequence of regular interaction between the principal organizations doing research in the Chesapeake, not

⁴³ The legal documents were signed in February of 1972.

⁴⁴ The results of the Agnes research were published as a joint effort of the Consortium later in 1976.

only within the cooperative agreements but in day-to-day scientific intercourse and in scientific meetings, a significant and reasonable degree of coordination exists among the major scientific actors in the Chesapeake.⁴⁵ All three have planned research programs together. Improvements are possible, as they always are, but strong coordinative efforts for research of Bay-wide importance have been made by the major academic research institutions on the Chesapeake Bay over a relatively long period and do exist now despite occasional contentions to the contrary.

My brief chronicle of the history of exploration, research and development on the Chesapeake will end on this relatively upbeat note of scientific cooperation. It is neither as complete nor as exhaustive as I would have desired. I hope to assay a more complete effort later. In the meantime, however, my apologies to any persons (or institutions) who have been overlooked or neglected.

SUMMARY

The development of knowledge of the Chesapeake Bay and its

⁴⁵ Each of the institutions in the Chesapeake Research Consortium has published a research in progress catalogue for some years to enable others to know what is going on in the way of research and engineering efforts. All three have planned research programs together.

tributaries, their wetlands and beaches and the adjacent highlands that saw its real beginnings within Elizabethan and post-Elizabethan times was prompted by the search for riches of the Orient. Expansion of Colonial efforts produced disappointments in the lack of attainment of the objectives of quick riches by gold and precious stones, but brought awareness of the true riches, the natural resources and their use and potential of the newly-found (by Europeans but not the Asiatic progenitors of the American Indians) continent. Later, exploration and exploitation of the potential became a driving force as did expansion of the Colonial Empire.

These factors plus the intellectual curiosity and desire for adventure of a few individuals were the driving forces behind exploration of its natural resources and other natural phenomena and its aboriginal people during that period which I have termed the First Quantum Jump Period of Chesapeake Knowledge (1600 to 1700). This period followed the early beginnings, especially those of the Raleigh expeditions and experienced its culmination in explorations of Captain John Smith and other early colonists.

As the early European colonists and their successors moved westward into the interior, scientific interest in the waters of the Chesapeake was displaced by the curiosity regarding

terrestrial wonders of the new land. Attention was focused inland. Knowledge of the phenomena of the Bay increased, to be sure, but at a much slower and more even pace. The needs of commerce and survival or conquest (military action) continued to be a driving force in exploration and study of the Chesapeake during the mid- and late Colonial Period and after the Revolution into the early 1800's. America had its moments of scientific endeavor in the decades just before and after the Revolution.

With establishment of relative peace after the War of 1812, scientific interest in the waters of the Bay and the flora and fauna of the Chesapeake and its lowlands and highlands grew. Collections of plants and animals were developed and new catalogues and other publications were issued.

In the mid-1800's, prior to the great Civil War, awareness of the utility and potential of science and technology increased markedly abroad and in the United States. Joseph Henry of the Smithsonian and Matthew Fontaine Maury of the Naval Observatory began their recriminatory battles during this period. However, both were responsible to a significant degree for a resurgence of science in America. Maury, himself the first oceanographer of the United States, increased attention

of science to hydrographic measurements, weather observation, fisheries and other resources. Hydrography flourished abroad and followed in America and the new science of oceanography was derived from it. New, more detailed sea charts for commerce, fisheries and conquest were developed. Weather observation and a number of other scientific activities were begun.

After the post-Civil War Reconstruction Era government and academic scientists were able to respond to the developing awareness of the importance of factual knowledge. The federal government supported research on the fisheries of the Chesapeake and their potential and problems -- as did the several states to a lesser degree. Expeditions were mounted and temporary laboratories were established. One such, the Chesapeake Zoological Laboratory of the Johns Hopkins University, operated productively for awhile and then perished. It was the antecedent of the Bay research organizations extant today.

During the late 1800's and the first third of the 20th Century, the development of scientific knowledge of the Chesapeake began a slow climb up the slope toward the Second Quantum Jump Period of Chesapeake knowledge (1946 to present) as the forces of modern science gathered and new scientific apparatus and theories developed. The motives behind this rise

were curiosity, economic need and the awareness of growing problems with development and maintenance of the fishery and other resources of the Bay and with overharvesting and diminishing water quality.

The slope steepened during the decades following 1920 and 1930. Maryland established its first permanent marine laboratory (CBL) on the Patuxent River and the United States developed and maintained the predecessor of VIMS at Yorktown on the lower York. Several public health-related organizations operated for a time. VIMS parent organization, the old Virginia Fisheries Laboratory, was developed by cooperative efforts of the Virginia Department of Health, the Commission of Fisheries, William and Mary and the federal government. It was formally established in 1940 by Virginia and placed under the auspices of the College of William and Mary and the Commission of Fisheries -- now the Marine Resources Commission.

World War II intervened and caused a pause in the development of scientific organizations and of research on the Chesapeake.

After the War the Second Quantum Jump Period of development of knowledge of the Chesapeake began and by 1955 came into full flower. VIMS and CBL underwent a resurgence and by this time the Chesapeake Bay Institute of Johns Hopkins was

established with ONR (U.S. Navy) help. The Golden Age of Chesapeake Bay Science started! Momentum continues to grow.

Other state and federal agencies and academic institutions, themselves, began to operate in and around the Bay and the development of knowledge accelerated.

The experience and knowledge of the first half of the First Quantum Period and of the following three hundred years (ca. 1645 - 1946) were essential to the development of Virginia and Maryland and of the United States. They laid the scientific groundwork for the Second Quantum Jump Period--the Golden Age of Chesapeake Science. Most of the scientific knowledge of the Chesapeake Bay and its tributaries and their phenomena and processes has been developed in the last thirty-three years and the rate of knowledge accumulation is still increasing.

The forces behind this resurgence have been the problems caused directly and indirectly by the growing pressures on the environment and resources of the region by increasing populations, growth of agriculture and industry and competing users and uses. As populations and industries in Maryland, Virginia and the hinterlands along the tributaries of the Bay, even far inland in West Virginia, Pennsylvania, upper Maryland, Virginia and New York, have grown so have the problems of the

Chesapeake. These problems can only be solved by rational management based upon complete scientific knowledge and the technological ability to apply that knowledge effectively. Commerce and society must again be dependent upon science and engineering skills to help solve the problems of the system so that the resources and resource potential of the present can be reasonably realized and posterity will have what it needs. This is no mean task. Much knowledge and many technological skills are necessary. Hence, it is of utmost importance that the scientific momentum developed during the last three decades not be allowed to diminish. It is vital to the welfare of the states of Maryland and Virginia, to the region and the Nation that development of Chesapeake science continues.

From this brief historical review of the growth of exploration, marine science and engineering efforts in Chesapeake it can be seen that there is a direct linkage between their development and the "need to know" -- the need by "decision-makers" for accurate information, predictions, and manipulations for practical purposes. To be sure, intellectual curiosity and the sense of adventure drove the seekers--in part. Other motives, greed, the profit-motive and the need to solve problems, drove the supporters and decision-makers--the public and private entrepreneurs and government regulators. The same factors operate today! The needs and motives of man

and society have not changed significantly since the beginning.

What of the future of Science and Technology in the Chesapeake Region? Problems related to resources and environment remain and magnify. Private users and government decision-makers need reliable, objective (not politically motivated and/or biased) information and advice. The cooperative and synergistic relationship that has developed between science and technology, government and business (the users and providers of knowledge) over the last 350 years in the Chesapeake must continue as long as there are unsolved problems and unanswered questions. The key is need! And need continues!

How much knowledge and technological ability are needed? No answer is possible beyond this -- We must have enough to solve the problems and answer the questions satisfactorily! How much scientific and engineering effort is required? How many professionals and supporting persons are needed? How many laboratories and ships and how much new and sometimes expensive field and laboratory gear must be provided? To provide answers to these important and entirely justified questions would be like answering the oft-posed question--How much is enough? All such questions can only be answered operationally. When the information users--the managers and decision-makers--stop

asking legitimate questions that their scientists and engineers cannot answer in sufficient detail to allow adequate and economical solutions to the problems prompting those questions, then knowledge will be adequate to their needs. When scientists, engineers and managers perceive no important unanswered questions then there will be enough. It is unlikely that such a situation will arise soon! Until those two situations arise research and development must continue. They must also increase because the effort required to secure detail is infinitely greater than that sufficient to answer generalized questions--to skim the ocean. In fact, the "cream-skimming" period of investigation was passed some years ago.

New uses are developing for the riches and amenities of the Chesapeake. Immigration and population growth continues, bringing new users with ever increasing and frequently conflicting needs and demands to the Bay area. The pressures on the Chesapeake system mount and new problems emerge. The need for scientific and engineering knowledge and advice increases with each passing year. Within this milieu of growth and pressure it is possible to predict that the necessity for growth of knowledge--hence scientific activity and ability to manipulate--hence engineering development, will never cease! The need for ever more effective management increases.

Management must have information! Information enables wise use of resources and environments. Information is money. Information is survival! There is no choice but to continue!

There must be adequate management. There must be adequate science and engineering to aid management. As Secretary James B. Coulter, of the Maryland Department of National Resources, said during the 1977 Bi-State Conference on the Chesapeake at which this paper was originally given in an earlier form, "we are locked in a continuous battle until the end of time."

The economic and sociological and environmental stakes of Dr. Coulter's battle are high. Posterity depends upon our sound and responsible action which require data and wisdom. Our battle, though not as dramatic or obvious as military action on land or at sea, involves stakes as high and the commanders must have intelligence and they must have adequate tools. Only science and engineering can provide the intelligence and basic informational tools necessary for rational management!

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Errors should be corrected wherever they may occur. Missing entries should be added and illogical conclusions replaced. Should any reader detect these or other faults the author will appreciate learning of them.

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