

Sixteen Decades of Political Management of the Oyster Fishery in Maryland's Chesapeake Bay¹

Victor S. Kennedy and Linda L. Breisch

*University of Maryland Center for Environmental Science
Horn Point Laboratory, P.O. Box 775, Cambridge, Maryland 21613, U.S.A.*

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Since 1820, when the first law was passed in Maryland relating to the oyster fishery, management of that fishery has been controlled to a large extent by state legislators. This has been accomplished by the passage of many laws, initially in an effort to conserve a once-bounteous resource. However, in the last century, the main effort has been to appease oyster fishermen, a vociferous minority in the state. The various management agencies that have followed one another have been relatively ineffective, although less so in the last 15-20 years. The state legislature has generally ignored the results of various scientific surveys and the reports of numerous advisory committees appointed to make recommendations to the legislature concerning the oyster fishery. The socio-political history of the fishery is described.

Keywords: Crassostrea virginica, oyster management, Chesapeake Bay, Maryland, politics.

1. Introduction

In his historical treatment of colonial Virginia's fishing activities, Wharton (1957) remarked on the extent of the eastern oyster (*Crassostrea virginica*) resource in Chesapeake Bay. He quoted a Swiss visitor, Francis Louis Michel, who wrote in 1701:

"The abundance of oysters is incredible. There are whole banks of them so that the ships must avoid them. A sloop, which was to land us at Kingscreek, struck an oyster bed, where we had to wait about two hours for the tide. They surpass those in England by far in size, indeed they are four times as large. I often cut them in two, before I could put them into my mouth."

In both Virginia and Maryland, such tremendous resources were rapidly depleted as demand increased, until the supply dropped to its present low level. At the peak of its production in the late 1800s, Maryland was the greatest oyster-producing region of the world. Stevenson (1894) noted that its landings comprised 39 percent of the total U.S. oyster catch and were more than twice the combined oyster catch

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of all foreign countries. Maryland's oyster industry equalled in value 17 percent of the total fisheries product of the U.S.A. and employed 20 percent of Americans in the fishing industry. Since then, the Maryland proportion of the U.S. catch declined to 17 percent in volume by 1929 (Fairbanks, 1932), was 18 percent in 1962 (Quittmeyer, 1966), and climbed to 31 percent in 1975 (Bell and FitzGibbon, 1978). Its value remained at about 17-18 percent in 1929 and 1962, and had risen to 29 percent in 1975 (Fairbanks, 1932; Quittmeyer, 1966; Bell and FitzGibbon, 1978).

Of all oystering states in the U.S.A., Maryland is unusual in that it has persisted for over a century in maintaining an extensive public fishery while discriminating against private cultivation on rented ground. It is a century since the first scientific investigators surveyed oyster grounds in Maryland's Chesapeake Bay, documented their despoilation, and recommended conservation measures including private cultivation.

Management of the contemporary oyster fishery is the responsibility of the Tidewater Administration of the Maryland Department of Natural Resources. However, important control over management resides in the Maryland General Assembly, the legislative body which has passed numerous laws governing the fishery. Local county committees of oystermen also play a key role in advising the Tidewater Administration in its management actions.

Chesapeake Bay, especially the Maryland portion (Fig. 1), is excellent habitat for oysters (Alford, 1975), and many observers have indicated that the potential Maryland catch could be increased substantially by combining a public fishery and private oyster farming (Quittmeyer, 1966). However, in spite of numerous such recommendations from a variety of sources, no real action has been taken. Indeed, the historical inattention by Maryland legislators to the extensive results of scientific studies and analyses stimulated Bowman (1940) to use the Maryland oyster fishery as one of his three examples of the failures of attempts to apply science to social problems. He cited the large amounts of scientific material collected on *C. virginica* and the various management recommendations that had been made. He noted that state legislators had ignored all these data and recommendations, preferring to consult "practical" (sic) oystermen.

Our report describes socio-political influences on the Maryland oyster industry over the last 160 years from the passage of the first oyster-related law in 1820. Reflecting on such influences can be instructive because resource management involves not just an application of biological principles but also an interaction with social attitudes, many of which may have been decades in the formation (McHugh and Bailey, 1957).²

2. Years of Harvest Increase

Locations mentioned in the text are displayed in Figure 1 and oyster harvest data since 1839 are presented in Figure 2. Data to 1911 are adapted from a similar figure by Grave (1912). These earlier data, at least until the latter part of the nineteenth century, are gross estimates based upon extrapolations from records of oyster packers, information on number of oyster fishery licenses issued, etc. Stevenson (1894) described the available statistics in some detail, citing their source. Christy (1964) discussed the problems of dependability of these early harvest estimates and whether the decline since 1890 was as extreme as pic-

² Throughout this paper, we do not refer to the situation concerning the Potomac River oyster resource, although the river is totally in Maryland. Its southerly bank is Virginia territory, so the management and harvesting of the oyster resource have been, until recently, matters of longstanding controversy between the two States (Ingersoll, 1881; Stevenson, 1894; Power, 1970). The mainstem of the river is administered by the Potomac River Fisheries Commission, a bi-State organization, whereas the tributary creeks come under the administration of the respective State resource agencies. A description of the oyster grounds and fishery, along with management recommendations, is included in Davis *et al.* (1976).

tured. He concluded that early harvests were probably not greatly overestimated and that the decline represented a real decrease which he attributed to overfishing and possible increased siltation of oyster grounds. Thus, these data, while perhaps not strictly accurate, do indicate trends in oyster harvests and are useful for comparison with the more dependable twentieth century data, which have been retrieved from various reports of what is now the Maryland Department of Natural Resources.

The early history of the Maryland oyster fishery was the subject of lengthy description by Ingersoll (1881) and Stevenson (1894), upon whom we have depended for much of the following information up until about 1880.

Stevenson (1894) was unable to find much historical evidence concerning oyster consumption by early Maryland colonists. He did note that the deposition in the Clairborne suit of 1680 had "Kent Islanders" (early settlers) citing among their grievances the fact that the exhaustion of their provisions had

forced them to eat oysters taken from along the shore. As colonial populations increased and hand tongs and then dredges were introduced as harvest implements, inroads into the oyster population began. Quantitative production data were apparently not collected until about 1839, when Maryland's yield was estimated at 710 000 bushels. Soon after, many of the large reefs in Tangier Sound were discovered and the fishery expanded greatly (Stevenson, 1894).

Meanwhile, the oyster beds of New England had become badly depleted throughout the 18th Century by over-fishing (Ingersoll, 1881; Sweet, 1941). The center of the U.S. oyster industry had been in Connecticut, especially Fair Haven. From there, apparently beginning about 1808 (Stevenson, 1894),

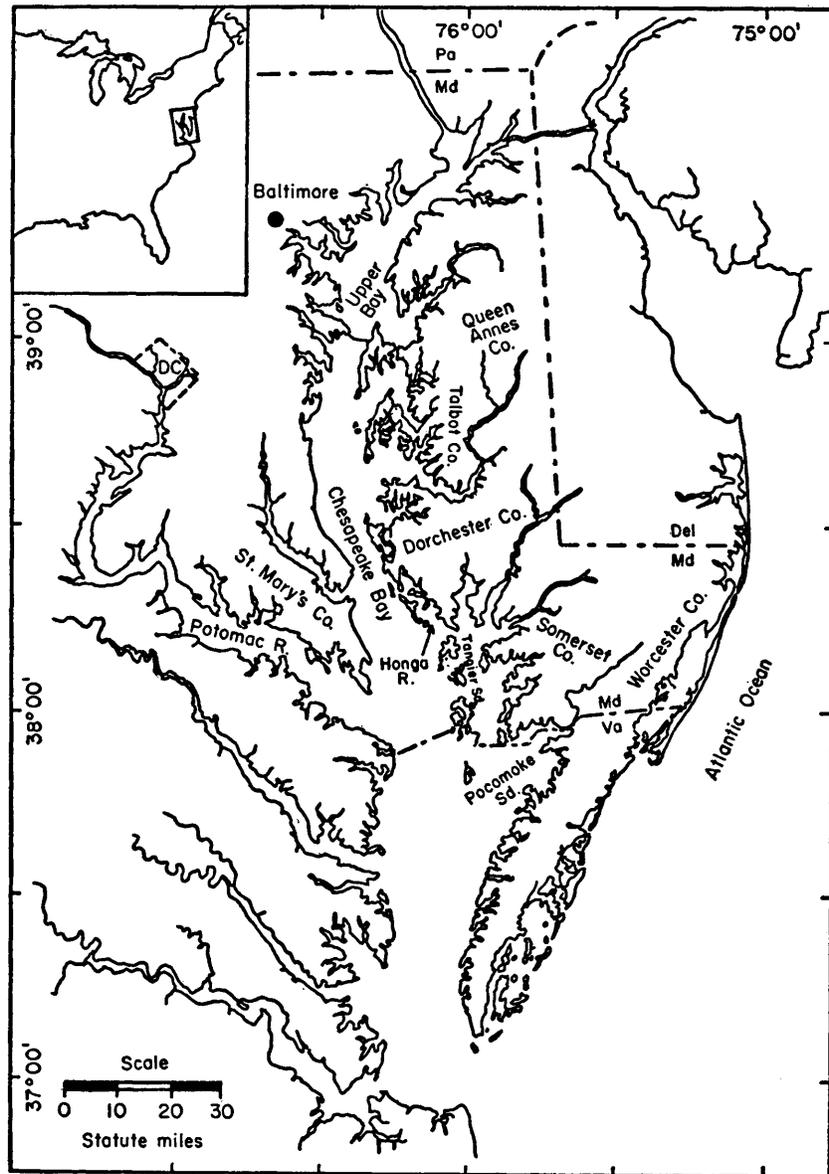


Figure 1. Chesapeake Bay region, including Maryland locations mentioned in the text.

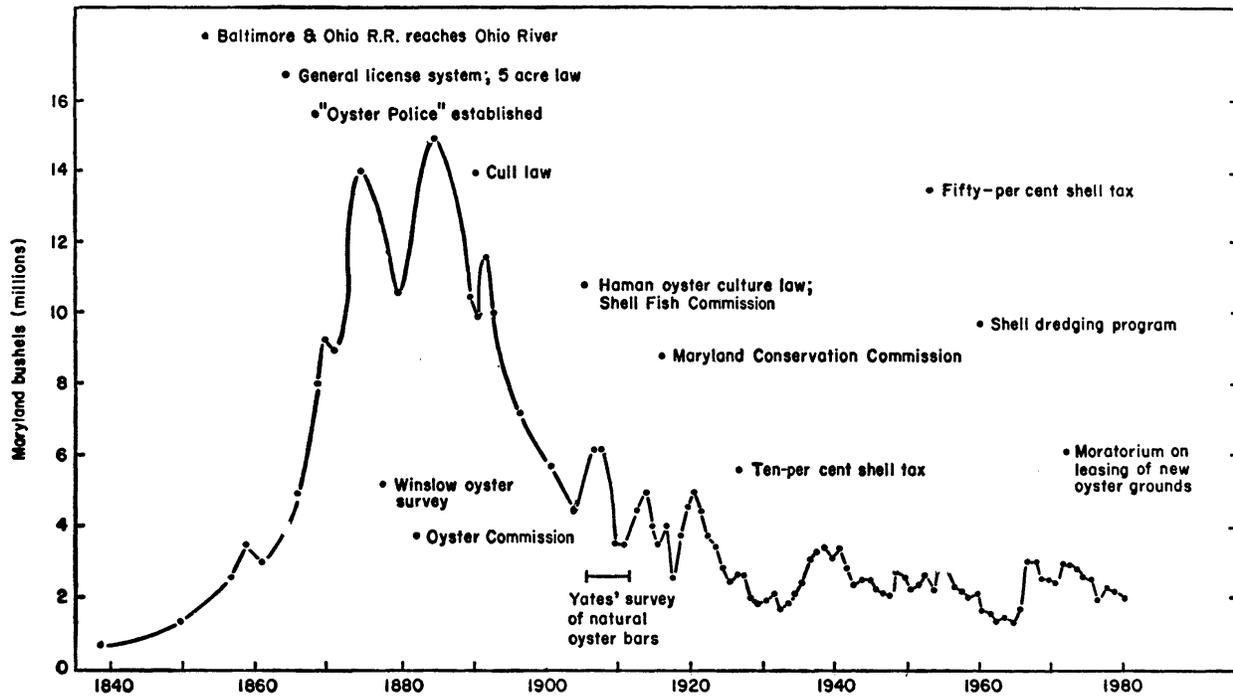


Figure 2. Reported landings of oysters in Maryland over the past 14 decades, in millions of bushels (approx. 1-3 times standard U.S. bushel). The harvest period for oysters begins at the end of the old year and extends into the new. The time line refers to the new year (for example, 1961 denotes the 1960-1961 harvest period). Important events in the history of management in Maryland are noted. (After Grave 1912, modified.)

dredge schooners travelled to New Jersey and Virginia to obtain oysters for the northern market. Because of this increasing activity, Virginia passed legislation in 1811 prohibiting dredging in its waters, forcing the fleet north up the Bay to Maryland. Concern about such increased fishing led the Maryland legislature in 1820 to enact its earliest oyster-related law, prohibiting both dredging in the state and the transport of oysters from the state in ships not wholly owned for the preceding year by Maryland residents (Stevenson, 1894). These prohibitions (Grave, 1912), coupled with the building and improvement of transportation systems such as national turnpikes and the Baltimore and Ohio railway (Nichol, 1937) and the desire to be closer to the principal source of supply (Sweet, 1941), led established New England oyster packers to open branch plants in Baltimore in the mid-1830s. These plants exported increasing quantities of oysters to western communities. Demand rose, with the number of processing establishments (raw packers and steam packers or canners) in Baltimore increasing from one in 1834 to 80 in 1868 (Nichol, 1937). By 1875, the oyster harvest was estimated to be about 14 million bushels, with a peak of 15 million bushels taken in 1885.

Associated with this great increase in harvest were changes in legislation concerning harvesting techniques and fishing regulations (Stevenson, 1894; Grave, 1912). In 1830, the "One-Acre Planting Law" was enacted, allowing Maryland citizens to use one acre of ground for planting and growing oysters and other shellfish. Landowners whose property bordered a creek less than 100 yards wide at its mouth had the exclusive right to use the creek for planting. It was a misdemeanor for others to harvest planted oysters without permission. This oyster-planting law was the third to be enacted in the U.S., after New Jersey (1820) and Rhode Island (1827).

In these early years, the extent of the oyster resource was not yet known, the rich grounds in Tangier Sound not being discovered until 1840, and there was concern that the resource would be over-exploited. Thus, in 1836 (Dorchester and St. Mary's Counties) and in 1840 (Somerset County), burning oysters for agricultural fertilizer (lime) was prohibited. In 1846, Worcester County established a closed season (April 13 to September 1), the first in Maryland and one of the earliest in the U.S.

In 1854, the use of small dredges (scrapes) was allowed in certain waters of Somerset County for county residents who had obtained a \$15 license. This was the first oyster license law in Maryland and one of the first in the nation. Similar laws were enacted in 1870 and 1874 with regard to certain waters in Dorchester and Talbot Counties, respectively.

In 1865, two major legislative initiatives occurred. The first abolished the old general oystering laws and enacted a new code, including adoption of a state-wide license system governing tongers, scrapers, and dredgers. Thus, use of large dredges became legal again after 45 years. A variety of factors led to this action: oystermen from other than Somerset County were limited to laborious tonging and were jealous of the legal use of the more efficient scrape by the residents of that county; oysters in waters deeper than 23 feet were out of reach of hand tongs; and the demand for oysters was rising quickly. The large, effective dredges could reach the great quantities of oysters living in the deeper Bay waters. The new code did prohibit the use of steam boats or steam machinery for harvesting, and enforced a closed season on dredging from June 1 to September 1. There was no closed season on tonging, except in Worcester County.

The second legislative initiative allowed riparian landowners to plant oysters on five acres of leased ground (this privilege was later extended to any Maryland citizen). However, rather than use this privilege to cultivate oysters, i.e. to increase production or improve quality, most individuals who took advantage of the new law used the ground for holding oysters until market conditions were suitable for their sale (Grave, 1912). The law drew a distinction between natural oyster beds (which could not be leased) and barren ground (which could).

The General License Law was unpopular with oystermen, many of whom refused to obtain licenses or to abide by other provisions of the new Act. Thus, in 1868 a State Fishery Force (popularly known as the "Oyster Navy" or "Oyster Police") was established. Initially, the Force comprised a steamer with two sailing vessels, then grew to a complement of two steamers, eleven sailing vessels, eight smaller "County" boats, and 120 men by 1894. These armed vessels patrolled the Bay and its tributaries to enforce the law, with varying degrees of success at first. Indeed, the Force fought a number of pitched battles with defiant dredgers on occasions, notably around 1888 (Earle, 1932). The sinking of a number of dredge boats by cannon fire and the death of some scofflaws led to fewer overt violations of the law (Burgess, 1963).

It is apparent that, throughout this period, regulations enacted by Maryland legislators represented reasonable attempts to protect the public fishery and to manage the exploitation of a resource that was providing jobs for tens of thousands of Maryland citizens. This is especially true considering the limited understanding of both oyster biology and the extent of the resource at the time. As noted earlier, in a number of instances Maryland was one of the first states to enact such protective legislation.

3. Harvest Declines and Major Surveys

A decline in harvest following the 14 million bushel yield of 1875 (Figure 2) induced the General Assembly to commission the U.S. Coast and Geodetic Survey to study the extensive oyster grounds in Tangier and Pocomoke Sounds (Winslow, 1882). Results of this careful two-year survey (1878-79) included valuable descriptions of the structural and biological differences between older worked grounds and

new grounds never before fished. Dredging had been beneficial in that it had broken up the tightly consolidated oyster “rocks” or virgin bars, dragging the oysters and shell on to new ground and expanding the area of the oyster beds. Thus, the oysters, being less crowded, tended to be larger and in better condition. The increased bottom coverage by shell (cultch) probably allowed greater surface area for spat settlement. However, Winslow found that oysters had diminished in abundance from 30 years earlier when the Sounds were first fished. He found a smaller proportion (about 30 percent) of shell debris on unworked grounds than on exploited beds (up to 97 percent in some parts of Pocomoke Sound).

Winslow (1881) set out earthenware tiles as spat collectors in an effort to estimate larval setting period, spat growth, and mortality. However, vandals destroyed 23 of the 24 bundles of tiles that were deployed. From the tiles that survived, Winslow was able to describe newly settled spat, to estimate their settling periodicity, and to determine that they grew much faster than had been expected. He suggested that old beds could be rehabilitated by scattering material such as stones, earthenware, water pipes, and shells about the beds. Mature oysters should be deposited with the shells. The cultch should be exposed late in spring to ensure its cleanliness and suitability for spat settlement. Such biologically sensible management recommendations appear to be among the first to be advanced (at least in print) in Maryland.

Winslow also recommended the formation of an informed Commission, free from political interference, to oversee management of the fishery. He stated that the Commission should be empowered to prevent exhaustive dredging, to reserve oyster grounds with large numbers of young oysters, to prevent harvesting of young oysters, to enforce the closed season which should include the spawning period, to cleanse the grounds before spatfall occurred, to add cultch where necessary, and to control pests and predators of oysters. These appear to be far-sighted recommendations for the time.

In a later paper (Winslow, 1884), he urged emulation of northern states in the establishment of private oyster culture on grounds rented from the state. He noted that the oyster yield in Maryland’s public fishery was 40 bushels per acre, compared with triple this yield in the northern states which depended on private oyster culture on less acreage than that of Maryland’s public fishery. He claimed that a common property resource was not easily conserved or improved, whereas self-interest should inspire such aims in a private oyster planter.

In 1882, an Oyster Commission comprising three men, including Dr. W. K. Brooks of Johns Hopkins University, was appointed “to examine the oyster beds and to advise as to their protection and improvement” (Brooks, 1905). Brooks had earlier discovered that *Crassostrea virginica*, unlike the European *Ostrea edulis*, expelled its gametes into the water where external fertilization and development occurred (Brooks, 1880), and he was familiar with the eastern oyster and its fishery. However, not everyone considered Brooks to be knowledgeable. He noted (1905):

“I speak on this subject with the diffidence of one who has been frequently snubbed and repressed; for while I am myself sure of the errors of the man who loudly asserts his rights to know all about it, it is easier to acquiesce than to struggle against such overwhelming ignorance, so I have learned to be submissive in the presence of the elderly gentleman who studied the embryology of the oyster when years ago as a boy he visited his grandfather on the Eastern Shore, and to listen with deference to the shucker as he demonstrates to me at his raw-box, by the aid of his hammer and shucking-knife, the fallacy of my notions of the structure of the animal.”

The legislature provided no financial support for the Oyster Commission’s work (Brooks, 1905), although the Governor provided a small sum from his emergency fund and Johns Hopkins University gave Brooks two years of paid leave to perform the survey. In spite of this limited financial support, the Oyster Commission visited 59 oyster bars and made 326 dredge hauls, covering 121,000 yd² of oyster bottom

(Brooks *et al.*, 1884). Over 30,000 oysters were caught and examined. The Commission attempted to duplicate Winslow's methods of estimating oyster abundance by dredging. The Commissioners noted a decline in oyster abundances and an increase in proportions of shell to live oysters in comparison with Winslow's earlier results. For example, in 1882, they found an average ratio of 1.3 bushels of oysters to each bushel of shell, which was a decrease from Winslow's value of 2.0 bushels in 1879 (Winslow, 1884). Similarly, Winslow's survey of Tangier Sound in 1878-79 recorded about one oyster in every 2.3 yd², whereas in 1883 the Oyster Commission found only one oyster per 4.2 yd² in the same Sound (Winslow, 1884).

The Oyster Commissioners recommended conservation measures and a system of private oyster culture beyond that envisaged in the Five Acre Planting Law (Brooks *et al.*, 1884; Grave, 1912). They recommended annual surveying and marking of oyster grounds by the Oyster Police. They advocated that oyster beds should be closed where and when necessary to allow for rehabilitation and growth, and that the opening or closing of areas should be decided upon by trained experts. Shell should be returned to the beds to serve as cultch.

However, in 1884-85, about 15 million oysters were harvested, apparently due to an excellent set of oysters in 1883 (Stevenson, 1894). It was the peak harvest for the Bay and it served to encourage state legislators to ignore the Commission's recommendations (Grave, 1912). Subsequent harvests declined to the present low level, with only a few periods of slight increase (Figure 2).

A century ago, tremendous public interest existed concerning the oyster fishery and the various recommendations for its protection. The Oyster Commission's findings were prepared for popular consumption by Professor Brooks in his treatise *The Oyster* which went to a second revised edition (Brooks, 1905). In this work, Brooks proposed reasons for the declining spat settlement and recruitment to the stock: i.e. scarcity of mature oysters to furnish spawn; wanton destruction of large numbers of spat by oystermen ignoring culling laws designed to have spat thrown back on the oyster bed; and a lack of clean shell on beds for cultch because of its diversion to the road building, lime, and chicken grit industries. He also argued strongly for private oyster culture on Bay bottom rented from the state, and reiterated the success of such culture in rehabilitating the depleted oyster resource in New England. He described a number of advantages of private culture, noting that some harvesting and processing activities added to the depletion of the fishery and suggesting that oyster farming could alleviate these problems.

The strong recommendations by Winslow, Brooks and others in favor of private oyster culture were condemned in many quarters. One such attack came from the Nationalist Club of Baltimore City (1891).

"It [leasing] involves the social enslavement of 16,000 of the free men of Maryland; it involves the continuation of a State Oyster Police whose inefficiency has become a matter of national comment; or the substitution in its stead of the hated Pinkerton system of police, hired by the owners or lessees of the oyster lots, it involves the employment in increased numbers of the lowest class of people, taken from our jails and penitentiaries, besides foreigners brought here to take the places at reduced pay of the American workers, and it involves the establishment, we contend, of a gigantic monopoly in the oyster business, which would control prices, charging customers what it pleases, and paying to those who do the actual work of that industry the merest pittance, which the ever increasing number of the unemployed will enable it to dictate."

Other attacks were less ideological in nature. In particular, most oystermen were adamantly against such private culture. A useful discussion of their attitudes, which generally persist today, was presented by Green *et al.* (1916), who noted that three special ideas or beliefs had shaped all the legislation enacted in the past.

The first idea was that natural oyster beds properly belonged to the people of Maryland and the working of these beds was a privilege to be reserved for Maryland citizens only. The second attitude was the fear of monopoly by some corporate entity such as the packing industry. Oystermen valued their independent status as freelance, generally self-sufficient, workers. They saw leasing as providing packing houses with the opportunity of planting oysters purchased cheaply in late spring or early fall and using such stock to supply the market throughout the year. Presumably such stockpiles would be harvested by packing house employees on daily wages, to the detriment of the self-employed oystermen. The third attitude rejected the possibilities of oyster culture, i.e. the placement of cultch and brood oysters on formerly non-productive ground to encourage spat settlement and formation of new oyster beds. Most oystermen insisted that oysters could not be grown on anything but a natural oyster bar. Indeed, they felt that if a once-barren bottom were to yield oysters as a result of culture practices, it must have been an unrecognized natural oyster bed and therefore should not have been leased. Because they believed that cultivating oysters on barren bottom was impossible, they felt that any leasing system would have to include natural beds, thus restricting their freedom of movement.

Oystermen brought (and have continued to bring) pressure on their representatives in the Maryland General Assembly to protect them from any attempts to encourage leasing. Until 1964, when reapportionment was mandated by the U.S. Supreme Court, the tidewater Counties (those bordering Chesapeake Bay or its tributaries) enjoyed excessive representation in the Assembly, with legislators and the state's administration being very sensitive to the wishes of the oystermen (Power, 1970). Such sensitivity persists to the present, even though oystermen remain a political minority (Power, 1970; Alford, 1973).

Protests against the political influences of oystermen on the General Assembly grew as the oyster catch declined after the 1885 peak. One of the most heated attacks came from businessman J. K. Cowan in a lengthy letter to the Editor published by the *Baltimore Sun* (1889a) and in a printed pamphlet (1889b). He castigated the legislature for its inattention to the scientific results and recommendations of the Oyster Commission, and pointed out (1889a) that the public aspect of the fishery led to "... a 'common of fishing', and a 'common' is always a neglected place". He urged the establishment of oyster farming in Maryland, noting its success in New England. There was much hyperbole in his writing but the gist, repeated by commentators then and later, was that political sensitivity to the wishes of oystermen (the result of the desire of politicians to ingratiate themselves with dredgers and tongers for their votes) was contributing to the decline of the oyster industry in Maryland.

While the legislature ignored many of the Oyster Commission's recommendations, it did pass the Cull Law of 1890, which Grave (1912) considered to be the most efficient method ever devised for protecting natural oyster beds. Among other things, the law required that shells with spat and young oysters be thrown back ("culled") on the beds from which they were dredged. It also set a minimum legal size of 21 inches for market oysters. Maryland was one of the first states to attempt the enforcement of such a law (Stevenson, 1894). The law was unpopular with oystermen who had been selling small oysters to steam canners, or to private oyster growers out-of-state as seed, and many ignored it (Brooks, 1905).

As catches continued to decline at the turn of the century, a Baltimore attorney, B. H. Haman, defended the concept of oyster culture and, over a 15-year period, submitted bills on this matter to the legislature. He turned to the inland counties for support, describing the increased revenues that would accrue from a revitalized oyster fishery and linking this with the opportunity to improve state roads and bridges (*Baltimore Sun*, 1893, 1903). He was backed by farmers' clubs and organizations which favored the Oyster Commission's recommendations. Delegates from the tidewater Counties derided these bills, expecting the fishery to repeat its 1885 rebound (Grave, 1912), but the decline had set in, resulting in the closing

of a number of packing houses in Baltimore as the export source steadily withered away (Nichol, 1937). Brooks noted in the preface of the second edition (1905) of *The Oyster*:

“... the oyster grounds of Virginia and North Carolina, and those of Georgia and Louisiana, are increasing in value, and many of our packing houses are being moved to the south, but there is no oyster farming in Maryland, and our oyster beds are still in a state of nature, affording a scanty and precarious livelihood to those who depend upon them”.

There was intense discussion of the leasing issue in Maryland newspapers at the time. As public sympathy for Haman's point of view increased, attitudes and actions of tidewater legislators drew protests. Between May 12, 1905, and April 11, 1906, the *Baltimore Sun* published at least 38 editorials on oyster culture and the General Assembly's handling of the matter. As an example, on June 17, 1905, an editorial entitled “The Oyster and the Politician” (*Baltimore Sun*, 1905) noted the support for Haman's proposals by most merchants and farmers and the increasing sentiment among some oystermen for private cultivation of barren bottom. Yet the editorial reminded its readers that the 1904 legislative session had defeated the Haman Bill by a vote of 14 to 13. The 14 Senators (most from Maryland's Eastern Shore, i.e. the eastern Counties bordering Chesapeake Bay) who opposed the Bill represented 316 322 people. The 13 Senators voting for the Bill represented 873 628 people. The *Sun* quoted a complaint from the Democratic Party organizer of Queen Annes County that “less than 400 oystermen were running the politics . . .” of the county.

Thus, by 1906, after intense political maneuvering and controversy, the time was ripe for the passage of the Haman Oyster Bill. It allowed individuals to rent up to 30 acres of barren bottom in county waters and up to 100 acres in the Bay beyond county boundary limits. Such leases were to be on ground found to be barren by a survey performed by a Shell Fish Commission which was provided for in the law (one of the members of the Commission being Caswell Grave, a former student of Brooks).

In 1906, the Shell Fish Commission embarked on an ambitious six-year survey of the natural oyster bars of the state in co-operation with the U.S. Coast and Geodetic Survey. The Maryland Oyster Survey was under the control of C. C. Yates, who subsequently published a series of important reports on the distribution of oyster beds in different regions of the Bay. Costing only about \$200,000, or four cents per bushel of oysters landed during the Survey period, the Survey resulted in 17 official documents and 43 large-scale charts, a total of 2,400 printed pages and 400 square feet of charts (Yates, 1913). This was coupled with a comprehensive technical report by the Board of Shell Fish Commissioners, including a manual of oyster culture (Grave, 1912). In all, 1,112 triangulation and 11,006 oyster investigation stations were occupied, 159,530 soundings were made and 8,600 hydrographic positions plotted. The Maryland Oyster Survey was the last extensive biological and environmental survey of Maryland's oyster bars until the last decade or two.

All of this material supplemented the earlier work of the 1882-84 Oyster Commission and the Winslow survey of 1878-79. In addition, the economic, historical, and social aspects of the fishery had been treated by Ingersoll (1881) and Stevenson (1894), as noted earlier. This tremendous accumulation of information, although incomplete in some aspects of the life history and biology of oysters, was undoubtedly sufficient for arresting the decline in production and for restoring at least some of the former economic strength of the industry, including the oyster packing industry. However, the sporadic and underfunded efforts at rehabilitation which followed in the ensuing decades were of minimal value because of socio-political resistance by oystermen and legislators.

4. Increased Controversy over Leasing

After his extensive six-year survey of Maryland's oyster grounds, Yates (1913) felt very optimistic: "It now seems not only reasonable but probable that within the next generation the citizens of Maryland will be leasing and cultivating a probable 100,000 and a possible 300,000 acres of so-called "barren bottoms" where oysters do not grow in commercial quantities; that the more than 200,000 acres of natural oyster bars now reserved for the use of the oystermen as a result of the Maryland Oyster Survey will be so conserved and developed that they will produce, as they have done before, twice the amount they now yield; and that the oyster industry of Maryland will then be based on annual production of 20,000,000 bushels of oysters where now it is barely 5,000,000 . . ."

Yates was wrong, not because the Bay was becoming less capable of yielding such quantities of oysters but because of human factors. Seven decades later, the acreage of oyster ground under lease is minimal: 651 lease holders control about 9,000 acres of bottom (Jensen, 1981), amounting to three per cent of the 279,000 acres of oyster ground reserved for public or private use. The small proportion is ironic because, as noted, in 1830 Maryland became one of the first states to recognize private cultivation of oysters with its "One Acre Act". Political influence of oystermen has prevented any major increase in oyster farming. Presciently, in 1894, Stevenson predicted that Maryland would be the last state to abandon the common oyster fishery on public reefs.

The history of the early years of oyster culture in Maryland after 1906 and of the determined resistance by oystermen and tidewater politicians was presented by Green et al. (1916), the Shell Fish Commissioners of the time. They described several shortcomings of the 1906 Haman Bill as passed by the General Assembly. Two important deficiencies concern us here.

One shortcoming of the Bill was the inclusion by its adversaries of arbitrary restrictions on the area that could be rented, on the types of gear that could be used, and on the seasons open to harvesting on rented plots. The lessee could only tong for oysters, rather than using the more efficient dredge or powered equipment for cultivating the grounds and harvesting oysters rapidly to take advantage of market demands. His seasons and hours were the same as those enacted to protect public grounds. In addition, unlike the public oystermen, the private culturist had the expenses of rental fees, shelling of the bottom, purchase of seed, and policing of the property. As the Oyster Police were rather ineffectual, many instances of poaching occurred leading to hesitation in risking money and effort by planters whose crop might be stolen overnight. Finally, to prevent monopoly, corporations or joint stock companies were prohibited from renting oyster grounds for cultivation. In response to concerns about these deficiencies, the Price-Campbell Bill was passed in 1912, modifying the Haman Bill. It allowed the additional rental of up to 100 acres of barren bottom per lease in Tangier Sound and increased allowable Bay holdings to 500 acres. It allowed the lessee to use dredges and extended his working season. However, it did not change the regulations against corporate holdings or use of powered equipment.

Another shortcoming of the Haman Bill was the attempt to make the results of the Oyster Survey a permanent determination of the character of the bottom without flexibility to allow for changes in future conditions. Thus, natural ground might become barren from disease or over-fishing or barren bottom might become replenished naturally, but this could not be taken into account by the Commission, because oystermen initially insisted on a rigid design for the Survey, to guard against further shrinking of the legal boundaries of areas designated as natural grounds (shrinkage of productive grounds was, in fact, occurring rapidly in nature as noted earlier). Thus, any errors of the Oyster Survey in declaring natural grounds to be barren bottom because of a lack of oysters at the time of the Survey were not able to be corrected after

the Survey had ended. Unexpectedly, when an extremely high settlement of oyster spat occurred during the Survey with consequent rehabilitation of over-fished beds, the oystermen found a number of the rehabilitated bars to be classified as barren bottom (as they had been when first surveyed) and thus available for leasing.

Passage of the 1912 Price-Campbell Bill had led to an increase in applications for leases (Fairbanks, 1932), with a parallel increase in protests from oystermen that the ground being applied for was natural and not barren bottom. Oystermen claimed that they had never been told of the filing in their county courts of charts outlining proposed boundaries of natural oyster grounds, and thus had not been able to meet the established appeal deadline. Green *et al.* (1916) disputed these claims, pointing out that the Oyster Survey had employed local oystermen as guides familiar with each county's waters; that copies of the charts had been sent to attorneys, state or county offices, oysterpackers, oystermen who had acted as guides, and village postmasters; and that newspaper advertisements of the filing of the charts and the initiation of the appeals period had been published in a large number of localities. They also noted that it was inconceivable that local politicians ". . . who had constantly been appealing to the oystermen for the vote, on the ground that they were the champions of the oystermen's rights, could be so little interested that the charts could pass into and out of their offices unnoticed". Nevertheless, many oystermen insisted that the appeals period had expired without their knowledge. Other arguments that they raised are reported by Maltbie (1914). Because of the increasing protests and the formation of county-based oystermen's associations, political pressures mounted to change the leasing law.

The 1914 legislative session was as controversial as the 1906 session had been. Because of pressure brought by oystermen, the Anderson Bill was introduced to repeal the Haman and Price-Campbell Acts. This greatly agitated supporters of private culture. The Baltimore Sun printed at least 33 editorials between January 24 and April 11, 1914, defending such culture. On March 9 and 10, 1914, the newspaper printed two pages of comments by 99 Maryland citizens, most with no financial interest in the industry, protesting at the attempts to repeal earlier Acts. The Sun also noted that oystermen comprised less than 20 percent of the population of the tidewater Counties, a numerical strength much less than their political strength. With regard to tidewater legislators, the newspaper noted "It would take a very brave man, physically as well as morally, to defy so desperate and furious an element of his own constituency, even if he actually differed from them" (Baltimore Sun, 1914a).

Because of the public clamor, the Anderson Bill was replaced by the Shepherd Bill, which was claimed to be a helpful amendment of the earlier oyster culture Acts. However, Delegate Cummings of Montgomery County was quoted as saying ". . . the Shepherd Bill is just as good as a repealer, because it is really a slow death for oyster culture", (Baltimore Sun, 1914b). That spring, the General Assembly passed the Shepherd Act ". . . which virtually nullified oyster culture legislation by providing that any bottom resorted to once in five years by oyster fishermen was natural bottom" (Earle, 1926). Such a claim in court, even if it were only a claim of one day's fishing activity, was sufficient to prevent leasing of an area. The Act also established a "neutral zone" 50 to 200 yards wide around natural bars where no person could plant or cultivate oysters. This just enlarged the area of the natural bar because oystermen were allowed to work it whereas planters could not, and so territorial disputes continued (Green *et al.*, 1916).

There was provision for reclassification of oyster grounds either on the initiative of the Board of Shell Fish Commissioners at any time or of any three or more Maryland residents who wished to dispute a barren bottom designation. In the latter case, the reclassification was to be done by the Circuit Court and not the Commission. As Christy (1964) noted, such reclassification efforts led almost immediately to 54,000 acres being removed from the category of barren bottom to that of natural oyster bars. Between

1915 and 1963, an additional 15,000 acres were reclassified as natural grounds as a result of challenges in court to lease applications (Power, 1970), with almost any protest serving to frustrate a lease application. Power (1970) stated that the Shepherd Act has effectively hamstrung the granting of oyster leases ever since.

After the Haman Bill passed, leasing of bottom had begun slowly (Green *et al.*, 1916) with 2,116 acres leased in 1906. By early 1914, 5666 acres were under lease, 9,529 acres were outstanding “awaiting signature”, and 22,705 additional acres had been applied for but not yet approved (Green *et al.*, 1916). Such an increase added to the oystermen’s anger. Shortly after the Shepherd Bill was passed, the acreage under lease dropped but then slowly grew to about 9,000 acres in 1930 (Fairbanks, 1932). As noted earlier, about 9,000 acres are presently under lease (Alford, 1973; Jensen, 1981).

5. Increase in Biological Research

In 1916, the Conservation Commission of Maryland was formed by the consolidation of the Shell Fish Commission, Fish Commission, State Game Warden and State Fishery Force (Earle, 1932). The Commission set aside suitable oyster grounds (Reserve Areas) to serve as sites for seed transplantation experiments. Stunted oysters were taken from the low salinity Upper Bay and placed on these Reserve Areas to grow. In 1918, Dr R. V. Truitt began a long-term research program which included sampling water quality, measuring larval abundance in plankton, studying larval setting and survival, characterizing oyster ground, and comparing various materials as settlement substrate. This research was not supported by dedicated funds (at least up until 1930) and depended on donated sampling gear, chemicals, work space, and field and laboratory assistance (Truitt, 1931a).

In spite of such constraints, Truitt produced many technical reports as well as an illustrated guide to oyster biology and Maryland’s oyster industry (Truitt, 1931b). He demonstrated that oyster shell was much more attractive to oyster larvae as a settlement surface than a number of other materials such as glass, wood, bricks, cinder and pebbles. He found a correlation between abundance of brood stock on an oyster bed and of larvae in the water column, noting however that high brood stock levels alone do not assure high levels of spat settlement in all regions of the Bay. He recommended an increase in the minimum harvestable size of oysters from 2 1/2” to 3” and the return of shell, along with suitable numbers of brood oysters, to areas requiring rehabilitation. Laws based on these recommendations were passed in 1927.

That same year, a Shell Planting Program was financed by a gas tax on work boats and by direct appropriations of state funds. A 10 percent shell tax was placed on packing houses, i.e. 10 percent of their shucked shell was to be made available to the state as cultch (State Planning Commission, 1936).

In 1931, construction of Chesapeake Biological Laboratory was begun, providing a base for the work on oysters by Truitt and associates. In conjunction with the Laboratory, an experimental “oyster farm” was established on a 1,000-acre reserve in the Honga River (State Planning Commission, 1936), in a region which had proven to have numerous oyster larvae in the water, although the oyster grounds had been badly over-fished. Over a three-year period, 42,000 bushels of shell were planted on one 50-acre section. About 4,000 bushels of seed were harvested in the fall of 1934 from a four-acre patch within the planted section, and it was estimated that 50,000 bushels of seed had set where oysters had not been produced for years (State Planning Commission, 1936). This demonstrated the potential of properly managed shell planting activity. Truitt continued research in this area for a few more years, but then the experimental region was turned over to public use as a tonging bar, apparently against Truitt’s advice and to the ultimate detriment of the area and the seed program (Wharton, 1959).

Continuing scientific research strengthened earlier ideas of proper management of the natural oyster beds (Beaver, 1945; Chesapeake Biological Laboratory, 1953). Essentially, the results demonstrated the importance of conserving shell as cultch and of expanding a seed-production program. The encouragement of private cultivation continued to be urged.

6. Commissions, Reports, and Management Efforts

From the Depression onward, concerned organizations or the General Assembly periodically commissioned reports on the state of the oyster fishery. In 1932, the Baltimore Association of Commerce reviewed the history of the oyster fishery and of leasing (Fairbanks, 1932). It recommended that the Conservation Department be given full authority to resurvey and reclassify unused oyster grounds to allow for increased private culture. It urged development of large seed beds, an increase in the maximum area that could be rented for private culture, repeal of the strictures against corporate involvement in private culture, and strengthening of laws to require actual planting of shell or oysters on rented bottom within specific time periods and in specific quantities.

In 1936, another Commission reviewed the fishery, blaming its decline on overfishing, export of seed oysters to out-of-state planters, failure to return shell to oyster bars, and the harvesting of small oysters (State Planning Commission, 1936). It recommended a resurvey of oyster grounds, development of seed areas, a change in leasing laws to allow for larger holdings and participation by corporate entities, and greater regulatory (not just administrative) authority for the Conservation Commission.

This latter point was reiterated by a committee studying the structure of the Maryland State Government (Bowman, 1938). The committee noted:

“The private enterprise whose manager could make no change in the nature, quantity or quality, or method of production except during a biennial stockholders’ meeting would be bankrupt before it started”.

This alluded to the fact that, at the time, the General Assembly sat every two years, thus hindering effective management of the oyster fishery if a situation arose between sittings that required immediate attention.

In 1943, the Tidewater Fisheries Department developed an Oyster Management Plan (Bowman, 1948) which was expected to increase production from three million bushels in 1944 to 10 million in 1978. It was to be financed from general funds and a tax on harvested oysters. Shell cultch and seed oysters were to be planted in appropriate areas, beginning modestly and increasing with time. However, poor enforcement resulted in failure to collect the 20 cents per bushel tax, and the quantities of seed and shell available were never sufficient to be very useful. From 1940 to 1946, 211,000 bushels of oysters were harvested from areas where seed had been placed. The planted seed had cost the state \$96,000. Taxes recovered were only \$42,000, probably due to tax evasion by oystermen (Bowman, 1948). In addition, extensive freshwater flooding of the Upper Bay seed areas killed millions of seed oysters, thus disrupting the seed-planting program (Beaver, 1945; Engle, 1947).

After describing the failure of the 1943 Oyster Management Plan, the Commission on Conservation of Natural Resources recommended adoption of a vigorous long-range plan (15 years or more in duration) for rehabilitation of the oyster industry (Bowman, 1948). At the time, the 1947 average catch from Bay dredging bars was one bushel per acre (harvested by 48 dredge boats), compared with an average of 50 bushels per acre in 1870–90 when over 1,000 dredge boats were fishing (Hammer, 1948). In 1948, 12,000 acres of oyster ground under state or private culture produced 700,000 bushels of oysters, a yield of

60 bushels per acre. In comparison, 1.4 million bushels of oysters were fished from public grounds which were about 260,000 acres in extent, for a yield of about six bushels per acre (Bowman, 1948).

The proposed 1948 plan was anticipated to increase the Maryland catch to four million bushels by 1965 as a result of the following recommended actions. A law should be passed requiring oyster packers and processors to sell at least 50 percent of their shucked shell to the state (such a law was enacted in 1951 and strengthened in 1953). Funds to buy the shell would come from an oyster inspection tax of five cents per bushel of processed oysters. One million bushels of shell should be planted in good spat-setting areas to enhance the seed oyster program. The seed oysters should be used to rehabilitate Bay and tributary bars. Enforcement of current regulations should be intensified. Private oyster farming by licensed watermen should be encouraged. Unfortunately, the proposed plan was not implemented to any extent, other than as noted.

One important recommendation by the 1948 Commission did have unintended repercussions. In an effort to integrate the various components of the industry (tongers, dredgers, etc.) to reduce squabbling and to gain support for any proposed rehabilitation programs, the Commission urged the election of state and county committees of oystermen, patterned after Soil Conservation Committees, to interact with management and to advise on closing oyster bars and on shell and seed planting activities. The resulting county committees have a strong voice in the deposition of shell and seed taken from county waters, and export of this material out of the county is discouraged by the local committees. Thus, rehabilitation of any one area by extensive planting of cultch or seed from elsewhere may be thwarted. Also, cultch has sometimes been planted in areas of poor spat settlement (personal observations) in spite of historical records documenting such poor settlement success. Shell and seed plantings tend not to be where scientific findings would suggest but where politics demand (Christy, 1964).

In 1966, a private organization formed yet another committee to report on Maryland's fisheries, including the oyster fishery (Quittmeyer, 1966). The report reviewed the history of the fishery and reiterated the call for increased private cultivation, providing a list of 14 steps or actions based on biological information which the Committee regarded as necessary for enhancing oyster production. They felt that production could be doubled in five years, if their recommendations were followed. Again, most of the recommendations were ignored.

7. Recent Management Activities

Even with the 50 percent shell tax being law, the state was often unable to obtain this amount of fresh shell from packers and processors (Maryland Board of Natural Resources, 1962). Thus, shell planting activity was hindered and efforts were made to find alternate sources, with emphasis on "fossil" shell dredged from formerly productive but now silted-over oyster grounds. In 1961, the state implemented an oyster repletion program with oyster shells from non-producing areas of the Bay being dredged and distributed over public oyster beds. By 1963, the amount of fresh shell planted by the state was the smallest for many years, due in part to the sale of oysters to out-of-state buyers (Maryland Board of Natural Resources, 1963). Use of dredged shell thus accelerated. During the 1960s and 1970s, the state was routinely contracting for the dredging, washing, and replanting of 5 million bushels of dredged shell a year. Those "fossil" shells provide the vast bulk of the present shell planting effort, outranking fresh shells by more than nine to one during the late 1970s (Cabral, 1978), even though fresh shell is a better cultch material than dredged shell (Cabral and Wheaton, 1981).

The annual oyster seed and shell planting program is considered one of the most important manage-

ment practices for maintaining levels of production during periods of poor natural reproduction (Ulanowicz *et al.*, 1980). Nearly all the oyster seed for the present program comes from 1200 acres of off-limits seed areas that in the past have proven highly productive for spat settlement (Cabraal, 1978). Every spring, the Tidewater Administration organizes a major seed planting program, contracting with oystermen who dredge spat-carrying shell off the seed areas and replant them on the fishing grounds. To organize this effort, fishery managers draw up a distribution plan that outlines where in the Bay the seed and shell will go. They review the plan with the oystermen's committees and consider a variety of factors including economic conditions and the number of oystermen living in each county, the number of shell bushels and seed bushels planted in each region in recent years, the biological condition of the waters, and the number of oysters harvested there (Cabraal, 1978). Their plan usually combines economic, political, and biological factors.

Presently, the Maryland oyster management program is currently conducting a resurvey of all the state's traditional and potential oyster grounds, the first since the Maryland Oyster Survey of 1906. The resurvey will establish the extent and character of the fishing grounds and may provide a basis for re-instituting the awards of new leases for oyster farming. The General Assembly in 1972 declared a moratorium on the award of new leases, pending completion of the new survey (Jensen, 1981).

However, since the 1950s, a complicating factor has arisen concerning use of Bay bottom. Maryland has extensive subtidal soft clam (*Mya arenaria*) beds which became increasingly exploited after the invention of a hydraulic dredge. This fishing gear uses water jets to blast the clams out of the sediment and on to a conveyer belt which carries them up the water's surface for harvesting. Clam fishermen do not want "barren bottom" to be opened to private oyster culture because such grounds often contain beds of soft clams. Since 1945, it has been illegal to lease natural clam beds. Clam fishermen have their own organizations and are often in conflict with oystermen's organizations over use of Bay bottom. However, both groups are united in opposing private oyster culture (Power, 1970).

8. Conclusion

Chesapeake Bay oyster stocks are not the only ones to have become depleted in the last century. Oyster populations in New England had declined greatly by the early 1800s (Ingersoll, 1881; Sweet, 1941). Thereafter, in states from New Jersey northward, a system of private cultivation was encouraged, with consequent revival of the industry (Sweet, 1941; Christy, 1964). It is worth noting that no region on the Atlantic or Gulf Coast of the United States appears to have managed its eastern oyster resource so well that rehabilitation has been unnecessary. Frequently, the resource has been over-exploited before any remedial measures have been taken.

Unfortunately, political considerations rather than limited biological knowledge have frequently contributed to declines in fisheries in North America and elsewhere (Wallace, 1952). Maryland's history of legislative management of the oyster fishery is particularly instructive. In spite of the extensive set of laws governing the industry beginning in 1820, Maryland's oyster catch is a fraction of what it probably could be. Numerous optimistic remarks by a variety of informed observers about the fishery's potential have not been borne out. Even today, if Maryland's Department of Natural Resources proposes unpopular management actions, vociferous opposition from commercial fishermen leads to legislative intervention and often the withdrawal or modification of the proposed actions. A century's accumulation of scientific insights, commission recommendations, and general popular support of private oyster culture has been negated to a great extent by political sensitivity to an influential, vocal minority.

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References

- Afford, J. J. (1973). The role of management in Chesapeake oyster production. *Geogr. Rev.* 63, 44-54. Alford, J. J. (1975). The Chesapeake oyster fishery. *Ann. Assoc. Amer. Geographers* 65, 229-239.
- Baltimore Sun. (1893). Editorial entitled, “An Economic Question of Importance”. February 18. Baltimore Sun.
- (1903). Editorial entitled, “Good Roads and Oyster Planting”. July 31.
- Baltimore Sun. (1905). Editorial entitled, “The Oyster and the Politician,” June 17.
- Baltimore Sun. (1914a). News Item. March 10.
- Baltimore Sun. (1914b). News Item. March 11.
- Beaven, G. F. (1945). Maryland’s oyster problem. Maryland Board of Natural Resources, Dept. of Research and Education, Solomons Island, MD. Educational Series, No. 8, 1-14.
- Bell, T. I. and FitzGibbon, D. S. (1978). Fishery statistics of the United States 1975. *Natl. Mar. Fish. Serv., Statistical Report* No. 69. Washington, D.C.
- Bowman, I. (Chairman). (1938). Report of the committee on the structure of the Maryland State Government. Baltimore, Maryland.
- Bowman, I. (1940). Science and social effects: Three failures. *Sci. Monthly* 80, 289-298.
- Bowman, I. (Chairman). (1948). Report of the Commission on Conservation of Natural Resources to the Governor of Maryland, Annapolis, Maryland. (See also Maryland Board of Natural Resources, 4th Annual Report, pp. 27-39).
- Brooks, W. K. (1880). Development of the American oyster (*Ostrea virginica* L.). *Studies from the Biological Laboratory*, Johns Hopkins University, Baltimore, Maryland, 4(1), 1-81.
- Brooks, W. K. (1905). *The Oyster. A popular summary of a scientific study*. Baltimore: The Johns Hopkins Press.
- Brooks, W. K., Waddell, J. I. and Legg, W. H. (1884). *Report of the Oyster Commission of the State of Maryland*. Baltimore: J. B. Ehlers and Co.
- Burgess, R. H. (1963). *This Was Chesapeake Bay*. Cambridge, Maryland: Cornell Maritime Press.
- Cabraal, R. A. (1978). Systems analysis of the Maryland oyster fishery: Production management and economics. Ph.D. Dissertation, Agricultural Engineering, College Park, University of Maryland.
- Cabraal, R. A. and Wheaton, F. W. (1981). Production functions for the Maryland oyster fishery. *Trans. ASAF* 24, 248-251, 254.
- Chesapeake Biological Laboratory. (1953). *The Commercial Fisheries of Maryland*. Solomons Island, Maryland: Board of Natural Resources, Dept. of Research and Education.
- Christy, F. T. (1964). The exploitation of a common property natural resource: the Maryland oyster industry. Ph.D. Thesis, University of Michigan, Ann Arbor, Michigan.
- Cowan, J. K. (1889a). Letter to the Editor, Baltimore Sun, February 4, Page 1.
- Cowan, J. K. (1889b). *The Maryland Oyster and His Political Enemies*. Baltimore, Maryland: W. K. Boyle and Son.
- Davis, J., Haven, D., Drobeck, K. G. and Dunnington, E. A. (1976). Plans for management of the fisheries of the tidal Potomac River. University of Maryland, Chesapeake Biological Laboratory Solomons, Maryland. CEES Ref. No. 76-123CBL.

- Earle, S. (1926). *Fourth Annual Report of the Conservation Department of the State of Maryland*. Baltimore.
- Earle, S. (1932). The fisheries of Chesapeake Bay. *Trans. Amer. Fish. Soc.* 62, 43-49.
- Engle, J. B. (1947). Commercial aspects of the upper Chesapeake Bay oyster bars in the light of recent oyster mortalities. *Proc. natl Shellfish Assoc.* (1946), 42-46.
- Fairbanks, W. L. (1932). The oyster industry of Maryland. In: *The Fisheries of Maryland*, pp. 96-139. Baltimore: Baltimore Association of Commerce.
- Grave, C. (1912). *A Manual of Oyster Culture in Maryland*. Baltimore: Fourth Rep. Board Shell Fish Commissioners.
- Green, B. K., Revell, F. S. and Maltbie, W. H. (1916). *Seventh Report of the Shell Fish Commission 1914 and 1915*. Baltimore.
- Hammer, R. C. (1948). Present status of the Chesapeake Bay oyster bars in Maryland. *Proc. natl Shellfish Assoc.* (1947), 8-10.
- Ingersoll, E. (1881). *The History and Present Condition of the Fishing Industries. The Oyster Industry*. U.S. Census Bureau, 10th Census. Washington, D.C.: Dept. of Interior.
- Jensen, W. P. (1981). Leased bottom and the Maryland oyster fishery. In: *Oyster Culture in Maryland 1980. A Proceedings*. (D. Webster, ed.), pp. 117-127. University of Maryland Cooperative Extension Service. Publ. No. UM-SG-MAP-81-01.
- Maltbie, W. H. (1914). Statements submitted by the Board of Shell Fish Commissioners to the State of Maryland. Available in Pratt Library, Baltimore. Call No. X3H 465 M3 A473.
- Maryland Board of Natural Resources. (1962). *Nineteenth Annual Report*. Annapolis, Maryland.
- Maryland Board of Natural Resources. (1963). *Twentieth Annual Report*. Annapolis, Maryland.
- McHugh, J. L. and R. S. Bailey. (1957). History of Virginia's commercial fisheries. *Va J. Sci.* pp. 42-64.
- Nationalist Club of Baltimore City. (1891). *The oyster question*. Pamphlet, available in Eisenhower Library, The Johns Hopkins University, Baltimore.
- Nichol, A. J. (1937). *The oyster-packing industry of Baltimore. Its history and current problems*. Bulletin, Chesapeake Biological Laboratory, University of Maryland.
- Power, G. (1970). More about oysters than you wanted to know. *Maryland Law Rev.* 30, 199-225.
- Quittmeyer, C. L. (1966). *A Report on the Chesapeake Bay Fisheries of Maryland*. Centreville, Maryland: Seafood Advisory Committee of Wye Institute.
- State Planning Commission. (1936). *Conservation problems in Maryland* (2nd ed.). Publ. No. 9. Produced by the Subcommittee on Conservation. (Mimeo).
- Stevenson, C. H. (1894). *The oyster industry of Maryland*. Bull. U.S. Fish. Commission for 1892, 205297.
- Sweet, G. (1941). Oyster conservation in Connecticut: Past and present. *Geogr. Rev.* 31 (4), 591-608.
- Truitt, R. V. (1931a). The oyster and the oyster industry of Maryland. State of Maryland Conservation Dept., Conservation Bull. 4, 1-48.
- Truitt, R. V. (1931b). *Recent Oyster Researches on Chesapeake Bay in Maryland*. Chesapeake Biological Laboratory. Publ. No. 3.
- Ulanowicz, R. E., Caplins, W. C. and Dunnington, E. A. (1980). The forecasting of oyster harvest in central Chesapeake Bay. *Est. Coastal Mar. Sci.* 11, 101-106.
- Wallace, D. H. (1952). A critique of present biological research on oysters. *Proc. Gulf Carib. Fish. Inst.* 5, 132-136.
- Wharton, G. W. (1959). *Proceedings of an Oyster Conference, 7 January 1959*, College Park, University of Maryland.
- Wharton, J. (1957). *The Bounty of the Chesapeake. Fishing in Colonial Virginia*. Charlottesville, Virginia: University Press of Virginia.
- Winslow, F. (1881). Deterioration of American oyster-beds. *Pop. Sci. Monthly* 20, 29-43, 145-156.
- Winslow, F. (1882). *Report on the oyster beds of the James River, Virginia, and of Tangier and Pocomoke Sounds, Maryland and Virginia*. Appendix 11. Washington, D.C.: U.S. Coast and Geodetic Survey for 1881.
- Winslow, F. (1884). Present condition and future prospects of the oyster industry. *Trans. Amer. Fish. Soc.* 13, 148-163.
- Yates, C. C. (1913). *Summary of survey of oyster bars of Maryland 1906-1912*. Washington, D.C.: U.S. Coast and Geodetic Survey.