

Maryland's Oysters Research and Management

By Victor S. Kennedy and Linda L. Breisch



A Maryland Sea Grant Publication
University of Maryland
College Park

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Preface

This critical review, *Maryland's Oysters: Research and Management*, is intended for fishery resource managers, researchers and students of marine biology. It joins a previous publication, *A Selected Bibliography of Worldwide Oyster Literature*, a comprehensive bibliography of the literature on the biology and ecology of oysters including the eastern oyster, *Crassostrea virginica*.

The goal of this series is improved planning both for research on the biology and ecology of the eastern oyster and for management of the oyster fishery of the Chesapeake Bay. Resource managers need an up-to-date review of the existing literature to make the most effective decisions on issues such as catch limits, sustainable yields, harvesting techniques, fishing season dates, shell planting and seed planting. Researchers and research managers need a current overview that illuminates the crucial questions remaining to be answered in order to achieve a more complete understanding of the species and to improve management of this valuable commercial fishery. Though thousands of published papers and dozens of books describe one or two aspects of oyster biology and ecology, only a few publications have tried to synthesize this extensive literature into an overall, analytical examination of the species. Since Korringa's review was published in 1952, only partial reviews of selected aspects of oyster biology have appeared. Recognizing the need for a current bibliography and review, the University of Maryland Sea Grant Program and the Tidewater Administration of the Maryland Department of Natural Resources decided to cosponsor this series of publications.

Our review considers the eastern oyster and its fishery in some depth, emphasizing the Maryland resource. We consider the biology and ecology of the oyster, with a view to delineating those areas of uncertain knowledge which require further research. We then trace the historical decline of the Maryland fishery and, in so doing, discover that environmental factors alone have not been the only cause of this decline. Sociological and political factors have been significant as well. We describe Maryland's oyster grounds and discuss current management of the oyster fishery in Maryland. At the end of the report, there is an

annotated bibliography of references to research on Chesapeake Bay populations of *C. virginica* and important associated organisms.

In general, this review considers mainly those reports that deal with the Chesapeake Bay oyster and the industry it supports. However, because no research is accomplished in an information vacuum, we refer to work performed elsewhere when its insights prove valuable.

During the preparation of this review, it became obvious to us that solid groundwork had been laid in earlier, comprehensive reviews of the literature. There is no need to reiterate this material in detail. Thus, the following publications provide extensive background material that our review seeks either to supplement or to apply to the special case of Chesapeake Bay oysters:

1. Recent Advances in Oyster Biology. P. Korringa. 1952. *Quart. Rev. Biol.* 27: 266-308; 339-365. An extensive review of the biology of oysters of the genera *Crassostrea* and *Ostrea*.
2. The American Oyster *Crassostrea virginica* Gmelin. P. S. Galtsoff. 1964. *Fish. Bull.* 64: 1-480. A detailed and important text, strong in anatomy and physiology, but with only limited discussion of ecology.
3. Oysters. H. B. Stenzel. 1971. *Treatise on Invertebrate Paleontology*, N3(6)) Bivalvia, pp. N953-N1224. A detailed description of oysters, emphasizing phylogeny and paleontology.
4. Speciation in Living Oysters. M. Ahmed. 1975. *Adv. Mar. Biol.* 13:357-397. Considers aspects of oyster taxonomy, speciation, and genetics.
5. Farming the Cupped Oysters of the Genus *Crassostrea*. P. Korringa. 1976. Elsevier, New York. 224 pp. A review of oyster culture.
6. Manual for Design and Operation of an Oyster Seed Hatchery. J. L. Dupuy, N. T. Windsor and C. E. Sutton. 1977. *VIMS Spec. Sci. Rep.* No. 142. 111 pp. A *vade mecum* for oyster hatcheries, developed from work in Chesapeake Bay.
7. Diseases of Oysters. V. Sprague. 1971. *Ann. Rev. Microbiol.* 25: 211-230. A general review of oyster pathology studies, with recommendations for future work.
8. Disease Diagnosis and Control in North-American Marine Aquaculture. C. Sindermann (ed.). 1977. Elsevier, New York. 330 pp. A summary of information on diseases and their control.
9. The Oyster Industry of Virginia: Its Status, Problems and Promise. A Comprehensive Study of the Oyster Industry in Virginia. Haven, D. S.,

W. J. Hargis, Jr. and P. C. Kendall. 1978. Va. Inst. Mar. Sci., Spec. Pap. Mar. Sci. 4: 1-1024. A detailed study of factors influencing oyster production in Virginia.

Access to these materials should provide resource managers with most of the information necessary for directing research, supporting oyster culture, and managing the oyster resource in the Bay. Our review addresses matters specific to the Bay oyster resource in general and to Maryland oyster populations in particular.

V.S.K.
L.L.B.

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The following people read sections of the review and provided helpful comments: Brian Bradley, Dave Cargo, Gene Cronin, Elgin Dunnington, James Engle, Roger Newell, Gary Newkirk, Sally Otto, Fred Sieling and Chris Valenti. George Krantz has provided helpful information and insight during numerous discussions of Maryland oyster biology over the past few years. Dan Levine developed the photomicrographs of gonad tissue. We are grateful to the University of Maryland Sea Grant Program and the Maryland Department of Natural Resources for financial support during the production of this review.

Introduction

In the Chesapeake Bay, one of the world's most fertile food-bearing estuaries, the American oyster (*Crassostrea virginica*) remains the most valuable seafood crop. And the most controversial.

Over the last century, the history of that fishery in Maryland shows a record of booms and slumps and partial recoveries. Harvests that averaged more than 10 million bushels a year during the late 19th century have averaged 2 to 3 million bushels a year during this century. Even at those levels, the contemporary fishery helps support 4,000 watermen who dredge and tong oysters out of the northern bay from early fall through late winter. In most years, their work brings in more than \$15 million a year in dockside sales and generates another \$30 million for the state's economy through shucking, packing, shipping, and selling. The oyster harvest outranks all other Maryland seafood catches combined, including crabs, clams, menhaden, striped bass, bluefish, white perch, and a dozen other species regularly fished from the Bay.

At present, hand tongs, patent tongs, and dredgers take oysters off nearly 1,000 public oyster bars spread over 215,000 underwater acres. Most watermen work as hand tongs, using long, lowsided tongboats equipped with a small cabin forward and an open cockpit aft for dumping and culling each day's catch. They spend their days at hard, physical labor, anchored over bars where they wrestle oysters up from the bottom with long, wooden-shafted tongs tipped with metal rakes for scooping oysters. A growing number of watermen have equipped their boats with patent-tonging rigs that feature power-driven winches; a small number have even taken to the water in scuba diving gear. Only a handful of watermen still sail their skipjacks. These graceful, wide-beamed sailboats—perhaps 30 are left—are the last survivors of a commercial sailing fleet that once numbered in the hundreds.

During the last two decades, the oyster fishery has changed from a “wild harvest” controlled only by natural cycles to a “put-and-take” harvest dependent in part on human efforts to replenish the oyster supply. On the public fishing grounds, state management officials now organize a major seed and shell plan-

ting program every spring, an effort that helps offset erratic sets of new oysters. On private fishing grounds, a few oystermen now lease Bay bottom and plant seed and shell to farm their own oysters. During the next two decades the fishery may change again, with more small oyster farms starting up outside the public fishing grounds now worked by watermen in skipjacks and tongboats and scuba diving suits.

For the Maryland fishery, however, nearly all change stirs controversy. When harvests decline, when oyster divers begin using scuba gear, when resource managers alter seeding plans, when oyster leasing increases, watermen and scientists and fishery managers begin arguing about the causes and effects, the costs and benefits of change. The history of the Maryland fishery, then, is a record of abundance and decline, of evolution and controversy. It is also a record of increased research and management efforts to understand those declines and to replenish those harvests.

Out of those efforts, a considerable body of knowledge about the biology of *Crassostrea virginica* and about the management of that species in the northern Chesapeake has developed — albeit in somewhat disorganized form. Most of the biological articles are scattered in dozens of scientific journals; much of the crucial management information is scattered in the “grey literature” of technical reports, administrative memoranda, and annual summaries long buried in office files or university archives.

In this book, biologists Vic Kennedy and Linda Breisch sketch that history and review that scientific and technical literature. Their goal in developing this publication was to assist current research and management efforts designed to improve our understanding of this species and to sustain a fishery that so many Marylanders have depended on for so long.

There are lessons, painful and positive, in all that history, research, and management. In tracing the record of the Chesapeake oyster fishery, the authors found sobering examples of overfishing, poor conservation, and environmental degradation. They also found encouraging evidence on the resilience of the oyster and the ecosystem, on the positive effects of active oyster management, on the potential for increased harvest in the future.

In their history of the early fishery, four themes recur:

1. The decline of the early fishery was predominantly a result of overfishing and ineffectual conservation efforts.

The Maryland oyster harvest began thousands of years ago with the Indians who roamed the Bayshore on foot and by canoe, before vanishing about two hundred years ago, leaving little but Indian names to mark the rivers and great piles of oyster shells to mark the sites of their ancient villages. Among the colonists who came after, a major commercial fishery developed late, and only after Connecticut watermen early in the 19th century began dredging the northern Chesapeake for seed oysters to replenish their own overfished waters. When railroads and refrigeration made oysters a favored food in fashionable, big city restau-

rants, Marylanders began taking their most plentiful shellfish seriously. Watermen began building boats and buying dredges, and legislators began passing laws keeping Maryland oysters for Maryland residents.

In the post-war prosperity of the 1870's the demand for oysters soon out-raced the supply, pumping up prices and profits, turning Bayshore villages into boomtowns, and sparking battles between Marylanders and Virginians, tongers and dredgers, oystermen and the Oyster Police. From 1870 to 1900, Maryland watermen sailing slant-masted log canoes, pungys, bugeyes, and skipjacks dredged and tonged oysters out of the Maryland Chesapeake at better than 10 million bushels a year. In 1875, they hauled home 14 million bushels; in 1885, 15 million. The Chesapeake Bay, in good years, was producing more meat than all the cattle farms of Maryland, Delaware, and Virginia. The great oyster hunt was on.

Watermen went out in small boats, in log canoes, in anything that could float. The hunt, according to one observer, was "simply a scramble," carried on with "regard neither for the laws of God or man," with tongers battling dredgers and both battling the Oyster Police—a scramble complete with night poaching, daylight rustling, running gun battles, and massive overfishing of the oyster grounds.

Those boom times faded with the century. The catch records of the 20th century show a sharp drop during the first decades, followed by a long decline during which the annual harvest averaged only 2.5 million bushels over half a century. The heydays of the wild harvest were over.

2. Political considerations, rather than limited biological knowledge, have frequently hampered efforts to improve fishery management.

Inspired by the huge harvests and sudden declines of the late 19th century, by the smaller booms and slumps and recoveries of the 20th century, the Maryland General Assembly has periodically established different commissions and boards and departments, stocked them with scientists and resource managers, and instructed them to oversee management of the resource and its harvesters. Over the last century, however, legislators in the General Assembly have always exerted the major influence on regulation of the fishery, ignoring in many cases the recommendations of the boards and commissions and departments they established. Naturally sensitive to the immediate concerns of watermen and seafood processors, legislators have passed many laws affecting management of the oyster resource which have little basis in biological or economic reality.

Wise management of any resource, stress the authors, depends upon close links between gathering information through laboratory and field study and applying the information to management questions. It also depends upon a supportive socio-political structure that leaves management to an informed group of managers.

3. The key management steps that have helped sustain the public fishing grounds have been: conserving available shell stock for replanting as cultch, protecting spat through cull laws, and expanding and protecting natural seed areas.

The early efforts to manage a wild but endangered fishery included the 1890 cull law that required watermen to throw back undersized oysters and shells with spat and young oysters. Throwing back the small oyster expanded the potential brood stock; throwing back the shell also provided a better base or cultch for the setting of new oysters. Later harvest declines during this century inspired laws requiring shucking houses to make 10 percent of their shucked shell available for replanting as cultch. The shell tax later grew to 20 percent, then 50 percent of available shell, before dropping to 25 percent—the current level.

The oyster seed for the current planting program comes in the form of shell dotted with young oyster spat. Watermen dredge these off the bottom of the state's 1,200 off-limits seed acres for replanting along public fishing grounds. Those new oysters reach market size two to three years later.

Fresh shell for the program comes from local shucking houses; old shell is dredged up from beneath the sediments covering long-abandoned oyster beds. Planted along the seed grounds and along the public fishing grounds, all this shell forms a clean, hard cultch for oyster larvae to settle on during the summer spawning season. These newly set oysters will grow to market size three to five years later. In a very literal way, this planting program helps lay the foundation for future harvests.

In recent decades shell planting and seed planting proved their effectiveness dramatically. When heavy fishing and disease drove harvests down to 1.6 million bushels during the mid 1960's, the Maryland Department of Chesapeake Bay Affairs stepped up seeding and shell plantings, boosting harvests to a 10-year average of 2.7 million bushels a year from 1966 to 1975. Those same efforts, though diminished in recent years because of rising costs, have helped sustain harvests above 2 million bushels, despite a decade and a half of poor natural reproduction.

What now threatens the oyster harvest and the way of life it supports is a series of oyster reproductive failures that could negate the oyster repletion effort and extend the fishery's historical decline. After significantly poor natural sets of new oysters in 1966, 1967, 1970, and 1971, Tropical Storm Agnes struck the Bay in 1972, causing enormous freshwater run-off, silting up oyster beds in the northern waters and diluting salinities. From 1965 through 1976, natural oyster reproduction was 72 percent lower than the average rates for the previous 27 years. If the supply of new oysters is not replenished soon, either by nature or by man, and if watermen continue to fish off the remaining oysters, the Bay harvest will soon decline again as it did during the early decades of this century.

4. Private oyster culture should have the stimulating effect here that it has had elsewhere. It should help revitalize the industry and increase yield and economic benefit for all involved.

By 1906, when the oyster harvest was down to 4.5 million bushels, leasing—first legalized in 1830—was tried on a large, half-hearted scale. The legislature commissioned a thorough survey of Maryland's oyster beds, and watermen began signing up for plots. Most of them, however, kept fishing the public bars while they waited to see if anyone else could learn how to plant and grow oysters successfully.

In the contemporary fishery many watermen continue to oppose private leasing, fearing eventual control of the fishery by large corporations rather than by independent, self-employed watermen. As a result less than 10,000 acres are currently leased; many of those leased areas are not under active cultivation; and a moratorium on new leases has been established by the state legislature, pending completion of a new survey of the state's oyster beds. The few planters who actively cultivate their leases with shell and seed oysters produce more bushels per acre than do watermen fishing the public bars.

Their current production, however, stands well below what would be possible under active oyster farming similar to what now works in countries like France, Holland, and Japan, in other states like Oregon, or in other estuaries like Long Island Sound. From this review of the aquaculture literature it is clear that effective farming techniques are being developed and that the natural environment in many parts of the northern Bay is ideal for this form of animal husbandry.

Managing Maryland's public fishing grounds can also be called a form of farming. And it requires the kind of detailed technical information now applied so successfully on most American farms. Most farmers now working the land rely on an immense amount of information about soil conditions and carrying capacity, about crop rotations and growth rates and nutrient needs, about fertilizers and herbicides and pesticides, about resistance to disease and response to genetic manipulations.

Most fishery managers, however, have much less to work with. As this review makes clear, a core of useful information is available and applicable to many of the major management issues—indeed, some of that information has been available for several decades. But the kind of precise management that could adjust strategies to different conditions in different parts of the estuary must draw on much more detailed information on dozens of key questions.

For our current understanding of oyster biology, say the authors, the areas of greatest ignorance concern: (1) the biology and behavior of oyster larvae while they float and feed in the water between spawning and spat set; (2) the food needs for those larvae and for juveniles and adults, and the food sources now available around the estuary; (3) oyster genetics, an infant science that may hold

the key to breeding healthier, faster-growing oysters; (4) disease among natural and hatchery-spawned populations; and (5) the effect of pollutants—especially chlorine, heavy metals, and petrochemicals—on all stages of oyster growth. Our understanding of these issues ranges from primitive to poor.

For many of the environmental factors affecting oyster productivity we know a little more; our understanding ranges from poor to almost adequate—adequate, at least, for status quo management. To boost harvests, however, fishery managers need more detailed information about the oyster's habitat, especially about: (1) the health, location, and abundance of brood stock in the Bay; (2) the best sources and best uses of seed oysters, fresh shell, and dredged shell; and (3) the best bottom areas for spat settlement and for spat growth and reproduction.

If oyster managing is a form of farming, if Maryland's oyster fishery is ever to blossom as richly as its land farms have over the last half century, then resource managers will need the kind of detailed biological and technical bonanza that came out of this country's massive investment in agricultural research.

The immense agricultural productivity of recent decades arrived slowly. It followed an era of overfarming for tobacco, depleted soil conditions, and ineffectual cultivation, an era that forced a westward migration for many 19th century Marylanders and inspired during the depth of the Civil War the federal creation of this country's land grant college system. Year by year, experiment by experiment, decade by decade, those land grant colleges and the experimental farms established on them built an information base that created and still supports our current agricultural abundance.

The historical decline of the Maryland oyster fishery, then, has clear parallels in recent agricultural history, and those parallels support a qualified optimism about the future of the fishery. If research efforts continue, if they focus on the key questions important to management, if current management programs can achieve greater freedom from political restraints than their predecessors did, if cheaper sources of seed oysters can be developed, if private farming can succeed—then Maryland's oyster harvests may recover as dramatically as did its agricultural harvests.

A better basis for optimism—again a qualified optimism—comes from the present, not the past. It comes from some of the findings of this review and from some of the recent behavior of the Chesapeake ecosystem. In reviewing the research records, the authors found evidence the oyster is a resilient animal, able so far to withstand heavy fishing pressures and large environmental variations without passing its "breaking point" as a viable commercial species. They also found that oyster management efforts, especially seed planting, can help sustain the fishery during periods of poor reproduction and that many oyster researchers still believe careful cultivation of the public fishing grounds and the growth of private farming could combine to increase the state's annual oyster harvest several fold.

The best reason for optimism comes from the Chesapeake itself, from the rich productivity and strong recuperative powers of this large, crowded estuary. In 1980, after 15 years of poor sets of new oysters, the Chesapeake Bay responded with one of the best crops of new oysters in the last 40 years. In 1981, it nearly duplicated that crop.

The Bay, despite depredations by humans and hurricanes, remains an impressive oyster growing ground. In many areas, it still has the temperatures, tidal circulations, and salinity levels that help spawning and growth. In most areas, it has shallow waters that help sunlight work on bacteria, detritus and plankton to build fertile food chains. The Bay retains such rich potential for oysters, in fact, that the well-managed harvests of the future could one day resemble the “wild harvests” of the past.

M. W. Fincham
Editor

Oyster shucking has been the focus of research and development for over 100 years, but to date there is no low cost automated oyster shucking machine commercially available. Automating oyster shucking is a difficult task due to the construction of the oyster shell and meat, the wide variation in oyster shell shape, and the effects of environmental parameters on oyster growth and shell shape. This paper describes areas where additional research is needed that will advance the science of oyster shucking. Oyster physical and thermal properties, various methods of applying energy to shuck oysters,... Maryland's Oysters Research and Management. Article. Jan 2001.