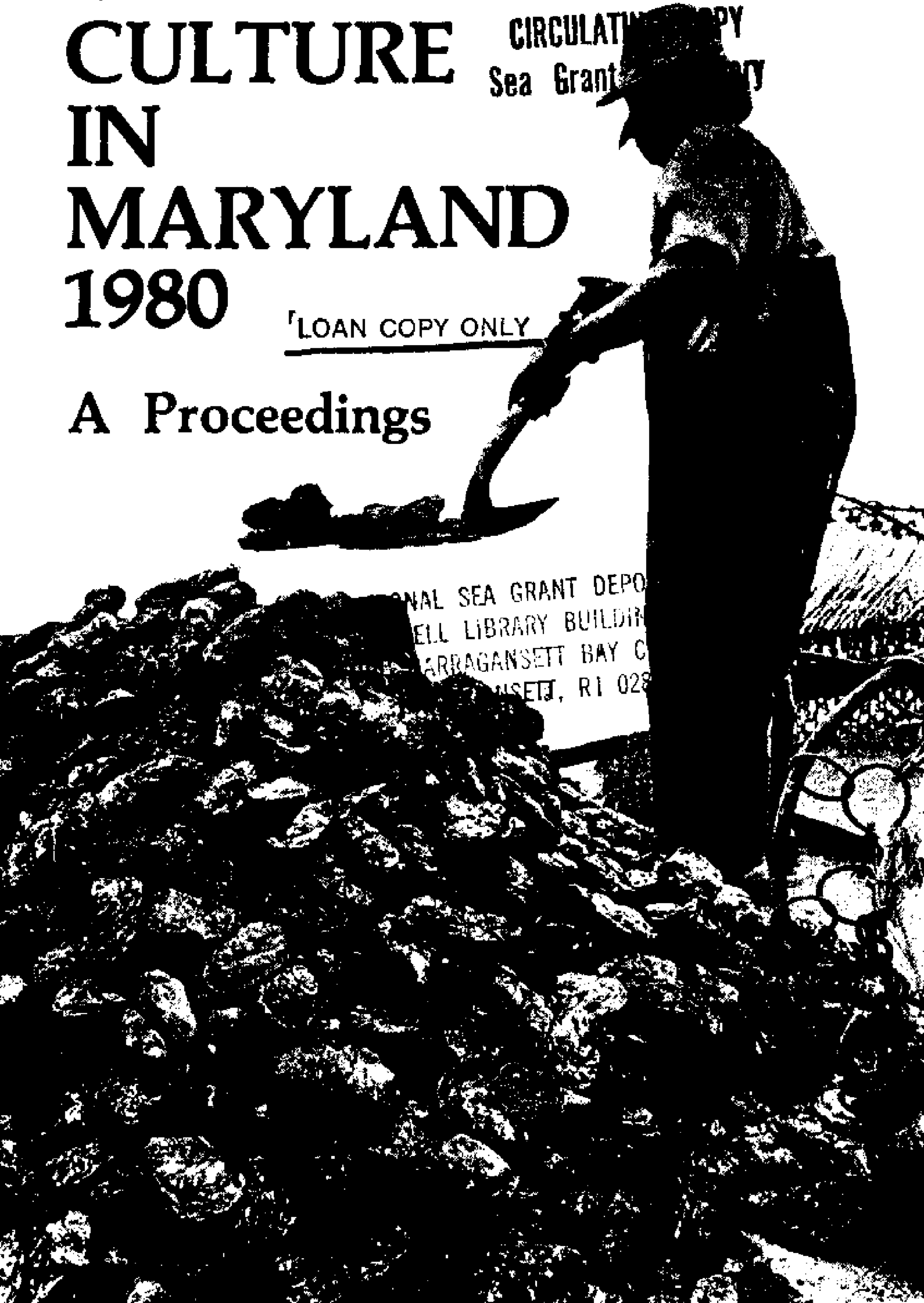
OYSTER CULTURE IN MARYLAND 1980

A Proceedings



OYSTER CULTURE IN MARYLAND 1980

A Proceedings

Technical Editor: Don Webster, Marine Advisory Agent
Copy Editor: Jack Greer

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COOPERATIVE EXTENSION SERVICE
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Editorial Assistant: **Valerie King**

Cover photo: **Skip Brown**

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Marine Advisory Program
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1224 H. J. Patterson Hall
University of Maryland
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Long-handled oyster tongs and skipjacks hauling heavy dredges: these are the images of Maryland's oyster fishery.

But new opportunities created by science and technology, coupled with severe irregularities in wild oyster populations, have spawned active interest in the culturing of oysters, especially as seed for both public and privately leased bars in the Chesapeake Bay. On January 8th, 1980, scientists, researchers, resource managers, watermen and seafood entrepreneurs assembled in Annapolis for the Second Annual Maryland Oyster Culture Conference.

Offering a wide range of perspectives, the participants discussed the production of seed oysters, the use of mechanized harvesting and shucking machines, processing problems, water quality's relation to the oyster industry, oyster diseases, hatchery methods, the status of the Bay bottom survey, and leasing oyster bottom. Speakers came from the Maryland Department of Natural Resources, the Virginia Institute of Marine Science, the National Marine Fisheries Service, the Maryland Seafood Marketing Authority, the Maryland Department of Health and Mental Hygiene, the University of Maryland, and private industry.

This proceedings, then, captures the thoughts and opinions of a given group of people on a given day, moving through issues of seed production to harvesting to processing and marketing.

Although the fall of 1980 would bring evidence of a healthy spat set in the Maryland portion of the Chesapeake

Bay, the participants of this 1979 conference could not know this: they faced a trend of dwindling oyster recruitment in the estuary. Still, had they been able to look into the future, little would have changed. Most scientists agree that 1980's good spat set cannot be expected every year: other assurances for a good recruitment of oysters must come, in the form of seed production, in the form of shell planting, in the form of good water quality and good resource management.

Such assurances could mean less peaks and valleys in oyster harvests, and a steadier market could open the door for greater use of oysters by large food stores and restaurants and for export outside the state. Already the Maryland Seafood Marketing Authority has targeted certain areas—like Detroit, Michigan—for marketing strategies which will increase out-of-state demand for the Maryland oyster.

The goal of these annual conferences, sponsored jointly by the University of Maryland Cooperative Extension Service, the University of Maryland Sea Grant Program, and the Maryland Department of Natural Resources, is to boost Maryland's oyster industry and to return to the Chesapeake the productivity it experienced at the turn of the century. Resource managers are quick to point out that increased production of oyster seed for the state will help the public fishery as well as the private oyster industry. A combination of public and private oyster harvests could provide work for many and a steady crop of Maryland oysters for the marketplace.

Already growing numbers of requests have come in for information on oyster spat collection devices, oyster farming, hatchery technology. All indications are that such interest will lead to an increase in the Chesapeake's oyster-producing capacity and a burgeoning prosperity for Maryland's oyster fishery.

A Message from the Director of Maryland Sea Grant

Dr. Rita R. Colwell

It is a genuine pleasure to address this audience. I am proud to know that Sea Grant has been a catalyst in putting together this program today.

Indeed, the Sea Grant Program at the University of Maryland is easy to be enthusiastic about.

In 1977, the University of Maryland Sea Grant Program began as a Coherent Area Program, meaning that we had several projects in marine sciences that could be brought together as a coherent program. Then, in 1979, our program developed to the point that it was recognized as a Sea Grant Institution, with strength in research, advisory services and education. In another year or two, we hope to be designated as a Sea Grant College.

What does this progress mean to the citizens of Maryland, to the waterman, or to seafood processors? One of the major research areas of the Sea Grant Program is the oyster industry, an important fishery in Maryland, but one which has seen, in the last several years, seriously declining harvests. The oyster fishery is a prominent fishery, because the Chesapeake is a large estuary, with a salinity, temperature regime and circulation pattern ideal for shellfish production. However, since the turn of the century, the oyster fishery has declined.

What can be done?

Through the Sea Grant Program and Sea Grant-supported research, good progress has been made in investigating some of the possible causes of the decline and in building a better understanding of natural recruitment. Dr. Robert Ulanowicz has developed a predictive model based on historical harvests in Chesapeake Bay, and his predictions accurately forecasted harvests for 1979 and 1980. The 1979 forecast came within 3% of the actual recorded landings, impressive evidence of accuracy for this predictive model.

We have been seeking probable causes of the harvest decline. Dr. Victor Kennedy, at Horn Point, has examined gametogenesis (i.e., sex ratio of oysters) to determine whether or not there are enough males and females in a balance to maintain oyster harvests. That may sound sort of amusing--a sex study of oysters--but, in fact, one of the causes of decline that had been suggested was an imbalance in sex ratios. After analyzing oyster samples collected in the upper Bay, Dr. Kennedy concluded that there was clear evidence that (and this is good news) Maryland oysters are sexually healthy, and if they are spawning, they do produce healthy sperm and eggs and the sex ratios are not wildly out of balance. This means that we must look for other causes of decline and that the sex ratio hypothesis simply does not hold up to careful scrutiny.

Sea Grant research carried out at Johns Hopkins University focuses on tidal currents, since the dynamics of frontal and interfrontal regions can relate to circulation patterns, spat distribution, and similar phenomena. Work done to date shows that the location of a major oyster bed in the Chester River correlates with a well-mixed interfrontal region that keeps phytoplankton at high densities, a possible explanation for good spat sets and good harvests. Mixed circulation ensures retention of food sources in a given area.

Other projects supported by Sea Grant include work on rehabilitating Maryland oyster production through aquaculture. George Krantz, Brian Bradley and Joseph Wutoh are studying variability in growth and survival of two oyster populations, research that should lead to better oyster breeding techniques in shellfish hatcheries.

A Message from the Director

Why is the Sea Grant Program so exciting? Sea Grant involves both basic research and results which are immediately applied to solving problems. It is a source of great satisfaction to be involved with "users" as well as "producers" of science. Sea Grant friends ask how I can "give up science" and be involved with practical kinds of things. My answer: because Sea Grant supports good science, as well as practical applications of that science. My message, then, is that we must support good research in order to maintain creativity, improve productivity, and develop technology so that we can provide consumers with improved products and maintain the natural resources of our region, the Chesapeake Bay.

During the last five or ten years, there has been movement away from basic research support to a demand for very applied kinds of work, to the point where many scientists feel they can not do basic research. We must not let this happen. As basic research declines in the U. S., creativity, invention, and new product development has centered more and more in other countries, such as Japan and in Western Europe. Creativity shifts to those areas providing research support. It is very important to strengthen further our Sea Grant Program, which represents a happy marriage of scientists, users, and technologists, wrapped together by our advisory agents who translate the scientific advances to our public. Sea Grant is a very happy combination of state and federal interaction. It is a program that gives us the opportunity to work together, by providing access to knowledge and opportunity to interact and to cooperate, to work together to solve problems, to understand, and to put to use the research done in the University.

I urge you not to downplay basic research, especially that done under the auspices of the Maryland Sea Grant Program, in which we are seeking to understand and improve water quality, to solve problems of toxic substances and their effect on developing larvae, to find a means of improving spat sets and of understanding and reversing the decline in the striped bass. Projects like the sex study of oysters may sound strange, but may, in the long run, provide the information needed to understand and manage the resources of the Chesapeake Bay.

It is particularly important to have groups like this meet, to provide interaction of scientists, users, marketing people, and citizens.

A major source of protein in the world today is from fisheries harvests. In the future, it may not be the filet of fish in the supermarket that is a major source of protein but perhaps, ten or twenty years from now, large scale efforts at fish culture in the laboratory, which could efficiently provide large volumes of protein. Already ferns and other ornamental plants are "cloned" and marketed throughout the country. It may sound wild-eyed and futuristic, but this kind of technology may be the open-minded, long-range view we should keep for the seafood industry. Until then, there are many, many problems to study and a lot of work to be done.

Our combination of Sea Grant, the University and other components of the state is proving effective. Sea Grant provides ideas, helps develop them and works hard to put the findings to good, practical use. Understanding what scientists and researchers in the University can do in providing knowledge or improving harvests may help you, the user, to help us define the best way to tackle the problems you face. From this and other workshops, we want to hear about the kinds of projects you wish to be done. The Sea Grant Program, true to its charter, must maintain relevance, as well as scientific excellence.

Beginnings: Oyster Spat and Seed

Running a Commercial Hatchery

Frank Wilde
Owner, Commercial Hatchery

Since my hatchery does not use sterilized water and uses only a natural feeding system to feed the larvae, we have the opportunity to observe the development of the oyster larvae in the hatchery parallel to its development in the wild. Each day the larvae are screened off and placed into a clean larval cone. When this is done, the larvae are examined with a microscope, so that we can keep close track as to what is happening. Up until Tropical Storm Agnes, I though I had most of the problems solved. Since Agnes, a problem has developed with Bryozoa, as you have seen on some of the slides here, which completely cover the substrate that the tiny spat are attached to, usually smothering them out. Not until this season did I discover that this Bryozoan also attaches to the oyster larvae before they metamorphosize. As the Bryozoa grow on the larvae, they prevent the larvae from swimming and force them to settle. The larvae cannot feed themselves and die.

I suspect that this same thing is happening in the Bay. Since Agnes, the Bay has been completely loaded with this Bryozoan, identified as Victerella. This is only one of many types of marine fouling that takes place. Use of anti-fouling paint helps in some cases, but I don't think it would make a very good environment to grow oysters.

Today I heard of some new problems that I haven't encountered yet. The problems in my particular area have been: Bryozoa, polydora (a little red worm), stilocos--which I have not had too much of a problem with--blue crabs, ducks, and last and most serious of all is the cow-nosed ray fish. This fish has now multiplied to the point that in my particular area it completely wipes out a whole oyster bed and can eat oysters up to four inches in size. I think this is probably going to be one serious problem in the Chesapeake Bay if something is not done to reduce the population of the cow-nosed ray.

My hatchery has been devoted primarily to developing an oyster that is a very high quality half shell oyster. I use the cultchless technique whereby the oyster does not attach to any substrate. There have been studies made as to how much predation there is on cultched oysters as compared to cultchless oysters. As far as I know there is plenty on both types, though there are benefits to growing one type over another type. There are also a lot of problems yet to solve with either. The advantage to a cultchless oyster is that it can survive very dense populations in trays. It also provides a much higher quality meat. Very true, tray culture is expensive and requires a lot of labor, but I think it is well worth the effort because the end product is of such high quality.

At present I am involved in two projects focusing on growing oysters to market size in trays. The indications are that there will be a good profit and, hopefully, that profit is going to start this spring. The cultchless oyster exhibits such high quality that the return is high enough to offset the expense in building trays and the additional labor that is involved in handling the trays.

Commercial Production of Spat

Max Chambers
Nanticoke, Maryland

I'm a bit of a rebel, so I am not going to talk the way the previous speakers talked. They gave you a bunch of scientific stuff. I'm not a scientist. I'm sort of self-trained and I only have one brain cell to work with, so I just filled it up as best as I could—and here I am. When Bill called me, he said I didn't have to give away any of my secrets; and I said that left the field wide open for me because I didn't have any.

But I have a dream—a big dream. And I am hoping I can get you to share it with me for a little while. In the Bay and related waters there are 9,200 acres of leased bottom, and everyone of you has a bit of that leased bottom shares in my dream. I am going to explain it as I go along.

Now for a few minutes I've got to talk in some scientific terms and I hope I don't get over your heads most of the time—and the rest of the time I hope I don't get over mine, because I usually do. I am sure you are all familiar with the true scientist or Chesapeake Bay biologist. He is the fellow who also has a dream. He is financed by that banker called government grant; his most studious preparation for his operation is called "writing the proposal"; and his final product is statistics. Now in between, he will probably have something you can see, and in the lab it will look like a pile of it. But spread it out over ten acres, and it won't look like much. Thank God we have them, for at least they provide the necessary starting point for the rest of us who are trying to do something to get going. We may have to change their procedures a little bit, but at least we can use them to get started.

Now for my scientific terms--the statistics. As I said, we have 9,200 acres of leased ground in the Bay. For those of you who are farmers you know that each acre has 4,480 square yards in it. Now imagine that we establish a density that would be 242,000 oysters or about 600 bushels of oysters per acre, assuming about 400 oysters per bushel. If we restock that so that we can get a yearly harvest of 50 oysters per square yard, that means that each year, off of leased ground, we have 5,520,000 bushels of oysters coming from those grounds.

Now, my personal goal is that we can eventually have all those grounds producing 50 oysters per square yard. That is not overproducing, but it would be a lot. I personally hope someday to produce 10,000,000 oysters per year. That gives me enough oysters to plant 20 acres, leaving 180 acres out of 200 for the rest of you to plant. Assuming that the good Lord looks upon me real favorable, and I push that to 100,000,000, I am still going to leave 9,000 acres out there that you can plant and I am not even going to effect you. So now, you have got my goal and my scientific facts.

Let us assume that the public grounds--which amount to about 270,000 acres--produce 50 oysters per square yard. What would be our oyster production in Maryland? I figured it out last night, and we would have slightly over 1,000,000,000 pounds of oyster meat coming off those grounds every year. Well, we don't have that. Something happened. The figures I have from summer before last, show a production of 46,000 bushels of oysters from 9,200 acres. If you look at that very carefully, you will see that figure works out to one oyster for every two square yards. That comes out to about three oysters lying on an area the size of your table are all we produced last year from private grounds.

So if I have any real secret, it is this: As oyster planters and oyster hatchers, we are miserable; and that is spelled with three z's because it is a pretty bad failure. We are just not producing oysters. I can't tell you that in my hatchery I can come up and give you all the seed oysters you want because I can't do it. I can give you maybe enough to plant my twenty acres in about five years, if Frank Wilde and I have good luck. He can take some of mine and I can take some of his. But that is about it. We are not going to make it because it takes too many, numerically speaking. I have seen some of the reports and statistics of the biologists. I'm not knocking them, but they give about 198 pages to productions and tests, etc. and then about two pages on economics. Perhaps that is because, as a biologist, they know best; but I am not sure that is the way to run a business.

When I started my business a few years ago, I asked two biologists working in the same office, on the same day, the same question. Neither of them heard the other's answer and the question was this: How much is it going to cost me to get started in this business? One said about $1,000 should do it. The other said, "a good microscrope costs about $1,000." I point this out, not because they aren't competent men (I have referred to these same men many times and they have given me very good answers), but because I feel that an oyster hatchery and production therefrom must be owned, set up and operated by a hard-nosed, practical, corner-cutting businessman who knows what the market will bear, how much he can get for his product, what the losses are, what the markups are, and what the consumer can pay in order that each individual in the line can afford to stay in the business.

Now I point this out because I just took a trip over Christmas and went out to Indiana. Oysters there are $5.80 for a 12 oz. can. Figure that out in terms of a gallon. That is about $50 per gallon. If you were paying that for oysters, oystermen, how many oysters would be on your table? Now we can't make it on two oysters or one oyster per 2 square yards, but we can do with 50 oysters per square yard and we can make that product something that can be used.

We people in the hatchery business have problems. We don't like to talk about our failures, so we lie a little about them, and when it comes to our successes we brag a little bit. I am inclined to do the bragging. But I also admit that I occasionally have failures too. Now last year, I had a real good batch of larvae going. I had about 30,000,000 and I said, since this was in June, "By July they will be about 1/2 inch, by August they will be 3/4 inch and by the time it gets cold, I'll have 1-1/2-inch oysters. I've got this made." Three days later they were all dead. I got about 100 oysters out of that 30,000,000. That's all.

Now if I were a scientist I wouldn't write that down, but you have to. If you are in the business, and you are a hard-nosed man, you have to say, "OK, some of these are going to die," and they do. But, on the other hand, I had a batch that neither George Krantz or I could believe, because in eight days from spawning they were setting. I couldn't believe that. The end result was that I had too much work to do and not enough time to do it in.

If there were twenty or thirty hatcheries operating here in the Bay and we didn't lie too much to each other and told each other what we were doing, I really think, as Mr. Webster said in the opening remarks, that we could really learn something. There just aren't enough of us there trying. Now it is true not all of you are going to have wives like mine who says, "OK, you can spend this money, but come wintertime I want a dozen oysters to eat," which is all I have to produce, because if she has a dozen oysters to eat, she is happy.

So here we are with one of the few forms of animal life we don't have to feed, certainly don't have to water, don't have to clean up after, and we have a product that is gourmet on the grocery shelf. But other meat producers who feed, water, house and clean up after their animals have a product over there on the staples shelf of the grocery store for every housewife to pick up as she goes along.

So much for the dream, so much for my thinking. I operate a little hatchery down in Naticoke. I have some elaborate tanks that I bought from someone who had them as fiberglass forms. I plugged some holes in them, put some drain lines in them and the larvae don't know the difference. I have an old water heater that I picked up for a few dollars, attached a circulating pump to it, threw some plastic pipe in the tank and that is my heat exchanger. It works real good. It doesn't come up to heat as fast as George's, but a few times to Don's distress at HPEL, I have been able to spawn oysters that he has had trouble with. Of course, he spawns some I have trouble with. But it works. The oysters don't know the difference, if the water temperature is the same, regardless of the type of equipment used.

I've got a problem trying to grow oysters in trays. I have been setting them on shell (tried innertubes one year and started out all over again because it killed everything I had, but that's part of the business). I am going to continue to set them on crushed clam shell for awhile. I have set some on plastic, in fact I was cutting up milk bottles for a while. They set terrific on milk bottles; the only trouble was they were so darn thick they looked more like sandpaper than anything else. When they were that thick they would not grow. We have troubles; we have problems; however, we are trying to work on solutions for you and produce the spat you need.

Production of Seed Oysters

Dr. George Krantz
Horn Point Environmental Laboratories
Cambridge, Maryland

This one-season study was a field demonstration/research effort to determine the technical and economic efficacy of using spat collection devices to obtain seed oysters from natural reproduction occurring in Maryland waters. The concept of placing man-made spat collectors on the bottom or on a floating device is a widely used technique for obtaining seed oysters in other estuaries around the world.

The Maryland shellfish management agency currently relies on natural spatfall that occurs on loose shell placed on the Bay bottom to produce seed oysters, oysters which the agency can then move to growing areas. This practice was very successful when introduced in 1964 because spatfall was high and consistent in all areas of the Bay. In the past decade spatfall has declined by 90-95% (Krantz & Merritt, 1977; Merrit, 1977) and the cost effectiveness of this procedure is now highly questionable (Figure 1).

An alternate management strategy to obtain seed oysters to sustain Maryland's oyster harvest could use hatchery technology to produce a predictable level of seed oysters. Critics of hatchery technology point to a high capital investment, high labor costs, and energy-intensive technology as being too costly to mass produce seed oysters for Maryland. Numerous books, technical reports, and public information bulletins document substantial evidence that the spat collection devices and techniques are effective in other parts of the world.

Reviews of off-bottom culture techniques by Iverson (1968), Shaw (1969), and Bardach et al. (1972) suggest a variety of substrates and techniques including strings of oyster bars suspended from rafts, baskets or bags of mollusk shells suspended from rafts or elevated off the natural bottom, man-made frames coated with concrete, large stones placed on the bottom, wooden stakes driven into the bottom or placed on inter-tidal racks, and frame devices supporting trays of shell or stone aggregate. Descriptions of these techniques imply that the materials and labor used to collect and handle the oyster spat provide more spat than do oyster shells on the natural bottom. Unfortunately, none of these descriptions address the comparative effectiveness of the various techniques with data on spat settlement and labor cost.

A portion of the West Coast oyster industry in the United States is based on collection of seed oysters from natural set through use of spat collection devices. Engle (1955), Butler (1955), and Shaw (1969) demonstrated that bags of oyster shell or concrete plates collected more spat than the same materials placed on the bottom of Chesapeake Bay. Even though these investigators worked during periods of high spatfall (1955-1956) relative to the present condition, spat set observed by these investigators would have produced less than 1,000 spat per bushel of shell.

This cooperatively supported study was conducted at four sites in the Maryland portion of Chesapeake Bay and at a site in Chincoteague Bay (Figure 2), where some of the greatest amount of spatfall has occurred in the past five years (Figure 3). Most of these sites have been used as seed areas by the State management agency. During the study, spatfall at each site was monitored on cement board "Butler plates" on a weekly and monthly basis. The Maryland Department of Natural Resources also monitored spatfall by this technique at 60 other locations throughout the Chesapeake and Chincoteague Bays. Spat collection devices were suspended from rafts and placed on the bottom during the first three days of July and allowed to remain in place through the end of August. Unfortunately, this study was conducted during a year with a very light spatfall. No spatfall was observed in

Chincoteague Bay, even at locations that produced 2,000 to 3,000 spat per bushel of shell in 1978.

At the end of the 1979 biological season, a Sea Grant-supported Bay-wide cruise to examine oyster bars for recruitment and mortality found levels of spatfall to be 5 to 34 spat per bushel of shell on the bottom adjacent to the study sites (Figure 4). No spat were found in St. Mary's River site and spat set in 1979 was relatively poor throughout the Bay. Unfortunately, this natural phenomenon destroyed our plans to quantitatively describe the efficiency of the devices for the collection of spat from the natural environment.

Another deterrent to the efficiency of spat collection was the biological fouling organisms which rapidly colonized the devices. All surfaces of collectors at the Chincoteague site were covered in one month with tube worms, bryozoa, and barnacles. Each location in the Chesapeake Bay had a different group of fouling organisms, but the heaviest growth was from bryozoans, Molgula, filamentous diatoms, and barnacles.

Suspended sediment from the water column was deposited on the surfaces of all collectors and trapped by the fouling community. A thin layer of Bay sediment has been demonstrated to kill newly attached spat in the Horn Point Environmental Laboratories (HPEL) hatchery system. Closely packed substrate (oyster shell and slag) collected the greatest quantities of sediment, whereas the concrete-coated wire collectors accumulated less sediment because of spaces between the wires.

The various types of experimental collectors (oyster shell in wire bags, oyster shell in polyethelene bags, tire chips in wire and polyethylene bags, slag, wood, and concrete coated wire) were assembled while time motion studies were conducted and mateterial costs documented. All collectors were "conditioned" for one month in flowing sea water in HPEL oyster raceways (Lomax and Krantz, 1979). The experimental collectors were cleaned prior to being placed on the bottom or on rafts at the five locations. The Maryland oyster management agency presently uses both dredged fossil oyster shell and "green" shell obtained from Maryland shucking houses to collect seed oysters on the state seed areas. In experimental management studies, DNR personnel have used "chicken-wire" mesh bags suspended from rafts and buoys. These two types of oyster shell are considered to differ in their capacity to collect oyster spat although a preliminary study by Engle in 1954 found no statistically significant difference. The minor differences in spat settlement on these two types of shell observed during the state shell-planting program may be a result of the location of shell plantings, density of the shell, and the time of the year when the shells were planted.

A modification to placing these shells on the natural bottom is to place them in a galvanized chicken-wire bag so that the shells will be slightly elevated off the bottom and more easily handled when being moved from the seed area to the planting area. Some attempts have been made to place shell bags in the water column by attaching them to styrofoam floats, piers, navigation buoys or poles driven into the bottom of the bay. Though limited observations indicte that shell-bags suspended in the water column will collect 20-50 more oysters than those placed on the bottom at the same location in Maryland (Engle, 1954), these studies gave no accurate information to the cost of materials or of the labor involved in this method.

In recent years, several types of polyethylene mesh nets have become commercially available (Vexar, Conwed) that are more durable and easier to handle than the chicken-wire bags. These items were introduced to the commercial market when petroleum chemicals were very abundant and relatively inexpensive. Recent changes in world economy may have made this type of bag cost as much as the chicken-wire bags.

The chicken-wire bags and Vexar polyethylene mesh bags were used to facilitate the handling of the two types of shell as well as tire chips from a waste recycling center. Slag--a solid byproduct of steel manufacture--was contained in shallow trays lined with fine-mesh Vexar.

Wooden spat collectors have been used for centuries in Asia and are readily accepted in specific areas of France, on the west coast of the United States, and along the Gulf of

Mexico. Wooden stakes, either placed on special holding racks or driven into the bottom, have proven an excellent, low-cost substrate for oyster shell in other areas. Maryland is fortunate to have large reserves of this renewable resource. Two types of wood (pine and oak) were either driven into the bottom or nailed into a frame on the raft.

The project plan was also to evaluate a recently developed "French" collector which is a series of interlocking polyethylene frames coated with concrete. During the past two years, numerous reports have been presented at scientific meetings describing a man-made collector developed in France. The device is made of polyethylene, modular in design, and can be stacked for mechanized handling. The polyethylene frame is coated with a dolomite cement that provides substrate for spat attachment. Preliminary studies of oyster spat settlement of C. virginica under hatchery conditions (Dupuy, 1977) have shown that the American oyster attaches and grows well on this collector. Growth of spat on the collector in Virginia waters was excellent, and predation and natural fouling was minimal. A 10-25 mm oyster was produced in one biological growth season. This collector, however, has not been tested for its ability to collect spat of C. virginica from a natural environment, especially under conditions that exist in the Maryland portion of the Chesapeake Bay.

This device was not available for use in the U. S. due to patent problems. As a substitute, layers of trays made of vinyl-coated wire were coated with one of three types of cement, or tile grout. Some of the concrete-coated trays received a second coat of finely ground oyster shell to increase the surface area and to increase the acceptance of the collector by oyster larvae. At each location shown in Figure 4 equal numbers of collectors were placed on the Bay bottom and suspended from a styrofoam and wood raft and allowed to remain there through September, the normal period for spat settlement in Maryland. "Butler type spat plates" served as a reference of spat settlement. One of the Butler plates suspended from the raft and from the frame resting on the bottom were removed weekly and replaced by a new plate. A second plate was removed monthly during the study. Oyster spat on the plates were counted to determine the periodicity of spat settlement (weekly and monthly). These plates provided a standard comparison among the substrates being evaluated and with results of other research studies.

Observations and Results

Table 1 summarizes the mean numbers of spat collected at each of the five sites. The number of spat setting on a bushel of loose green shell placed on the bottom was greater than on the collectors which had less total surface area. However, the concrete-coated wire collector was very close to natural shell in its ability to collect spat. Green shell in bags appeared to be more attractive to spat than dredged shell in bags. The other collectors proved to be very poor substrate for spat setting and survival. Detailed comparisons of spat set on individual collectors at each site showed very few differences between spatfall of suspended collectors versus that on the same collector on the bottom.

The above observation may have been strongly influenced by the relatively poor natural spatfall in Maryland during 1979. Another factor which greatly influenced the results in Table 1 was the loss of a high percentage of the collectors suspended from rafts during the three-month study period. One thunderstorm in July produced 20-knot winds and destroyed 50% of the suspended collectors. These were replaced only to have Tropical Storm David destroy 60-70% of the collectors in a two-day period in August. These losses occurred at sites that were chosen to be the most protected locations in the river systems. The unsuitable nature of Chesapeake Bay for suspended oyster culture has been described by numerous authors (Andrews). This study has provided a demonstration of the high economic risk that would be encountered by a commercial spat collection venture. Losses of the magnitude experienced in this study would be disastrous to recently established businesses.

Another factor to be considered in the cost of handling the collectors is the volume and weight of each type. The oyster shell bags contained one-half Maryland bushel of shell that weighed 35 pounds. After the shell bag had been in the environment, biological fouling and sediment increased its weight to 80 pounds. Wood materials doubled in weight, whereas slag and tire chips remained relatively clean. The concrete-coated wire collectors doubled in weight but weighed only 10-11 pounds at the end of the study.

Several laboratory tests to determine the relative acceptability of the collectors to oyster larvae during setting were conducted at the HPEL oyster hatchery. Each type of collector substrate was placed in vinyl-coated wire trays of the same dimensions as the concrete-coated wire collectors. Several trays of each type of substrate were placed in HPEL hatchery tanks containing filtered water with aeration to which setting stage oyster larvae were then added. Concrete-coated wire collectors sprinkled with oyster shell chips proved to be the collector most utilized by setting larvae (Table 2). Concrete and oyster shells were similar. The results of one test shown in Table 2 suggest that dredged shell was more attractive than green shell but this result was not consistent with other tests. Two other lab tests of this type confirmed the superiority of the concrete-coated wire collector coated with shell chips. Even at the high density of spat on the collectors, spat growth was equal to that of spat at lower density on shell and concrete surfaces.

Foremost in the Maryland oyster industry is an extreme concern for the cost of product, amount of investment, and financial risk of raising oysters. To remain competitive with natural sources of oyster seed and very simple culture procedures, any aquaculture technique--shellfish hatcheries or suspended seed collection techniques--must be competitive with seed oysters that are available from natural sources. Table 3 shows the labor and material costs for preparation of the collectors used on this study and the cost for placing them on the Bay bottom or suspending them on the raft system. These costs include the labor to handle the collectors, a vehicle to move the collectors to a boat, boat operation, and the labor to remove the collector from the bottom or the raft.

Spat collectors suspended on rafts were approximately twice as expensive as those placed on the bottom due to the cost of the raft. Rafts used in the study could be constructed for $300 and the construction cost was amortized over 5 years. An additional cost of material, labor and boat time was incurred to place the raft at a given location. Therefore, collectors suspended on rafts would have to collect twice the number of spat as those placed on the bottom to produce spat at the same cost.

The last two columns of Table 3 are estimates of the cost per 1,000 spat produced if a natural spat fall of 500 spat/bushel of shell had occurred on the collectors during the study period. This level of spat settlement is rare in Chesapeake Bay, occuring only four times in 40 years of recorded data (Figure 1). In the estimate, four wire shell bags would have been required to produce 1,000 spat, whereas one concrete-coated collector easily provided enough substrate for 1,000 spat (Table 2). Data in Table 3 do not include the cost of harvesting the seed, removing it from the collectors, and moving it to a planting location.

Data on the theoretical cost of oyster seed production in Table 3 clearly indicate that the experimental concrete-coated wire collector, an imitation of the French design, is the most cost-effective device for collecting spat. Suspended shell in wire bags is the most expensive collection device. The cost of spat collected by the wire bags destroys the potential for using this approach as a seed collection device for Maryland oyster growers.

The ultimate objective of this study was to evaluate techniques that could increase the quantity of oyster spat for the Maryland oyster industry. An experimental procedure must be demonstrated to be reliable and less expensive than the cost of the present oyster management program and the present practices utilized by the private leaseholders.

Analyses of the multiple factors influencing the Maryland oyster industry have identified one critical biological problem that existing aquaculture technology could possibly alleviate, the problem of the lack of seed oysters, or natural recruitment, needed to increase the supply of oysters to watermen and processors (Anatasi, 1976). With more oysters, new markets could be developed, processing equipment modernized, greater income realized from the commodity, and the industry expanded to counter rising operational costs due to inflation. In 1977-78, a special legislative advisory group, the Maryland Oyster Resource Expansion (MORE) task force, conducted an in-depth analysis of the problem and recommended research-management functions that could increase the supply of seed oysters. These included:

- using oyster hatcheries,
- developing natural methods that could increase recruitment of seed oysters under conditions that currently exist,
- increasing the efficiency of the existing shell-planting seed program.

The oyster hatchery approach to the problem is being addressed by existing research studies at the Horn Point Environmental Laboratories (1977 Sea Grant Program RF/5), and management advisory on the economic feasibility of hatcheries will be prepared for the State of Maryland in the immediate future.

Some of the preliminary data from this research effort can be used to compare the cost of producing spat with the suspended spat collectors used in this study to the cost of producing spat in the HPEL pilot hatchery, to the cost of seed from other commercial hatcheries in Maryland and California, and to the costs of seed from sources of naturally produced seed (Table 4).

Among the suspended spat collection systems, only the concrete-coated collector produced spat at a cost comparable to other sources of seed oysters. The most cost-effective system for the collection of spat from the natural environment is the Maryland State Shell Planting program operated by DNR. However, this technique has the constraint encountered by any procedure relying on natural spatfall—a highly variable annual yield and therefore an unpredictable cost for seed oysters.

The cost effectiveness of Maryland's seed program is totally dependent on the number of spat that set naturally on the planted shell. In recent years spat set has fallen until one bushel of seed oysters no longer produces a bushel of marketable oysters after two to four years of growth and natural mortality. Many "seed areas" (regions with traditionally high spat settlement) have been abandoned by the state, and public sentiment against the cost effectiveness of this program is very strong. Another constraint on this program is that the fossil shell reserves being used to plant the seed areas are limited (Biggs, 1965). Since these resources may be depleted within the next decade, an alternate strategy (substrate and spat source) must be developed to replace the existing program.

The MORE task force recommended that off-bottom spat collection techniques be more roughly investigated in Maryland, since the scientific literature describes several techniques used to sustain fisheries in other parts of the world. Technical descriptions of these procedures indicate that great quantities of spat can be collected on various types of substrate other than oyster shell.

One important consideration is the cost of labor and materials in the United States in comparison to costs in other regions of the world where suspended devices are used successfully to collect seed oysters from the natural environment. In a fixed analysis of all of these techniques, only hatchery procedure, which has only slightly higher spat production costs, produces predictable yields of seed oysters. Future demands for oysters may soon make this technology an attractive addition to Maryland's present management of techniques for oyster production.

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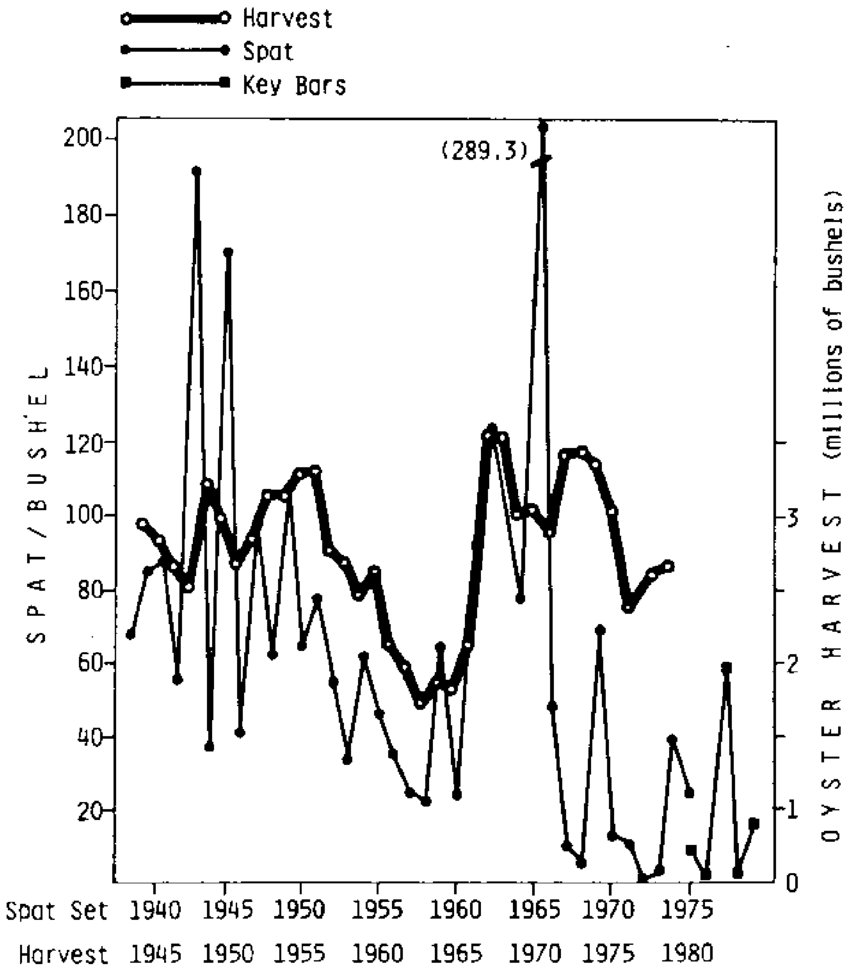


Figure 1: Comparison of oyster spat set on natural cultch (lighter line) to commercial harvest statistics adjusted to 5 years behind (heavier line). Data from key bars are indicated by squares on spat line, beginning in 1975.

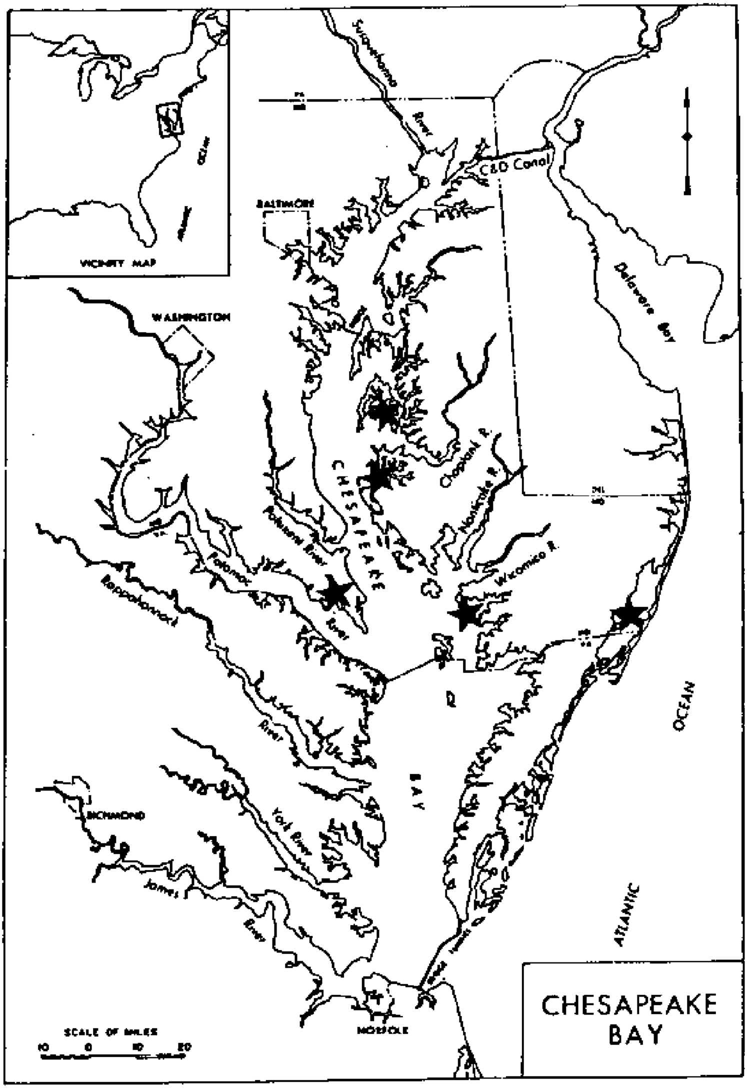


Figure 2: Location of study sites for evaluation of oyster spat collectors.

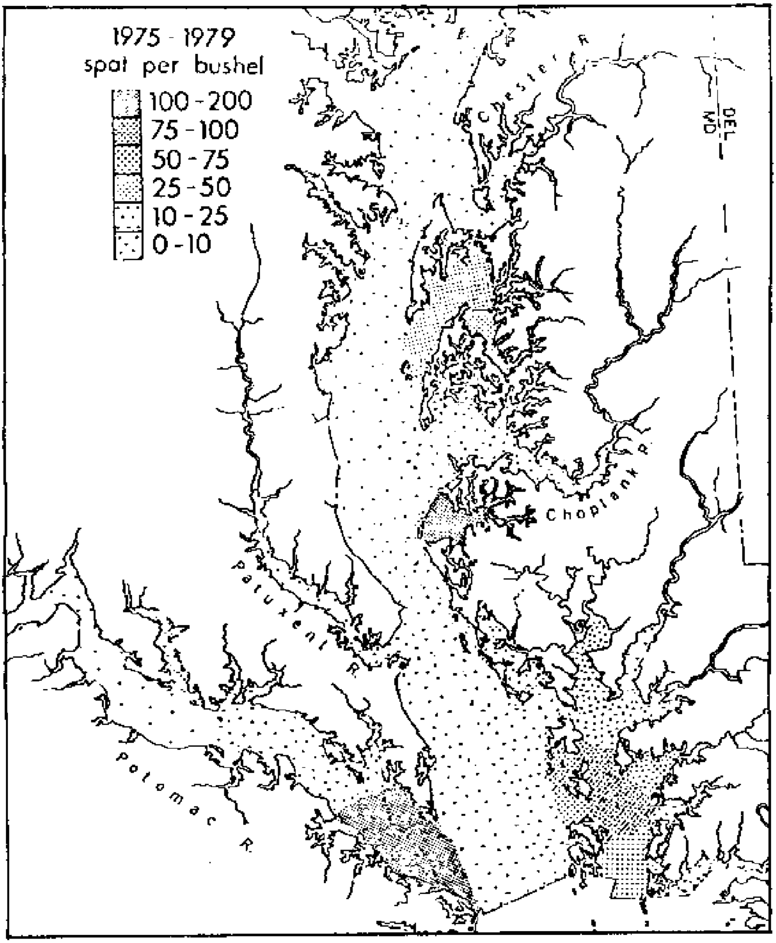


Figure 3: Distribution of oyster spatfall, Maryland portion of the Chesapeake Bay, 1975-1979.

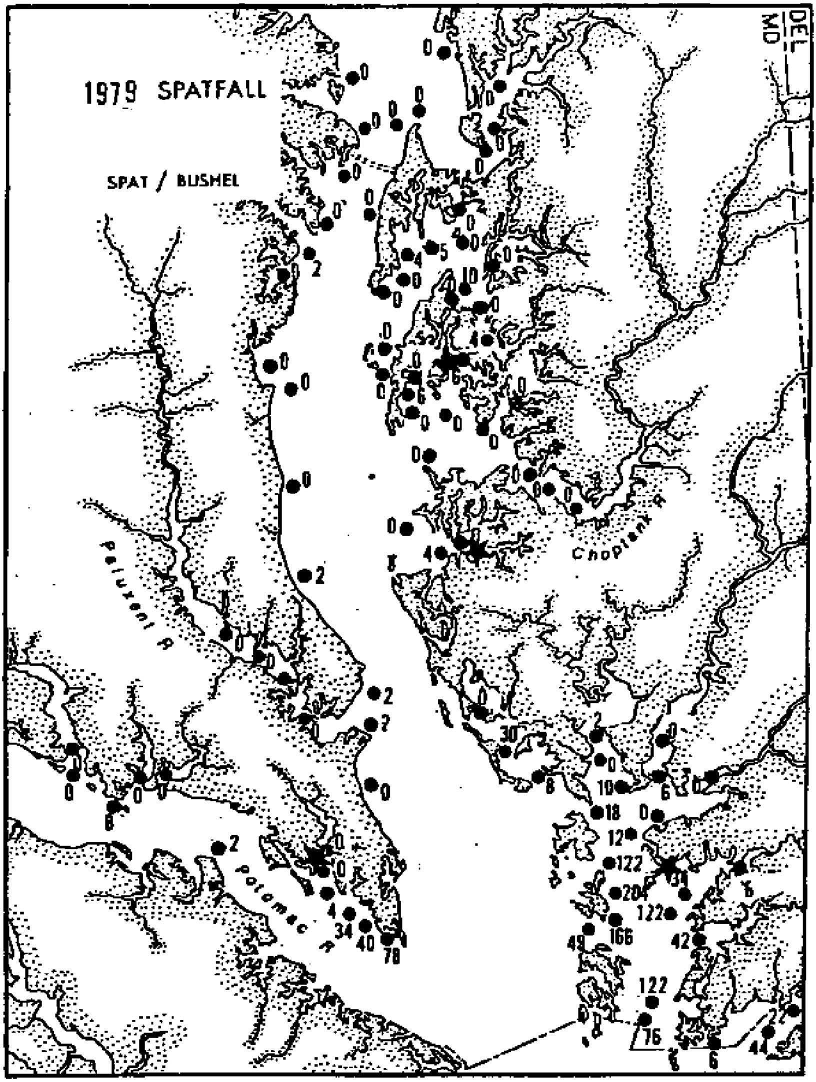


Figure 4: Oyster spatfall on natural bottom, Maryland portion of the Chesapeake Bay, 1979. Numbers indicate spat per Maryland bushel of dredged material. Stars indicate study sites.

Collector	Mean Number of Spat $\bar{X}$	Rank	Broad Creek	Little Choptank	St. Mary's	Deal Island	Chincoteague
Green shell							
Wire	3.9	2	5.6	10.7	2.0	0.8	0.3
Vexar	3.3	3	8.1	4.6	1.3	2.5	0
Dredged shell							
Wire	3.0	4	7.4	5.5	0.3	1.7	0
Vexar	2.9	5	4.5	6.2	1.3	2.0	0.3
Tire chip							
Wire	0.8	6	1.5	2.4	0	0.1	0
Vexar	0.7	7	1.1	1.9	0	0.4	0
Slag	0.6	8	0.1	2.0	0.3	0.8	0
Pine wood	0.1	9	0.3	0	0	0	0.3
Oak wood	0	10	0	0	0	0	0
Concrete collector	8.4	1	13.0	22.3	0.3	6.4	0
Natural shell, bottom	12.1*	1*	6.5	24.0	0	18.0	-

* Data are for one Maryland bushel of shell, a greater surface area and volume than collectors.

Table 1: Summary of spat set density on collecting devices placed at five different sites.

Collector	Mean no. Spat/ 116.14 sq. cm. tank space	Mean Spat Size (mm)	Spat Size Range (mm)	Collector Surface Area (cm^2)
Green shells	361	26.3	8-42	4000+
Dredged shells	505	28.1	12-44	5000+
Tire chips	65	28.9	20-41	2624
Slag	8	13.2	7-20	5000+
Pine wood	0	--	--	4181
Oak wood	0	--	--	4181
Concrete Collector:				
Portland I + Chips	1236	27.8	13-36	1000+
Portland II + Chips	2052	28.8	11-42	1000+
Grout + chips	1100	28.1	15-39	1000+
Portland I	600	28.4	18-44	712.5
Portland II	156	24.4	18-33	712.5
Grout	193	23.4	18-38	712.5
Masonite plate	14*	31.2	18-41	208

* = 1 - 10.2 cm plate

Table 2: Spat set on collectors placed into the same tank with hatchery-reared larvae, 21 August 1979. Measured 20 October 1979.

	Material Cost	Substrate Cost	Labor Cost to Construct	Labor to Fill	Labor to Place	Transport Cost	Total Cost on Bay Bottom	Suspended System	Rope Cost	Raft Cost	Total Cost Suspended	Suspended Spat Cost per 1,000	Bottom Spat Cost per 1,000
Wire bag w/	0.34	-	.35	-	.60	.10	(1.39)	.50	.07	1.12	(3.08)		
Dredged shell		.08		.14			1.61				3.30	13.20	6.44
Green shell		.38		.14			1.91				3.60	14.40	7.64
Tire chip		.04		.20			1.63				3.32	13.28	6.52
Slag		.04		.07			1.50				3.19	12.76	6.00
Vexar bag w/	0.16	-	.07	-	.60	.10	(0.93)	.50	.07	1.12	(2.62)		
Dredged shell		.08		.20			1.21				2.90	11.60	4.84
Green shell		.38		.20			1.51				3.20	12.80	6.04
Tire chip		.04		.25			1.22				2.91	11.64	4.88
Slag		.04		.07			1.04				2.73	10.92	4.16
Wood	1.98	-	1.50	-	.60	.10	4.18	.50	.07	1.12	5.87	5.87	4.18
Wire collector w/	1.58	-	.45	-	.60	.10	(2.73)	.50	.07	1.12	(4.42)		
Concrete		.08					2.81				4.50	4.50	2.81
w/shell chip		.10		-			2.83				4.52	4.52	2.83
Grout		.12		-			2.85				4.54	4.54	2.85
w/shell ship		.14		-			2.87				4.56	4.56	2.87

Table 3: Cost components of spat collection devices and theoretical cost of oyster seed production.

Source	Year	Spat Cost per 1000
Hatchery:		
University of Maryland	1978	1.40- 4.70
Maryland	1976	7.50
California	1978	14.00
Natural; bottom:		
James River, Virginia	1977	3.00
Maryland shell-plants	1976	0.32- 2.00
Maryland shell bags	1979	6.44- 7.64
Concrete collector	1979	2.81- 2.87
Natural; suspended:		
Maryland shell bags	1979	12.76-14.40
Concrete collector	1979	4.50- 4.56

Table 4: Comparative costs for obtaining seed oysters in Maryland.

Improving Survival of Seed Oysters

Clyde L. MacKenzie, Jr.
National Marine Fisheries Service
Northeast Fisheries Center
Sandy Hook, New Jersey

I have been asked to discuss with you the possibilities of increasing the survival of natural and hatchery-reared oysters. We need to recognize that every living species has a biotic or abundance potential which far exceeds its actual abundance. The oyster has an enormous biotic potential since each mature female produces many millions of eggs, growth is relatively rapid, and the survival capacity in the larvae, juveniles, and adults is high. The abundance of each species, including the oyster, is held in check and chiefly governed by its total environment; various physical, chemical and biological factors on beds and commercial harvesting limit oyster populations to their current sizes.

I believe that the most effective strategy for increasing oyster abundance on beds is the primary one that is used in the management of agricultural and wildlife crops: improve their environments by identifying and removing major limiting factors. As we are aware, in agricultural management common practices include: tillage, fertilization, irrigation and pest control, among others. In wildlife management they may include: improving cover for protection from predators, increasing food supplies, controlling erosion and conserving water supplies, among others. These practices improve the environment of the plants or animals being managed, and consequently they increase in abundance and size.

The highly successful program of spreading quantities of shells on setting beds in Maryland is an example of how oyster abundance is being enhanced by improving the environment of the oyster; the spread shells relieve a limiting factors, i.e., a shortage of setting sites for oyster larvae. However, other limiting factors are present in the beds.

The strategy of environmental improvement for the oyster differs from that of increasing the size of the spawning stock, which is sometimes recommended for increasing oyster abundance. I believe that the strategy succeeds as a management practice only when spawning stocks of oysters are extremely low or absent.

Little scientific attention has been focused on the condition of oyster beds as an environment for ready-to-set larvae or for survival of sedentary oysters. Thus, in most beds, factors that limit oyster abundance are scarcely known. To obtain information on this subject, I examined with SCUBA the general condition of many oyster setting beds in Connecticut, New Jersey, Delaware, Maryland, Virginia, Mississippi and Prince Edward Island, Canada, during the late 1960s and early 1970s. Beds were examined in several parts of Maryland. The examinations were made during the setting season of oyster spat, late June-September. I compared the condition of the beds with those in ideal condition for receiving a dense oyster set and tried to identify specific factors that limited oyster setting in each. The condition of the beds for receiving an oyster set ranged from poor to excellent.

In Maryland, I noticed that the bay anemone, a predator of oyster larvae is abundant in most beds: densities ranged from 100-200 anemones/m^2 to about 500 anemones/m^2 in Holland Strait. The anemones occupied much space on the bottom. These observations were later confirmed and elaborated upon at the Horn Point Laboratory, University of Maryland. I rate the bay anemone as a major factor limiting the density of oyster setting in Maryland.

Recently, Horn Point Laboratory, University of Maryland, studied predation by blue crabs and mud crabs on hatchery-reared oyster spat. It was found that cultchless oyster spat, 3-40 mm in diameter and reared in a hatchery, suffered almost total mortality from blue crabs when spread on oyster beds. On the other hand, spat attached to a large piece of cultch, had much smaller mortalities from crabs. The mud crab also preyed on small oyster spat.

Within the oyster industry along the Atlantic coast of North America, large scale control of oyster predators has been achieved only in Long Island Sound. It may be possible to control bay anemones on oyster beds in Maryland with a method used for controlling starfish in Long Island Sound. Granulated quicklime (CaO) spread at rates of 1,500-2,000 pounds per acre kills starfish on oyster beds. Starfish have an unprotected epidermis, which makes them susceptible to quicklime.

In Connecticut, two oyster vessels are used exclusively for starfish control: each has a tank which holds nine tons of quicklime placed amidships on its deck. The vessels find concentrations of starfish with towed mops. Soon after it has been spread, quicklime looks like a light snowfall it dissolves completely in 3-4 days. I believe that quicklime may also control the bay anemone which, like the starfish, has an unprotected epidermis. Anemones need to be controlled at the beginning of setting season for oysters. On the other hand, oysters and other shellfish—as well as crabs, shrimp and fish--are not harmed by quicklime because their live tissues are protected by shells or scales and mucous.

A predator board-net (Figure 1) would probably control crabs on oyster beds. Undoubtedly, control of blue crabs would be undesirable because they have high economic importance, but perhaps at certain times during the year few blue crabs are present on oyster beds. If so, mud crabs could be controlled at those times.

Next comes the important question of implementing technologies on beds to increase oyster abundance. Can quicklime and the board-net be put to use to control predators in Maryland, as have similar technologies in Long Island Sound? To answer that question, I have listed below nine criteria all of which must be met for the adoption of a new technology or method to take place.

1. Relative advantage. Use of the technology must be advantageous over the existing system(s).

Comment: Use of quicklime to control bay anemones and the predator board-net to control crabs would be advantageous, if their use produced a substantial increase in oyster abundance.

2. Compatability. The technology should use about the same procedures that are already used, with no more than a few minor changes; also, the personnel team should remain about the same.
Comment: Granulated quicklime is available in Maryland and can be spread by equipment that is easily constructed and used with vessels and personnel already present. The predator board-net can be easily constructed and used by existing vessels and personnel. Neither technology is difficult to use.

3. Simplicity. People will accept an idea they can understand, and reject one they cannot understand.
Comment: The concept of the use of quicklime and the predator board-net to control predators is easy to understand.

4. Communicability. The description of a technology should be easily put into words, diagrams and photographs.
Comment: The use of quicklime and the predator board-net can be easily described.

5. Divisibility. It should be possible to test the technology on small plots, where testing will not affect shellfish abundance on the principal beds.
Comment: Use of quicklime and the predator board-net can be tested on small demonstration plots.

6. Relative costliness. The implementation of a technology should absorb only a small amount of

the local community's resources: money, equipment, manpower, and time.
Comment: Quicklime and the predator board-net are inexpensive to purchase and apply.

7. Reversibility. The withdrawal from the use of a technology should be easy and without lingering consequences if it does not work on the beds.
Comment: The equipment for spreading the quicklime is simple and inexpensive to construct. Thus, no expensive equipment would be left unusable if the technologies did not work.

8. Failure consequences. A failure in the use of a technology should not injure the oysters on the beds in any substantial way or mean loss of substantial time or money; it should not create a trauma.
Comment: Use of quicklime and the predator board-net would be tested first on small plots; if they did work, they would be used on increasingly larger plots. Thorough testing on small plots would be a safeguard to oysters on the main commercial oyster beds.

9. A taboo. A technology must not represent a taboo symbol in the local community.
Comment: Surveys would have to be conducted to determine whether local people will accept the use of quicklime and predator board-nets on Maryland oyster beds.

The conclusion is that it may be possible to implement the technologies in Maryland.

I will conclude my talk with two recommendations. The first is that regular investigative surveys be made of the oyster beds in Maryland. Whenever I have surveyed oyster beds with SCUBA, I usually observed opportunities to increase shellfish abundance: one or more factors are present that strongly suppress oyster abundance. Most factors appear to be easy to remove, but they cannot be easily identified from the surface of the water.

The second recommendation is that a permanent group or board be formed to review and test any methods--quicklime, the predator board-net and others--that are developed in Maryland or elsewhere, for possible application on beds to increase oyster abundance in Maryland.

Question: Is there any evidence that quicklime interferes with the setting of oysters?

Answer: No, none at all. Quicklime dissolves completely from a shell, and oyster larvae can set on shells as soon as it has dissolved. Years ago, tests conducted at Milford Laboratory, Connecticut, Bureau of Commercial Fisheries, proved this point.

Q. But the effective time for application of quicklime would be when the oyster larvae are in the water, isn't it so?

A. I recommend that quicklime be applied 2 to 3 days before the oyster setting season in Maryland. In other words, if larvae normally begin to set in mid-June, quicklime would be spread in early June.

Q. Were quicklime and Polystream spread with the same equipment in Long Island Sound?

A. Yes, they were spread with the same oyster vessels and about the same deck equipment. However, they are different chemicals. Quicklime is composed of calcium oxide and trace elements, all of which are common in sea water. Polystream is a mixture of chlorinated benzenes and currently cannot be used on shellfish beds.

Q. What would be the purpose of the board-net?

A. The main purpose of the board-net would be to remove crabs from the bottom. The board by itself can be used to remove silt from the bottom. As a matter of fact, I should think that the board could be used profitably in Maryland. Many acres of former oyster beds have become covered by silt, which prevents any attachment of oyster larvae; moreover, setting densities of spat are substantially reduced by thin layers of silt on many additional acres of beds. The silt on shells is another major factor which limits the density of oyster setting on shells.

Q. Wouldn't the board stir up the larvae?

A. Yes, but oyster larvae swim up and down in the water anyway, and the induced currents would not harm them. Again, I would try to remove silt from the beds just before the beginning of the setting period, but I don't think that silt removal during the setting period would harm the larvae.

Q. You said that quicklime was used specifically for starfish. Do you mean starfish and not anemones in Long Island Sound?

A. There are no bay anemones along the coast of Connecticut where most oystering occurs. Quicklime kills animals with an unprotected epidermis. Thus, animals with shells or scales are protected and unharmed by quicklime.

Q. You mentioned the question of taboos. I can see that the predator board-net might be a taboo in Maryland. Probably, it would catch not only mud crabs, but also blue crabs, and thus the blue crab fishermen would be rather upset.

A. Yes, I agree. Perhaps, as I said in my talk, blue crabs may be scarce on the beds during certain seasons. Then, mud crabs could be removed. Also, if any blue crabs were caught, they could be released unharmed at some distance from the oyster bed.

A bay anemone captures an oyster larva.

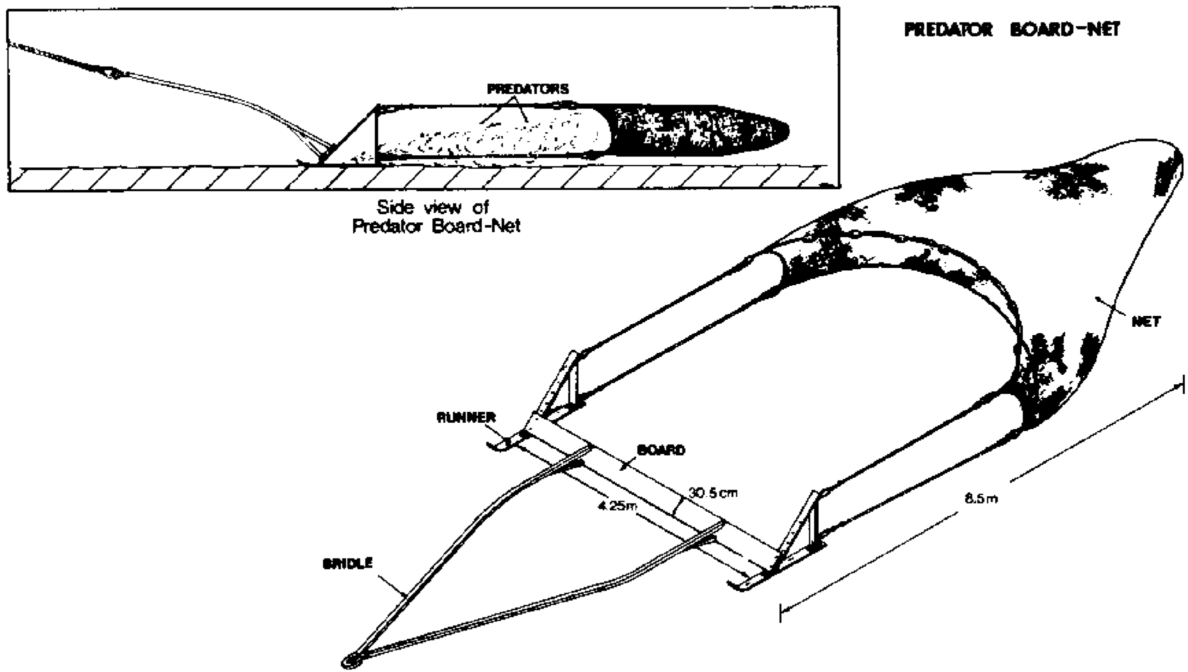


Figure 1: Predator board-net, designed to remove crabs and other predators from shellfish beds.

Sources of Seed Oysters

Dexter S. Haven
Virginia Institute of Marine Science
Gloucester Point, Virginia

The seed supply from the James River in Virginia as of January, 1980 is more than adequate to meet today's lowered demand. This does not mean, however, that this river is as productive today as it was in the past. The James River experienced a major decline in setting beginning in 1960. Since then, setting in the lower half of the seed area has averaged about 10% of its former level. In the upper reaches, the decline has averaged about 50%. Coupled with the lower setting rates, however, there has been a gradual decline in the demand for seed. In 1979, about 380,000 bushels of seed oysters were harvested. In effect, the lowered production of seed from the James is now in equilibrium with the lowered demand.

During the summers of 1978 and 1979 there was an above-average strike over most of the seed rocks in the James. Coupled with lowered demand, this has resulted in an accumulation of seed oysters on many rocks, which helps explain the adequate supply which now exists.

The quality of seed in the James River is high, as shown by surveys during the fall and winter of 1979-80. A survey made by the Virginia Institute of Marine Science showed that there were about 600 to 1,400 oysters per bushel. These numbers include the 1979 year class as well as older oysters. The maximum counts occurred at Wreck Shoal in the middle of the seed area. (Exceptionally low salinities in October 1978 killed almost all of the 1979 set in seed areas such as Deep Water Shoal, Horeshead and Point of Shoals, where salinity is usually lowest. The 1979 spat set survived in higher salinity areas below this zone.)

While the James River presently has high quality seed, the price at mid-season (December and January, 1979-80) was very low ($2.00 to $2.50 per bushel) compared to past years. Watermen currently (May-June, 1980) are receiving about $3.00 per bushel.

Who May Harvest James River Seed

The James River is opened for seed harvest by all residents of Virginia from 1 October to 1 June each year. The length of this season, however, may be modified by the Virginia Marine Resources Commission. There is a graduated tax on seed, which depends on its sale price. For example, the tax on a bushel of seed selling for $2.50 or less is $.10; for $2.51 to $3.50 the tax is $.15. The maximum tax is $.50 for seed selling for $6.51 or more. In recent years, however, most seed has been selling for less than $3.50 per bushel.

Seed From Other Rivers

While the James River is still the largest and most productive seed area on the East coast, other areas in Virginia are producing seed. Areas of leased bottoms located in the Piankatank River and in the Mobjack Bay region are now producing large quantities of high quality seed. Culture of seed by private interests in Virginia is a growing industry and about 124,834 bushels were harvested state-wide in 1979. In the past, large volumes of seed from public bottom came from the Great Wicomico and Piankatank rivers but the public bottom in these two regions is not currently producing seed oysters.

A factor which has helped stimulate seed culture in regions like Mobjack Bay is the absence from the area of the oyster drill Urosalpinx cinerea. This pest was eliminated or greatly reduced in numbers by freshwater associated with tropical storm Agnes in 1972. It is quite probable that oyster drills will return to these areas in a few years and they will again pose a major threat to growing seed.

Bringing Them In: Harvesting

Modernizing the Oyster Industry

Dexter S. Haven
Virginia Institute of Marine Sceince
Gloucester Point, Virginia

Declining state-wide oyster production in Virginia since 1960 has been caused by a combination of the onset of MSX in 1959, adverse economic conditions, and a failure of the industry to adopt modern cost-efficient growing and harvesting techniques. Obviously, remedial action is indicated and is long overdue.

State-wide production in Virginia has declined from about 3.5 million bushels annually in the decade preceding 1960 to about 1.2 million bushels in 1979. A major part of this decline has been due to the absence of production from the approximately 110,000 acres of leased bottoms; production from the state's 243,000 acres of public bottom has actually increased slightly over the past ten years. In 1979, the annual harvest from public Bay bottom was 629,534 bushels and that from leased bottom was 528,443 bushels. Also, 383,443 bushels of seed oysters came from public Bay bottom.

There is a major need to modernize the oyster industry in Chesapeake Bay. In Virginia, for example, oyster tongs, patent tongs and tow dredges are still used to harvest oysters, and oysters are still hand culled. In many instances, seed oysters are still shoveled off barges onto growing bottoms. Such practices are labor-intensive and costly. The adoption of more cost-effective techniques by the private sector and by those involved in the state's repletion program would do much to increase state-wide oyster production. In the private sector, production cost could be lowered and profits increased. Consequently, more oysters could be planted and harvested at less cost. Lower sale prices at the retail level would also stimulate sales.

It is not the purpose of this paper to discuss the pros and cons of mechanical dredges vs. towed dredges or tonging or other similar aspects of mechanism in respect to conservation measures. It is sufficient only to emphasize that legal restrictions as well as socio-economic factors often dictate the continued use of inefficient gear. But more efficient harvesting techniques do exist. Several are being used in other areas, and their use should be investigated. Some of these are discussed below.

Automatic Culling of Seed

A highly efficient gear has been in general use in New Jersey for culling unwanted shell and small oysters from seed dredged from the public rocks in the upper reaches of Delaware Bay. On the deck of the dredge boats are mechanical sorters which cull shell and small oysters back onto the seed rock. Oysters are harvested by dredges in the usual manner and the oysters and shell are dumped into a hopper. From there, shell and oysters are transported by a conveyor belt to an inclined rotating drum constructed of evenly spaced iron bars. As the drum rotates, shells and small oysters fall through the spaces between the bars onto a second conveyor which dumps them back on the seed area. Seed falls into a pile on the deck of the boat. The spacing between the bars determines the size of oysters retained.

Mechanized Seed Oyster Planter

A highly efficient gear has been developed by the B & G Seafood Company at Bowlers Wharf, Virginia for planting seed oysters. It consists of a motorized barge with a movable rubberized belt about 24 inches wide running lengthwise along its center. The deck of the barge slopes gradually from its sides toward the belt. Seed oysters (up to 500 bushels) are stored along the sides of the belt. As the barge cruises slowly over the area to be planted, workers shovel seed onto the belt which moves forward and dumps the seed over the bow of the barge onto a rapidly revolving disk that scatters the oysters evenly over the bottom. All systems on this boat are activated by hydraulic power.

Mechanized Oyster Harvesters

Several mechanical oyster harvesters are based in part on a soft clam harvesting device invented by Fletcher Hanks in 1954 in Maryland. The Hanks soft-clam escalator dredge jets water into the bottom through a series of vertically directed jets just ahead of a box which slides over the bottom on steel runners. A steel blade located slightly behind the jet streams and about 16 inches below the steel runner channels the clams up from the bottom of the box to a moving chain-link conveyor belt which carries them to the surface. This device was modified to harvest oysters by Dr. MacPhail in Canada in 1961. Rubber wheels were substituted for the skids; the blade of the box was relocated so it traveled about 6 inches below the sediment surface. Tests at the Virginia Institute of Marine Science indicate that this design works well if oysters rest on top of a soft bottom. If the bottom is firm or if it contains significant quantities of shell, the blade or scoop encounters so much resistance that the gear's efficiency is greatly reduced.

A second oyster harvester has been developed by the Olympia Oyster Company in Washington. This harvester consists of three units. The first is a large motorized barge with a pilot house, a large air compressor, and a powerful water pump. The second component, which is towed by the barge, is open and supports a harvester head similar to that developed by Fletcher Hanks in 1954. As this head is towed over the bottom, powerful water jets directed horizontally (not vertically as in the Hanks unit) sweep oysters off the bottom into a collecting box where they are transported to the storage barge (third unit) through a tube by the air-lift principle.

A harvester developed in Louisiana about 25 years ago by Mr. Jurish had a long cantilevered chain-link belt conveyor system which was towed over the bottom; the forward half of the conveyor system was suspended over the boat's deck. Located on the conveyor belt were rows of looped galvanized wire rope spaced on the belt about 2 feet apart. As the boat towed the apparatus over the oyster ground, the loops of wire on the moving belt pulled or "whipped" oysters from the bottom, and the belt transported them to the surface. In a series of tests in Louisiana, this harvester worked well. It was, however, never adopted by industry.

Suction-type dredges similar to those used by the U. S. Army Corps of Engineers to remove sediments from harbor bottoms and channels are currently used to harvest both seed and market oysters. Dredges of this type are now being used by Long Island Oyster Farms in Long Island Sound. One of these dredges is a converted Ferry boat 80 feet long with a 30 foot beam. It tows a hooded 12-inch suction pipe on skids and it operates at a discharge rate of about 5,000 gallons per minute. Oysters are simply sucked from the bottom, transported to the surface and emptied into a hopper on the boat's deck. There, mud, sand and unwanted shell material are screened from the oysters. This firm harvests over 75% of its oysters using this gear, and they report harvest rates of up to 1,200 bushels an hour.

On the West Coast there is a suction-type oyster dredge, more complex than the one developed by the Long Island Oyster Company, which has been developed and used commercially. One of these is termed the Bailey Harvester[1]. This gear, like the unit developed by Long Island Oyster Farms, is quite large. It operates on the principle of having large impellers set up water currents under a hood. The hood is suspended just above the bottom from a boat, and as the boat cruises over an oyster bed, water currents lift oysters and shells from the bottom by the current and deposit them on a

[1]R. H. Bailey. 1950. U. S. Patent No. 2,508,087.

moving screen which transports them to the surface. The Bailey Harvester has been used commercially to harvest the Japanese oyster Crassostrea gigas.

VIMS Oyster Harvester

A mechanical oyster harvester was designed and tested by the Virginia Institute of Marine Science from 1972 to 1976. It couples the escalator system of the conventional Maryland soft clam escalator dredge with a newly designed head (Figures 1 and 2)[2]. Two revolving drums equipped with spring-loaded teeth in the head pull or rake oysters from the bottom and powerful horizontal water jets impell oysters and shell onto the chain-link conveyor belt which transports them to the surface.

This design eliminates problems associated with the MacPhail harvester. The rotating teeth loosen the oysters from the bottom prior to their being impacted by the scoop which travels about 5 inches below the skids. Therefore, there is little, if any, resistance to the forward movement of the blade through the substrate. Harvest rates of 500 bushels of oysters and 774 bushels of shell per hour have been achieved. In 1978 a slightly modified copy of the VIMS harvester was constructed by the North Carolina Division of Marine Fisheries. The harvester worked well and harvested up to 500 bushels of oysters per hour[3].

[2]From D. S. Haven, J. P. Whitcomb and Q. C. Davis. 1979. A mechanical escalator harvester for live oysters and shell. Marine Fisheries Review, U. S. Marine Fisheries Service, 41 (12): 17-20.

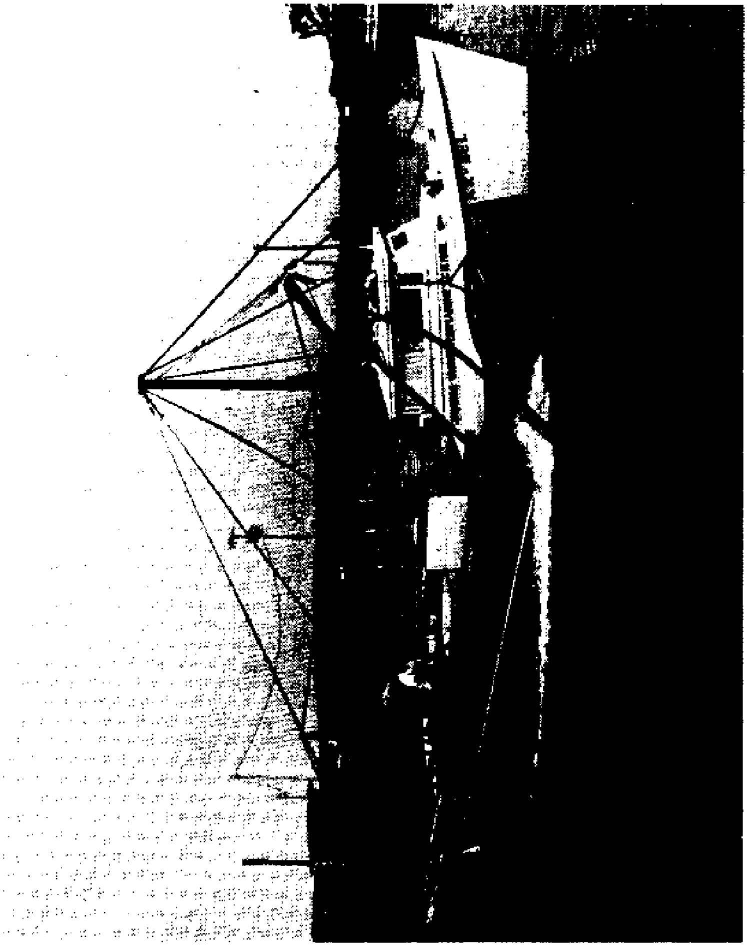
[3]Ibid.

Summary

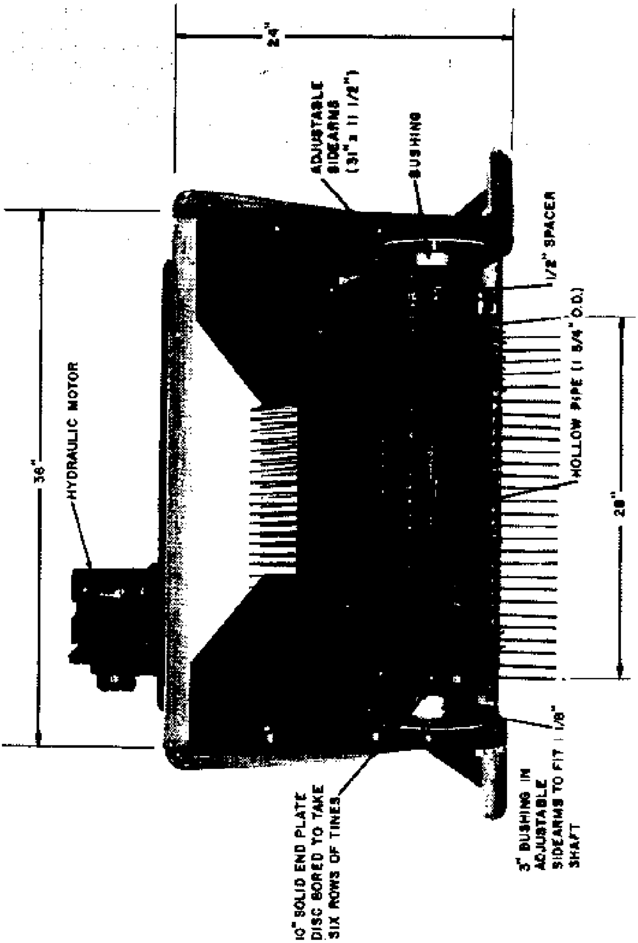
Mechanical gear has been described which if used by either the public or private sectors in culturing oysters would greatly reduce production costs. If production costs could be reduced, monies spent on repletion efforts by state agencies would enable those groups to grow more oysters with little added expense. In the private sector, the unit cost of raising oysters would be reduced, and the final cost to the consumer could be lowered, thereby stimulating sales.

If modern cost-efficient gear is adopted, regulations must be simultaneously enacted which will prevent over exploitation. Harvest rates must be closely monitored and areas closed if necessary. Repletion efforts must be proportional to exploitation rates.

It is recognized that laws and regulations as well as adverse public opinion may impede the introduction of new techniques. Nevertheless, the introduction of cost-effective methods for planting and harvesting would boost Bay-wide oyster production.



VIMS mechanical oyster dredger underway.



Mechanical oyster dredger with steel rake teeth.

Water Quality and the Oyster

A Clean Bill of Health

Mary Jo Garreis
Maryland Department of Health and Mental Hygiene

The Wicomico River is on the Eastern Shore of Maryland separating Wicomico and Somerset Counties. The study of the Wicomico River was initiated because of the restriction placed on oyster harvesting by the Department of Health and Mental Hygiene in the spring of 1978. Water quality did not meet the standards for the National Shellfish Sanitation Program (NSSP). Primarily we were experiencing a fecal coliform count in excess of the fecal coliform standard. The NSSP water quality standard that is used in Maryland is not to exceed a median of 14 fecal coliform MPN/100 ml and 10% of the sample set cannot exceed 43 MPN/100 ml where a 3 tube/3 dilution test is used. This is extremely good water quality —it is a very tight standard and in many cases, we have been accused of trying to grow oysters in drinking water.

After we placed the restrictions on the Wicomico River, we were approached by a number of less-than-satisfied leaseholders who were caught by this restriction with a number of elderly oysters which needed harvesting. Because of the restriction, they could not take their oysters to market. The leaseholders requested that we investigate the problems in the river, so the area could be reopened to harvesting or an alternative solution found.

Our usual alternative, particularly where private leases are involved, is to recommend relaying the oysters to another lease in open waters, where the oysters undergo natural depuration. Once they have cleansed themselves of pollution, the Health Department permits them to be marketed.

In this particular situation, the leaseholders involved maintained they did not have any other leases, as we had restricted them all. Therefore, we had to come up with another solution. One alternative proposal was to float the oysters in the lower Wicomico River, near Tangier Sound, where the waters are of satisfactory quality and traditionally had not been subject to restriction. The oysters would be placed in floats for the purposes of natural cleansing. They would remain in the floats 14 days, the same amount of time involved if we had relayed them to natural bottom. The biggest problem with the proposal was that floating oysters are too easy to steal, although the leaseholders assured us they would provide adequate safeguards.

At the same time, we decided to try to resolve the problem in the Wicomico River, since this is not the first time the river has been restricted. Therefore, we undertook the two projects together.

One question that has bothered me for years about the Wicomico River is the very variable water quality in that area. There are rivers in the state where we experience variable water quality that we can usually relate to rainfall events, pollution sources, etc. In the Wicomico River, it has never been that simple. We were concerned that if we did permit the floating operation in the lower Wicomico, we might not get the results we anticipated. The water quality, particularly in the near-shore shallow areas where people usually like to put their floats, does not have stable bacterial population counts. So before we had huge floats in place with hundreds of bushels of oysters in them, we wanted to make sure the float idea would work. Data collected in 1979 was typical of the fecal coliform levels we see in the Wicomico River (See Table 1). The data from stations 208, 210, 211, and 7 were well in excess of the fecal coliform levels permitted in shellfish growing waters. Even stations 201 and 202 in the unrestricted area showed tremendous variability although the water quality is generally good.

A small cove on the Wicomico River was selected for the first float tests. In the Wicomico River, the shellfish beds are found just below Deep Point and continue into Tangier Sound. When we tested the water quality in the original cove, we found fecal coliform levels exceeding standards for shellfish growing waters. We took a closer look at that cove and went over the adjacent land surface with a fine-toothed comb. The land was mostly uninhabited marsh with a large animal population. We found one small septic system violation and corrected that. We retested assuming we would find good water quality. Again the fecal coliform levels were high (43 MPN/100 ml). We then considered the results might be a function of poor circulation in that cove. We tried another cove closer to Tangier Sound and again had high fecal coliform levels.

Meanwhile, we were maintaining our normal sampling stations in the Wicomico River. We have 17 routine sampling stations in the river which were monitored the whole time we were monitoring these two coves. Except for the elevated levels in the two coves, water quality at all other stations remained normal. We checked the shellstock quality, and it was highly variable. We had shellstock fecal coliform levels ranging from 18 fecal coliform to as high as 7000 MPN/100 ml, with no apparent explanation. We continued to test again in July, August, and September. At the end of that time, we concluded that we might not be working with pollution of public health significance but were measuring background levels of fecal coliform associated with animal populations in the marshes.

To eliminate the possibility that the elevated fecal coliform levels were associated with pollution of public health significance, we began a sanitary survey. A sanitary survey is a property-by-property search for pollution sources. The sanitary survey extended 10 miles up the river to Keroo Wharf and included the drainage basins of all streams. Six violations associated with the improper treatment of domestic sewage were identified. None of the violations had any impact on the shellfish growing area.

Three cattle farms were identified as having an impact on the fecal coliform levels in the Wicomico River. The primary health risk associated with animal farms, particularly cattle, is illness caused by salmonellae or excessive fecal coliform levels in the oysters. The cattle farm located near the upper extremity of the growing area (near Deep Point) was eliminated as a source because of good pasturing and fencing practices. The other two cattle farms were located approximately nine miles upstream of the growing area. These two farms have 146 cattle fenced near the river. The cattle have been observed in the river on a number of occasions. The two herds contribute to the fecal coliform loading in the river but because of the distances involved, the health risk is negligible.

After eliminating the possible pollution sources of health risk, we attempted to identify other sources of fecal coliform. Our attention turned to the small streams entering the growing area. Shiles Creek drains an area of approximately 12 square miles. This small watershed has approximately 20 homes, most of which are located well back from the water. We couldn't find any drainage from any failing septic systems into this marsh. We also went up into the Ellic Bay Wildlife Management area, which is a whole interconnection of small drainage basins with no human habitation. We did some bacteriological monitoring on both Shiles Creek and Ellis Bay.

Little Shiles Creek is almost completely uninhabited. No humans, no farm animals. The Ellis Bay Wildlife Management area has no habitation, not even a hunter, yet there were high fecal coliform counts again in the streams. Ellis Bay itself is also uninhabited.

We began to count animals observed in the marsh--some informal animal inventories. There are astronomical numbers of muskrat, nutria, and deer in the shiles Creek watershed and in the Ellis Bay watershed. The muskrat are so dense that they don't even bother to hide during the day. We came to the conclusion that we have a definite background coliform population in this river.

We also decided to investigate what the Salisbury and Fruitland Sewage Treatment Plants contribute to the Wicomico River. The Department of Health and Mental Hygiene's routine monitoring program indicated good effluent quality for both sewage treatment plants. In addition, travel time from the two discharges to the growing area was approximately 42 days. Based on this information, we decided the primary source of fecal coliform count is associated with wild animal populations and the marsh. Therefore, we decided the fecal coliform do not represent a significant health risk and we have recommended to the Secretary that the restrictions be lifted.

After we established that the fecal coliform represented background levels in the river, we decided to do a little bit more work with floats. Mr. Wilde was kind enough to lend us a couple of his floats to do some experimental work. With the cooperation of Doug Campbell and Harold Davis of the Department of Natural Resources, we went out into Tangier Sound and took a couple bushels of oysters off Middle Ground, put them on our floats and ran our basic first line samples for good background. We went home for the weekend, only to return on Monday to find that someone had stolen our oysters and damaged one of the floats. We abandoned the experiment for the year, because the water temperatures were dropping (it was late September). We will start again in the spring.

We do see the floating of oysters as a viable alternative in areas where we have restricted leases or public bars. The available literature indicates that it is an acceptable method if we can work out the regulatory mechanisms and if we can prevent vandalism or theft.

Question: Animal factors in coliform are okay, but human coliform are not?

Answer: Yes, the primary reason is that the source of greatest public health risk for the transmission of disease is another human being. We are our own greatest infectors. In this type of medium, we are talking about human waste. Probably the second greatest source we run into in this type of situation would be some kind of domestic animal waste, particularly poultry, which is in some way infected, either through the feeding with animal foods or through some contact with humans. Usually the pathogenic organism involved is Salmonella. When you start talking about wild animal populations, populations which have no human contact, they are generally assumed not to carry pathogenic organisms that are readily or easily transmitted to the human populations. In this case, it appears to be mostly a wild population causing a high fecal coliform background level. The sewage treatment plants are far enough removed from the situation, that with good treatment and with a long residency time in the river, we are fairly confident that most of the risk there is removed. It appears that in this situation, the fecal coliform represents the runoff or the background levels in those hugh swamps. It is not only the marshes in the lower Wicomico which contribute, but also the marshes for most of the river's length.

Date/Station	201	202	208	210	211	7
4/11/79	9.1	23	9.1	15	3.6	43
5/10/79	3.6	23	23	43	23	21
6/25/79	23	3.6	7.3	23	9.1	23
7/10/79	9.1	3.6	43	43	43	93
7/17/79	3	3.6	9.1	3.6	9.1	93
7/23/79	3.6	15	9.1	43	21	150
8/27/79	23	23	23	23	23	23
9/24/79	240	93	43	2400+	460	1100
10/2/79	9.1	9.1	23	240	43	93
10/16/79	43	23	43	43	93	43
10/31/79	9.1	23	23	15	15	23
11/5/79	43	23	93	1100	93	240
12/6/79	23	23	93	15	23	93

Table 1: Fecal coliform levels in restricted growing waters, Wicomico River MPN/100 ml.

	Shiles Creek							Ellis Bay Tributaries			
Date/Station	501	502	503	504	505	506	507	508	509	510	511
8/7/79	1100	2400+	240	460							
8/9/79	93	93	240	93							
8/16/79	23	15	3.6	240				2400+	1100	2400+	150
8/14/79	43	43	93	39				93	75	43	9.1
8/23/79	2400+	460	240	2400+				2400+	460	43	460

Ellis Bay, Wicomico River
Fecal Coliform MPN/100 ml

Date/Station	204	205	206
4/11/79	3	9.1	206
5/10/79	3.6	23	93
7/10/79	43	43	93
8/27/79	7.3	43	240
9/24/79	43	93	93
10/2/79	3.6	43	21
10/16/79	43	23	3.6
10/31/79	9.1	9.1	3.6

Table 2: Fecal Coliform levels in Shiles Creek and Ellis Bay.

Oyster Diseases

Janet B. Hammed
Maryland Department of Natural Resources
Marine Animal Disease Investigations
Oxford, Maryland

We thought it would be interesting if you took a little trip with us to our research vessel "Spatmobile."

The Marine Animal Disease Investigation Laboratory is located on the ground of the Department of Commerce's National Marine Fisheries Services Biological Laboratory, Oxford, and we are employed by the Department of Natural Resources, Tidewater Administration. After our samples are collected by the field personnel, they are delivered to the refrigerator at our lab until initial processing.

Our greatest volume of work is with Chesapeake Bay oysters. Soft-shell clams from the Bay are next, and hard clams from the seaside areas are third.

Generally, we examine 25 oysters per bar. Each animal is given a permanently assigned code, scrubbed, measured in centimeters from the hinge to the bill, and macroscopically examined as to whether barnacles, mussels, or drill cases are attached to the shell, or if there are drill holes and a normal amount of periostracum (the outside layer of the shell, which is an organic material secreted by the cells located near the edge of the mantle). Also, any spat found on the oyster shell are counted and the year of their set is recorded. This alone can give a hint to the setting rate in each area examined in the Bay.

The oyster drill has in years past been a common predator in southern Bay waters. It actually drills its way through the oyster by chemical secretion and a mechanical rasping action of the radula which is a band of horny teeth in the drill. Eventually, it penetrates the shell and consumes the meat of small oysters. The drill holes are very apparent because of their perfectly round form. The drill may also deposit egg-cases on the outer shell of the oyster. During the reproductive period, the drill climbs up from the river bottom onto the shells and lays its eggs which are encapsulated in yellowish cases.

Cliona is a boring sponge and may also be fatal to the oyster or clam. It attacks the outside of the shell by secreting a chemical which progressively dissolves the shell, causing it to become brittle. If Cliona penetrates the shell, it appears as tiny black dots on the interior of the shell, and it attacks the mantle tissue or the skin of the oyster.

After the external examination, the animals are then opened, washed in seawater, and examined for abnormalities or predators—such as Cliona or Polydora. Polydora, a worm which builds a purplish "U"-shaped mud tube on the inside of the shell, is a common invader of the oyster. The condition of the meat, which we classify from fat to watery, is recorded as well as any abnormal meat colors or growths. When I say abnormal meat colors, I am referring to pink oysters, green oysters, etc., and as far as growths, we have small growths, maybe a small tumor, or something of this nature, and we record this condition also.

Some signs of poor conditions in the shell are mantle recession, mud or shell blisters, and maladie du pied. Mantle recession may occur when the oyster is diseased or under physiological stress. The result is that the shell stops growing, the mantle recedes, and the shell edge becomes fouled. Recovery is the result of an oyster starting to grow again after it once had mantle recession. This usually means the oyster has rid itself of either the disease or some other stress condition. Shell blisters are found at various times inside the shells of oysters and clams. Irritations or injuries, as well as worms, cause the mud blisters in both oysters and clams.

Maladie du pied occurs at the site of the shell itself. The result of this raised lesion could mean complete muscle detachment or abscess.

Anyone interested in our work is welcome to come down to our lab. We would be more than willing to assist you in any way we can.

This work was supported in part by funds made available by P. L. 88-309; CFR&D Act, subsect. 4(a); U. S. Dept. Commerce, NOAA-NMFS, Grant #NA79FAD MDAB (project #3-310-R-1).

More on Oyster Diseases

Dr. George E. Krantz
Horn Point Environmental Laboratories
Cambridge, Maryland

Sara V. Otto
Maryland Tidewater Administration
Department of Natural Resources

The previous speakers have introduced you to what a special type of research technology can do for you—the oyster grower, state management personnel, and the research scientists working in Chesapeake Bay. We want to share with you some of the detailed observations that have been developed with this technology on the presence and distribution of "Dermo disease" in oysters in the Maryland portion of Chesapeake Bay. As Ms. Otto points out, the scientific community is not really sure whether the "Dermo disease" organism, Dermocystidium marinum or Perkinsus marinum, belongs to the plant kingdom or to the animal kingdom. It is a different form of organism from other Bay life. It is very primitive in structure, and is probably transmitted through the water from one oyster to another, especially those in close proximity.

Historically this oyster disease was geographically located in the southern United States along the Gulf Coast states and in Florida. During the early 1950's, scientists began finding it in various states along the Atlantic Coast. In 1950 it was found in Virginia waters and approximately five years later became a very serious problem. Eighty-five to ninety-five percent of Virginia's oysters that were left on leased bottoms for over three were killed by this organism during the disease outbreak. About the time that scientists at the Virginia Institute of Marine science (VIMS) discovered that "Dermo disease" was involved in these high losses, "MSX disease" entered the Bay and killed the few surviving oysters in Virginia's high salinity waters.

During the initial study of "Dermo disease" in Virginia, investigators from VIMS made a survey of the prevalence of the disease throughout Chesapeake Bay in 1954. They found "Dermo disease" rather widely distributed and in high levels throughout the Virginia portion of the Bay. In the Maryland area, Andrews and Hewitt (1955) found relatively low levels of "Dermo" infection at the mouth of the Potomac River and northward on the western shore of the Patuxent River. In Eastern Shore waters of Maryland, the distribution of "Dermo disease" was not as clearly defined. Some populations of oysters had "Dermo" infection (Pokomoke Sound, Middle Tangier Sound, and Holland Straits), whereas other adjacent populations (Sharkfin Shoal, Lower Tangier Sound) were not found to contain "Dermo disease." The pattern of infection in Chesapeake Bay suggested that the disease was just beginning to invade populations of oysters in Maryland waters.

An excellent synopsis of the dynamics of "Dermo disease" in oysters may be found in a publication of Andrews and Hewitt (1957). Their studies contribute many biological facts that aid in understnding the present status of "Dermo disease" in Maryland oysters. "Dermo disease" proliferates and causes mortality during the warm periods of the year once water temperatures have exceeded 25 degrees C. Infected oysters show a gradual increase in intensity of infection until the oyster dies. There have been very few reported instances of recovery from "Dermo disease." If the infection proliferates to a sub-lethal stage in the oyster by late fall of a given year and water temperatures drop below 10 degrees C., the intensity of the infection declines. Populations of oysters will appear to be free of the pathogen in late winter and spring. Most investigators hypothesize a patent infection stage of the disease during the winter which explains the sudden resurgence of the disease during the summer months. Other investigators suggest that a few heavily infected oysters survive through the winter with an active infection, die early in the spring, and release the motile infective stage of "Dermo disease" to oysters located nearby.

Through the 1960's most researchers studying the Maryland portion of Chesapeake Bay felt that the findings of Andrews and Hewitt in 1954 described the dynamics, prevalence, and distribution of the disease in Chesapeake Bay. That study suggested that "Dermo disease" was usually absent from oysters growing in waters where the mean summer salinity was 15 ppt. or less. To sustain the concept that salinity had limited the distribution of "Dermo" in the Bay, studies by Andrews and Hewitt demonstrated that new infections of the "Dermo" were not produced in low salinity waters and that the development of the disease in infected oysters that were placed in low salinity waters was retarded. A key point in this study was that the disease was not eliminated from infected oysters that were placed in low salinity environments.

In other areas of the United States, "Dermo disease" does not appear to be restricted to salinities above 15 ppt. Mackin (1956) concluded that the etiologic agent of "Dermo disease" had a salinity tolerance very similar to that of its host, the oyster. He found the "Dermo disease" in oysters growing in Louisiana waters with a mean summer salinity of 9 ppt.

In September 1974, Captain O'Berry and the crew of the University of Maryland Center for Environmental and Estuarine Studies R/V Aquarius found an alarming percentage of dead and dying oysters on Clay Island Bar in Fishing Bay. Figure 1 shows the location of this bar in upper Tangier Sound on the Eastern Shore of the Maryland portion of the Chesapeake Bay. Approximately 15 percent of the oysters from this bar were gapers, and over 60 percent of the live oysters were weak and had a watery condition. The place where this sample was taken lies between two stations (Elliotts Island and Sharkfin Shoal) where oysters had been obtained annually since 1963 to document the prevalence of oyster disease in the Maryland portion of the Chesapeake Bay. In previous years, MXS disease (Minchinia nelsoni) was found at epizootic levels at the two test stations, whereas "Dermo disease" had been found only at the Tangier Sound station, Sharkfin

Shoal. MSX had always been the predominant disease in this area, and "Dermo disease" was found to be present only in low intensity infections and rarely associated with moribund oysters. Recent samples, 1969-1971, of these stations suggested that they were free of both "Dermo" and MSX diseases. Laboratory examination of fresh and histologically processed tissues of oysters collected from the sample delivered by Captain O'Berry revealed intense infections of "Dermo disease" in both the gapers and living oysters. This extremely high level of infection prompted the study that we would like to describe.

In October of 1974 oysters populations were systematically sampled adjacent to the site of the Clay Island Bar mortality. The highest prevalence of dying oysters and "Dermo disease" was found on Clay Island Bar (100 percent) and the Clay Island addition (88 percent). As we proceeded upstream in Fishing Bay, the prevalence of "Dermo disease" dropped to 64 percent at Duck Island with no mortality or infection at Goose Creek. Bungay Bay (Elliotts Island) also appeared free of the disease. Sharkfin Shoal in Tangier Sound had a lower level of disease (23.1 percent) than Clay Island, even though it lay immediately adjacent to it. This survey suggested that there may be a decreasing level of infection with the decreasing gradient of salinity in the Fishing Bay system.

To understand more about the course of "Dermo disease" in this area, we took samples of oysters from these bars at periodic intervals during the following year. Our intent was to take advantage of a situation where there was a gradation of infection of "Dermo disease" in a truly susceptible population. We had samples of late epizootic disease conditions (Clay Island Bar, Clay Island Addition), early epizootic condition (Duck Island Addition, Sharkfin Shoal) and early stages of epizootic infection on Goose Creek with an immediately adjacent oyster bar without infection (Bungay Bar).

During the ensuing year (1975), our samples documented the expected pattern of "Dermo disease" as described by Andrews and Hewitt in 1957. Oysters on Clay Island Bar, Clay Island Addition, and Duck Island Addition showed a high prevalence of "Dermo" in September which persisted through

December of 1974, then rapidly declined in prevalence and intensity of infection by March 1975 (Figure 2). The disease remained at low levels throughout the spring and then exploded into an epizootic during the mid-summer (July and August 1975). By September 1975 (Figure 3), "Dermo disease" situation was very similar to that which we observed in October 1974.

The pattern and periodicity of oyster mortality on the heavily infected bars was estimated by examining the samples for the presence of "fresh boxes" or oysters that had recently died and the valves of the shell were not fouled by biological organisms or sediment. During the summer months this fouling occurs in a 1 to 2 weeks period, whereas fouling and sedimentation during winter months is much slower and fresh boxes may be 1-2 months old in the winter. Our studies also included measurements of temperature, salinity of the water on the oyster bars, percentage of living and dead oysters, oyster meat condition and the intensity of "Dermo" infections, the presence of "Dermo" in oyster tissue that was cultured in thioglycolate, and the histopathologic response of oysters to the disease entity.

We found the pattern of oyster mortality on the most heavily infected bars to correspond to the months (July-October) in which Andrews and Hewitt (1955) reported the highest mortality in Virginia oysters (Figure 4). There is an obvious relationship between the periodicity of mortality and the high prevalence of infection in the oyster populations in these bars. As the prevalence of the disease builds up on an enzootic bar such as Goose Creek, mortality is delayed until the second year of infection. On oyster bars where an epizootic has already appeared, such as Sharkfin, winter mortality frequently occurs followed by a heavy spring mortality. Bars that experience a new epizootic such as Clay Island, Clay Island Addition and Duck Island show a typical cyclic phenomenon described by Andrews and Hewitt (1955), in which both the prevalence and mortality are related to one another with disappearance of the disease during the winter months.

One of the most important aspects of "Dermo disease" is the impact of the mortality on the abundance of commercial size oysters on an infected bar. We feel the members of the oyster industry and shellfish management biologists have underestimated the seriousness of "Dermo disease" mortality. Using the technique describing new mortality and the detection of the presence of new boxes in the oyster samples, we were able to reconstruct the pattern of mortality on the oyster bars where "Dermo disease" was detected (Table 1). Our final observations found significant levels (39.6-59.4 percent) of new mortality occurring in adult oysters on the three most severely affected bars. Compilation of mortality in this table is a corrected mortality rate, based on the number of oysters that would have remained on the bar after a disease attack. Therefore, the cumulative percent mortality is based on the mortality of surviving oysters during the study period.

The levels of annual mortality found on the Fishing Bay bars (Figure 4 and Table 1) are very similar to the mortality found in trays of "Dermo"-infected oysters and on planted leased beds in Virginia by Andrews and Hewitt (1957). Farley (1975) found a similar range of mortality (30-55 percent) in oysters on Marumsco Bar that were experiencing an epizootic of MSX disease in 1961-1967. Mortality of oysters in the Fishing Bay areas may have exceeded the mortality produced by MSX, technique and periodicity of our sampling probably underestimated the mortality that occurred beween sample periods. The data in Table 1 suggest that "Dermo disease" is an extremely dangerous oyster pathogen in Maryland waters.

During our studies, the temperature and salinity were measured at each sample period. To determine whether "Dermo disease" was influenced by changes in the salinity regime, we plotted the annual range of salinity and temperature. (Figure 5) The data indicate the period of high "Dermo disease" in Fishing Bay developed under conditions other than those the scientific community considers optimal for the proliferation of this disease. Initial spring infections must have occurred when the salinity regime ranged from 8-12 ppt. Temperature during the expression of these early spring infection ranged from 15-20 degrees C. Records of temperature and salinity at Horn Point Environmental Lab and Chesapeake Biological Lab at Solomons Island showed no major excursions of salinity during this time period and salinity at both of these locations was lower than the average for the past 15 years. The disease did express itself in epizootic form at salinities that were under 15 ppt.

As we observed the "Dermo disease" condition in Fishing Bay, we became uncomfortably aware that there was a major change in the status of this disease in other areas of the Bay. To confirm the high prevalence of "Dermo" in a few samples of the Bay, University of Maryland and Department of Natural Resources oyster management personnel conducted a very careful survey of oyster bars throughout the Maryland portion of the Bay. Sally Otto and her staff (88-309 disease investigation studies) provided the laboratory analyses that were necessary to describe the distribution of "Dermo disease" on a Bay-wide basis. Figure 6 shows the prevalence of "Dermo" on the sample stations distributed over the Maryland portion of Chesapeake Bay for the years 1963-1967. (The top portion of circle representing a given station). In general "Dermo disease" was at a relatively low level and was sporadically found in Tangier Sound and at the mouth of the Potomac River. Our Bay-wide survey for the disease in 1975 (bottom half of the circle on Figure 6) revealed a dramatic increase in the presence of the disease in Tangier Sound and in the Potomac River. The samples located near Cove Point on the western shore suggested that the disease may be moving up the Bay into lower salinity waters.

In the fall of 1976 the survey was repeated and Figure 7 shows a comparison of the change in one year in the prevalence of this disease at several locations. The disease subsided at some stations, probably due to the effect of very high mortality in oyster stocks. It is interesting to note that the disease spread up the Bay to the mouth of the Little Choptank this year. (Figure 7) Oysters at the mouth of the Little Choptank had shown no previous history of "Dermo" infection. Manokin River showed a decrease in the prevalence of the disease but there was no detectable mortality in that area. We noted an increase in the levels of infection in Goose

Creek and Bungay Bar in Fishing Bay. The disease also decreased in prevalence on Clay Island Bar-Sharkfin Shoal where the original epizootic was found in 1974.

I think it is perfectly natural for oyster growers to ask: "What value do I get out of this type of study and what do the data mean to me?" Essentially, we within the scientific community are trying to discover some basic information about diseases and their relationship to oyster populations and oyster growth. Our efforts are to characterize the role of "Dermo disease" in the Maryland portion of the Bay and to make sure that we understand how it comes and goes and what possible impact it could have on your planted oysters. Our studies have made the state shellfish management personnel aware that some consideration should be given to the protection of Maryland's oyster stock from the potential of spreading the "Dermo disease" by planting infected oysters. At present our only weapon to combat natural epizootics such as "Dermo" is to restrict the movement of diseased animals into areas of the Bay where uninfected and susceptible animals are living. If we carefully describe the extent of the diseased area, we can often prevent the continuation of the disease by preventing it from spreading to uninfected oysters. Essentially the idea is to deny the parasite populations a susceptible host population in which to grow.

Through these studies we now know that "Dermo disease" in Maryland is not restricted to salinities above 15 ppt. It will probably express itself wherever it is introduced in Maryland waters. Therefore, we must entertain a very frightening question to which we do not know the answer: "Do seed oysters from 'Dermo' epizootic areas contain "Dermo disease?" At present, neither Sally nor I have been funded to address this question.

If you as an oyster grower have a large acreage of leased bottom in the portion of the Bay where we have found "Dermo disease," it would behoove you to think about the age of your oysters and to check to see if you are experiencing any mortality from "Dermo." If they are experiencing mortality, you are helping to perpetuate the disease and doing nothing but reducing your income by leaving the oysters on the bottom. I would suggest that you do something like Frank Wilde has previously suggested: start thinking about what has happened to your planted seed oysters. Are they living or dying? If they are dying, try to find out what is killing them.

If you need help, don't be afraid to ask for assistance. You can call Ms. Otto most anytime and she will help arrange for people to get a sample of your oysters. Bill Sieling, who helped put on this conference, is your Extension Specialist in the Department of Natural Resources. Don Webster, Marine Advisory Agent, is available to handle your request through Maryland Sea Grant, and I am personally interested in the dynamics of this disease and will respond to your request for help. If we do not give you some assistance, you can resort to calling your local agriculture Extension Service. They have the capability of routing the information back to the proper individuals who will come and help you solve your problems.

It is very important for you as an oyster grower to document the reason for your crop losses. If you have documentation by professional biologists, it will help validate your losses as a tax deduction. I doubt seriously if anyone will challenge survey results as we have described for "Dermo disease" in the Bay; but if you do not have such data and you claim that you lost 10,000 bushels of oysters to "Dermo disease," a representative of the Internal Revenue Service may ask for proof that you really did suffer the loss. Those of us who have presented papers to you on the subject of the disease are quite anxious to help document and describe the problems. This is the only way that we can realistically control and eliminate disease from Maryland oysters.

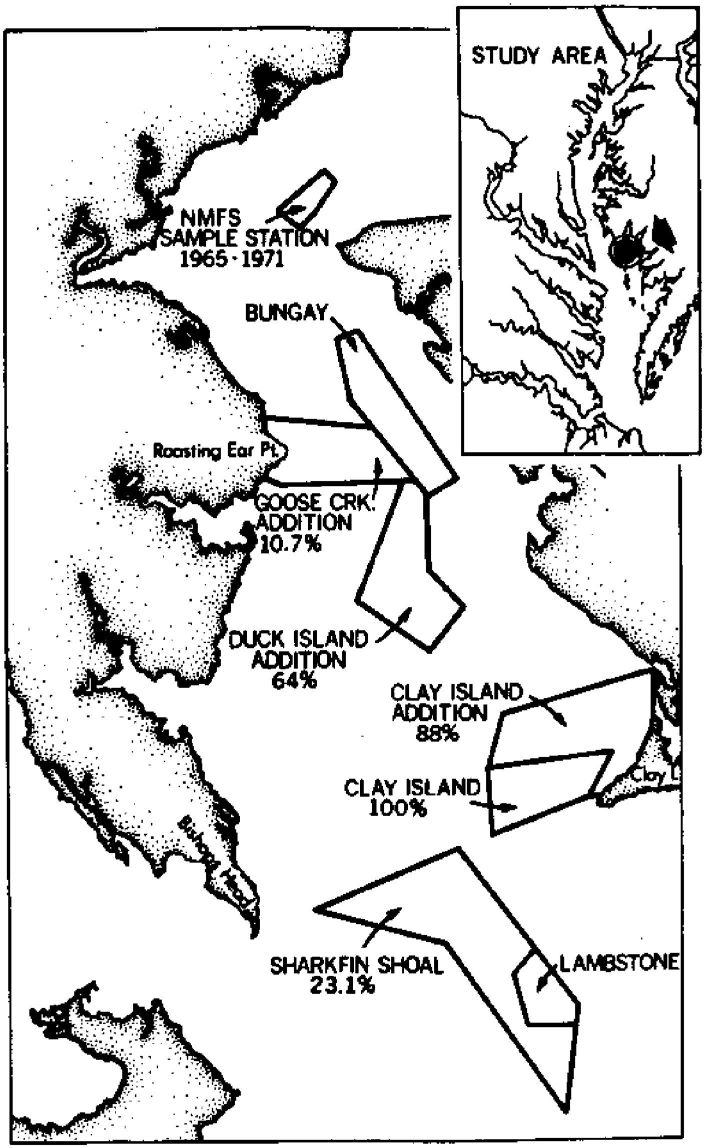


Figure 1: Prevalence of "Dermo disease" in specific oyster populations

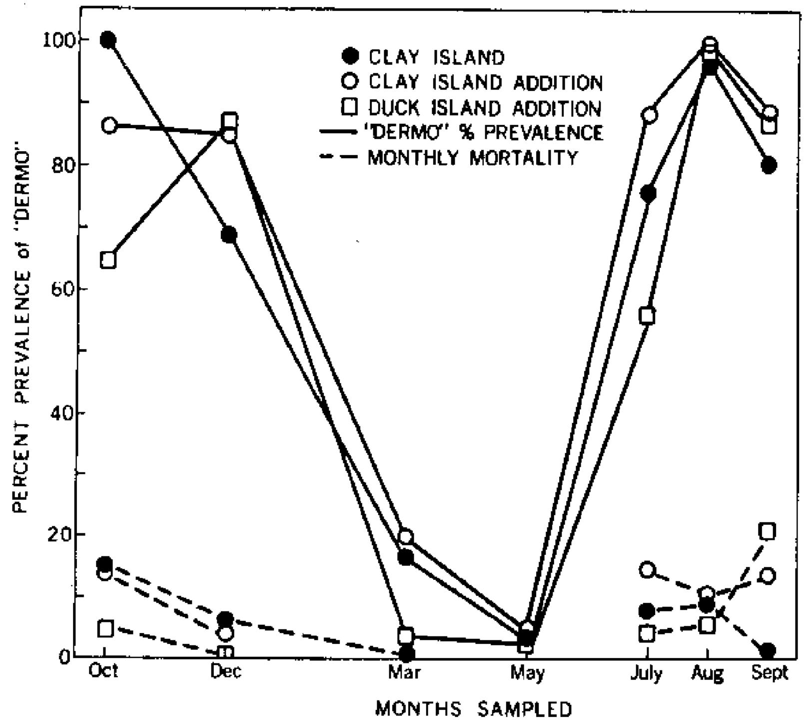


Figure 2: Seasonal prevalence and mortality of "Dermo disease" on selected oyster bars in Fishing Bay during 1974-1975.

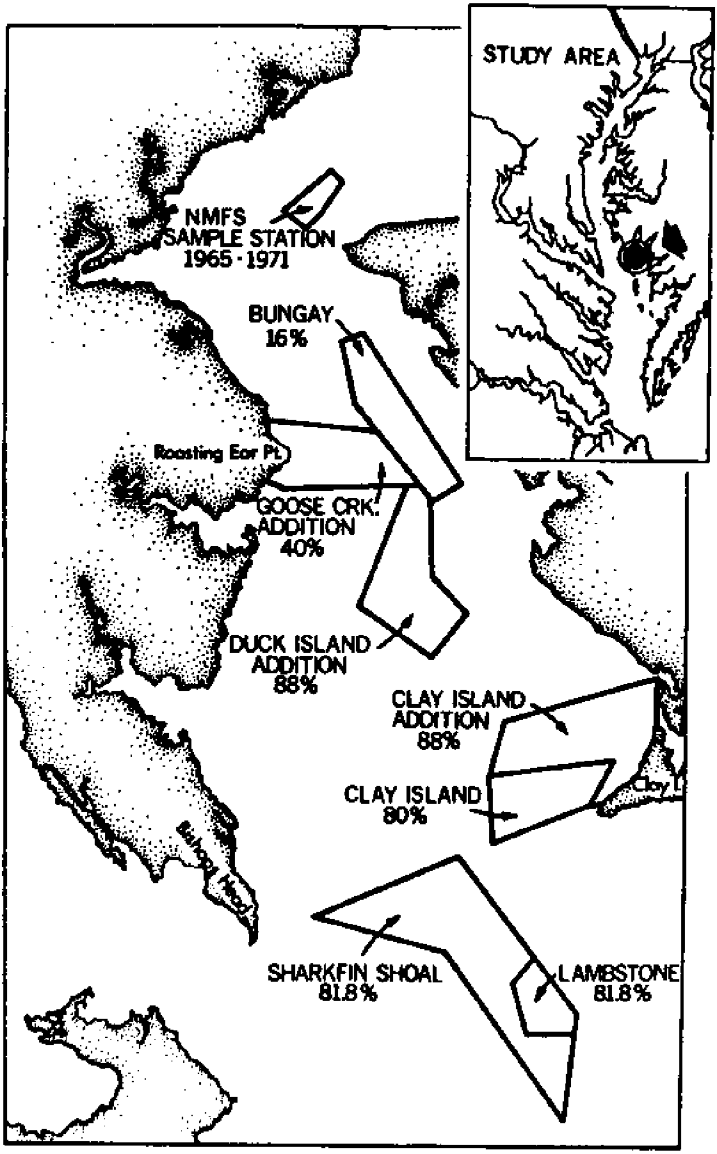


Figure 3: Prevalence of "Dermo disease" in specific oyster populations in the Fishing Bay area in Fall of 1975

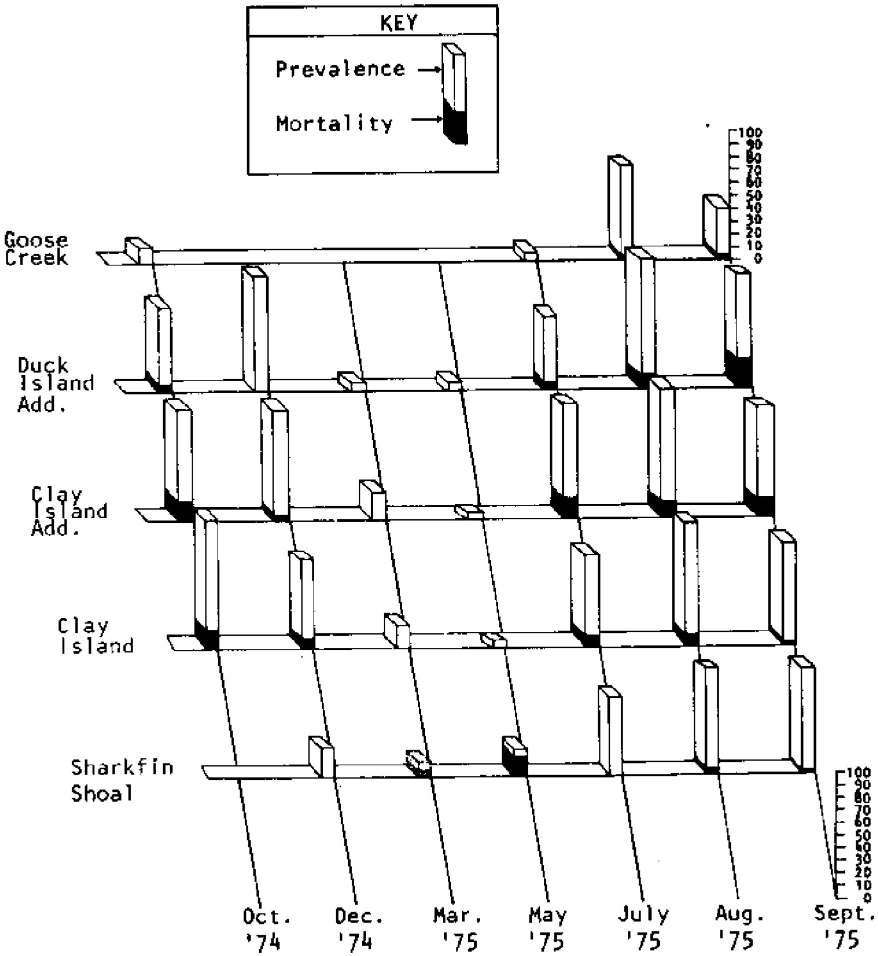


Figure 4: Prevalence of "Dermo disease" and seasonal oyster mortality on specific bars in Fishing Bay. Bars are arranged from higher salinity waters of Tangier Sound (Sharkfin Shoal) at bottom to lower salinity bars at headwaters of Fishing Bay (Goose Creek).

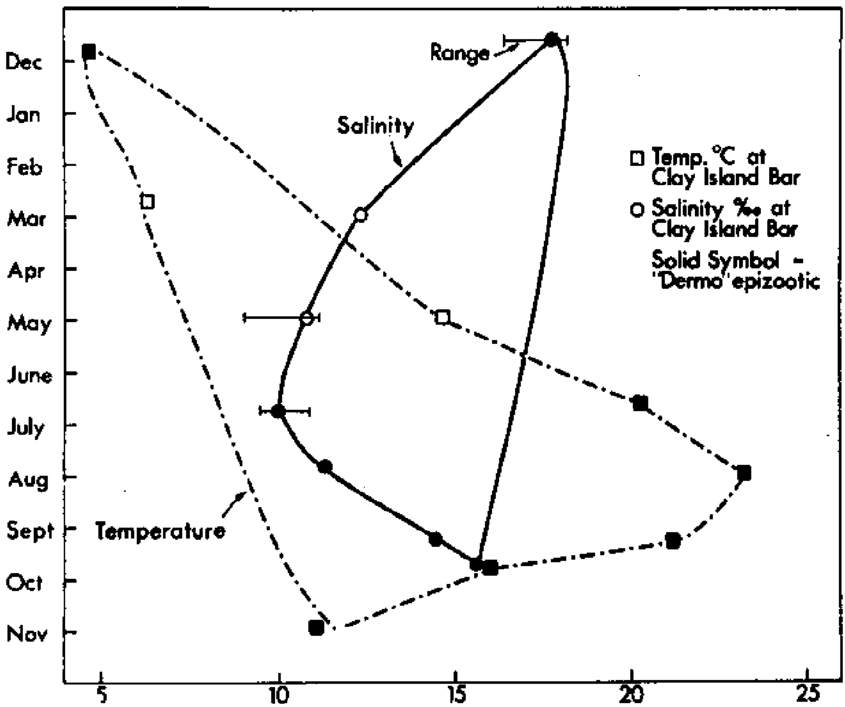


Figure 5: Environmental conditions during 1974-1975 "Dermo disease" epizootic on Clay Island Bar. Solid symbols indicate periods of high disease prevalence.

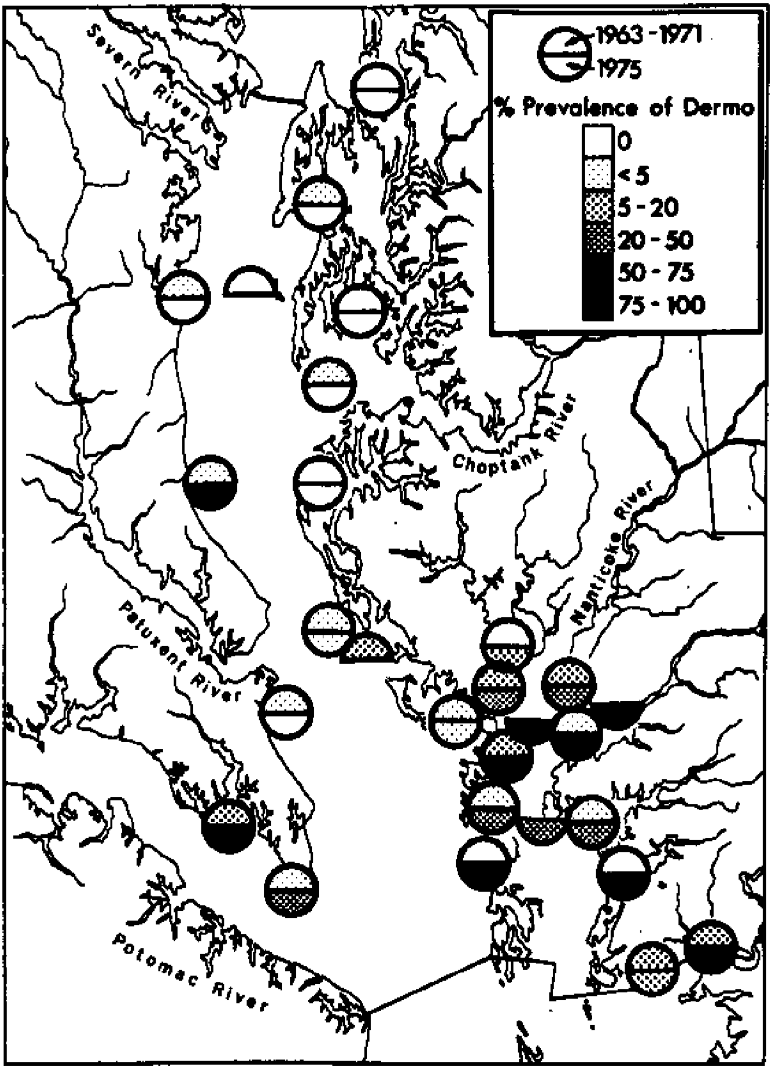


Figure 6: Comparison of changes in prevalence of "Dermo disease" in Maryland waters from the 1963-1971 data base to epizootic conditions found in the fall of 1975.

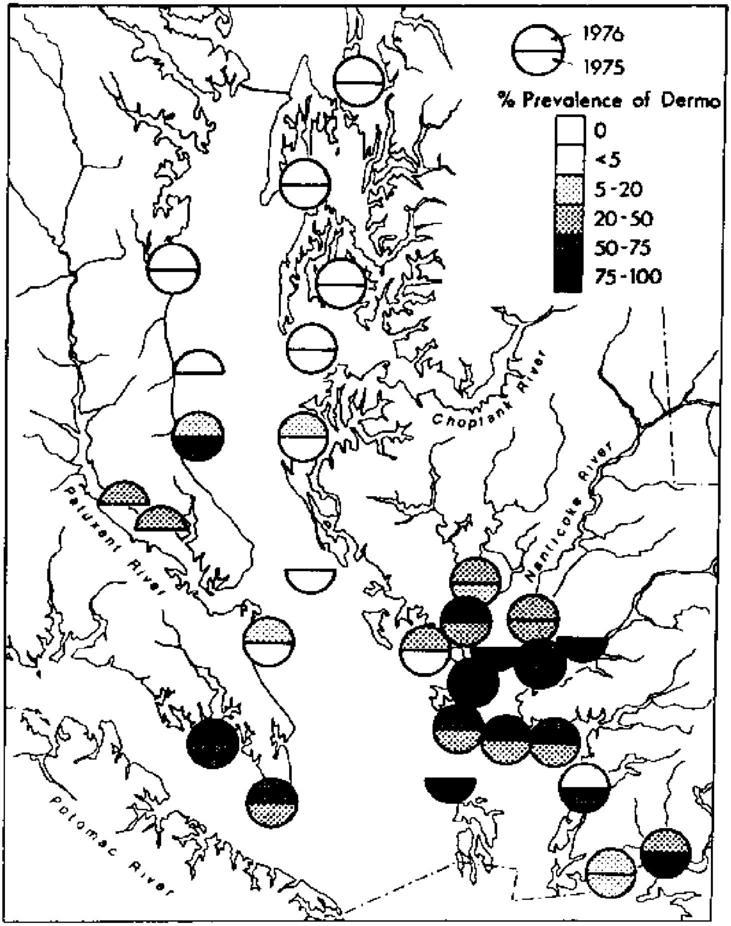


Figure 7: Comparison of changes in the prevalence of "Dermo disease" in Maryland waters of the Chesapeake Bay between 1975-1976.

TABLE 1

FISHING BAY "DERMO" STUDY

CORRECTED NEW MORTALITY OF ADULT OYSTERS AND PERCENT BOXES IN OYSTER BAR SAMPLES (Bottom)

	October 1974	December	March	May	July	August	September 1975	Cumulative Percent Mortality
Goose Creek Addition	$\frac{0}{0.6}$	$\frac{0}{1.0}$	$\frac{0}{2.0}$	$\frac{1.14}{16.1}$	$\frac{0.62}{1.8}$	$\frac{2.06}{3.3}$	$\frac{3.32}{3.5}$	7.14
Duck Island Addition	$\frac{4.65}{8.9}$	$\frac{0.83}{18.1}$	$\frac{0}{14.9}$	$\frac{0}{3.4}$	$\frac{4.8}{7.4}$	$\frac{7.06}{18.2}$	$\frac{22.3}{44.9}$	39.64
Clay Island	$\frac{15.09}{23.9}$	$\frac{5.35}{35.7}$	$\frac{0.49}{16.1}$	$\frac{0.82}{10}$	$\frac{7.52}{30.5}$	$\frac{9.37}{35.9}$	$\frac{2.46}{13.3}$	41.1
Clay Island Addition	$\frac{14.73}{33.3}$	$\frac{4.54}{28.3}$	$\frac{0}{22.5}$	$\frac{0}{34}$	$\frac{15.13}{32.9}$	$\frac{11.48}{38.9}$	$\frac{13.53}{38.5}$	59.41
Sharkfin Shoal	--	$\frac{0}{13.3}$	$\frac{10.5}{15}$	$\frac{13.96}{29.1}$	--	$\frac{3.22}{8.2}$	$\frac{1.81}{18.5}$	29.49

Table 1: Fishing Bay "Dermo disease" study

Processing

Looking Ahead

Mike Paparella
Marine Products Laboratory
Crisfield, Maryland

Whether or not we agree, our food habits are changing and the forms of foods are changing as well. Much of tomorrow's food will be formulated and fabricated, conventional foods displaced in spite of the present popularization of so-called "natural" foods. We will see greater use being made of machines for the fabrication of these new foods. The need to feed a hungry world is greater than the desire to go back to nature.

Our cherished evening meal at home is no longer sacrosanct. Our changing life styles have reduced the importance of this meal in the family and even in our own personal scheme of things. So the emphasis is less on family meals and more on eating out often and snacking. We will look on this as a natural outgrowth of our way of life, i.e., increased population, urbanization, and modernization. Rather than rail against it and wish for the good old days, the better policy will be to utilize these new foods as a means of providing better nutrition and of eliminating malnutrition the best way possible.

For those of us in the seafood industry, new product development may at times be uniquely tied in with the modernization of the industry. Up until recently the concept of mechanization, especially to the more conservative seafood processor, had been to produce by machine that which was commonly produced by hand. The concern was the reduction of the need for direct hand labor--of the oyster shucker or crab picker, for example. The philosophy has been to oppose altering the integrity of the raw material in the transition from hand to machine. Well, we can't have our cake and eat it too.

In mechanization we are confronted with the fact that raw material properties may change. This change may take place in the appearance, texture, color, taste or in some combination of these attributes. But this should not deter us from our objective of producing new foods from the same raw material.

In the development of many oyster shucking machines that came to our attention, the main effort was to substitute for the hand shucking operation a mechanical device which would produce a fresh and unmutilated oyster meat. Proceeding on this concept, the shucking rate of one machine might possibly outpace three or four or even five shuckers.

But what has been gained by automation here, if a processor needs a half dozen high-priced and complicated machines to replace his labor force of twenty or more shuckers? And why go this route just to sell fresh oysters? Processors cannot sell any more fresh oysters than thay are selling now because the marketability of these oysters in limited. Marketing researchers tell us that the industry has reached the "steady state" in selling fresh oysters. It can sell just so many and no more. If, then, we stay with the premise that the seafood processor cannot sell any more fresh oysters than he is selling now, and there is a goodly supply of oysters out there to be harvested, what does he do then? He has to tell the watermen to stop harvesting because the market has all the fresh oysters it wants or can handle.

Up to this point we have assumed that the market place was filled with fresh oysters because the shuckers were available to do it. But remember that this supply of hand labor is dwindling rapidly, and not too far into the future there just won't be enough hand shuckers around to fill half the market. There may be just a handfull of shucker specialists needed for the raw oyster bars around the country.

So now the processor, willingly or not, must face the fact that mechanization of the oyster shucking process must come about. And up to now the most logical way to go has been "steam and shake." This is a time-honored method used by the soup people for many years. The oysters are placed in a retort basket and then into a retort to be steamed at atmospheric or higher pressure for sufficient time to loosen the meat from the shell. The oysters are shaken to release the meats from the gaping shells and the meats are cooled for further processing. It is true that the oyster meat is no longer a fresh oyster as before. It is also true that moisture loss is at least 50%, thus increasing the cost of the oyster at this point. But with the cost of hand shucking and recovery of the oyster liquid during retorting added in, economic factors in the market place may eventually resolve this problem.

Now, this cooked oyster has to be processed further--frozen in blocks for slicing later like a fish portion or packed in a glass jar with a cocktail or marinade sauce or packed in a retort pouch to be pasteurized or sterilized or most anything else that an imaginative processor can think of producing. And we know that the seafood processor is ordinarily a very imaginative fellow, and I say this with all true admiration.

For reasons unknown to many of us this "steam and shake" method has not taken root. A few years ago some industry members asked us this: "Instead of being cooked as they are in the 'steam and shake' method, why could not oysters be marketed as a pasteurized product such as pasteurized crabmeat which has been marketed successfully for the past quarter century?" A good question—which no one has answered until recently.

The Southeast Fisheries Center of the National Marine Fisheries Service (NMFS) in Charleston, South Carolina published information last year on a combination pasteurizing/shucking process for oysters. Single layers of oysters were steamed on trays in a cabinet. The temperature was monitored by using thermocouples inserted into the oyster viscera through tiny holes drilled into the shells. As soon as the average internal temperature of the oysters reached 140 degrees F. (60 degrees C.), the steam was removed and the oysters were cooled with a water spray to 86 degrees F. (30 degrees C.). The heat-treated and gaped oysters were then shucked and packaged in the conventional manner.

Our laboratory has had reservations about this method because after steaming the oysters for gaping and presumably for pasteurizing the meat, they still had to be handled for removing the meat from the shell and for packaging. It appeared to us that the benefits of pasteurization by this method may at times be vitiated. Incidentally, this method claims a 50% increase in shelf-life for the shucked meats. We interpret this to mean an extension from two weeks to three weeks or slightly better.

We have approached the pasteurization method in a different manner. Our concept is to pasteurize oysters to prolong shelf-life, as did the NMFS study, but for a longer period--say up to three months--and still maintain the near-fresh characteristics that NMFS had achieved. We are not trying to duplicate a process equivalent to that of pasteurized crab meat as we know it today.

In the one preliminary experiment at our laboratory last year, Dr. "Win" Duersch took conventionally hand-shucked oyster meats, washed them in a chlorinated cold-water bath, packaged them in a boilable plastic pouch, heat-sealed the pouches, and pasteurized the sealed pouches in a hot water bath to an internal temperature of 150 degrees F. for about four minutes. He cooled them in cold tap water and stored them at 35 degrees F. (2 degrees C.). Monthly samples were drawn for bacteriological and organoleptic analyses. No bacterial growth occurred until the sixth month. Between the sixth and ninth months bacterial growth was progressive, indicating spoilage. We have a sample here for your observation. You will note the appearance of these oysters and judge for yourselves whether or not they look like fresh oysters. Organoleptically, the meats have a slightly firmer texture and the surrounding liquid is "milkier" than that of fresh oysters. However, taste test panelists agreed that they did not taste cooked.

Dr. Duersch plans on continuing work on this project for corroboration and refinement. We feel now that our procedure will result in a considerably improved storage life for shucked oyster meats while simultaneously achieving the same degree of "freshness" as the NMFS method.

This procedure may well be the interim step that industry members have been waiting for, before taking the inevitable next step toward the processed food products of the future.

Shucking by Machine

Robert Prier
Chesapeake Bay Seafood Industries Association

"He was a bold man that first ate an oyster," wrote Jonathan Swift more than 200 years ago. He was also a clever man to figure out how to get at the pesky thing. Inside what looks like nothing more than a muddy rock lies one of the world's greatest delicacies, and getting it out of its crusty dwelling is the first--and most difficult--step toward gustatory delight.

The Indians, it is said, used a large stone to place the oyster on and a smaller one to smash the top shell, much like some sea birds still do. Later they discovered that the heat from fire would cause the shells to gape, making them much easier to pry apart so the delicious meat could be extracted.

In the early days of the industry, it soon became apparent that to catch the oyster was not enough. Something had to be done to it before it could be sold and used by the consuming public: the meat had to be extracted from the shell. Thus some harvesters lay down their tongs and built small structures along the shoreline where the shell oysters could be opened by hand, placed in containers, and shipped to market.

This hand opening was done with a special knife consisting of a short oval handle and a long, slim, steel blade with a point that could be forced between the shells, more or less, at the mouth end of the oyster. Once the blade forced the shells apart it was further inserted to sever one attachment of the muscle which the oyster uses to open and close its shells. The shell from which the first attachment was removed was discarded, leaving one shell with the meat still adhering to it. The second attachment was then severed by the blade and the meat was free of its crusty dwelling. This of course was completely a hand operation, and in general it is still labor intensive.

Over the years many inventors and just plain idea people have labored long and hard, with considerable expenditures, to devise a method to open the oyster other than by hand, yet to date it has proven to be an elusive target.

Some of the problems associated with opening an oyster result from its unpredictable shape. The oyster grows on the bottom of rivers and bays which are made up of sand, silt, oyster shells, stones, clay and other animal life, and therefore grows in a shape that conforms to the particular environment. The oyster may be long and slim, short and broad, twisted, bent, in groups or clusters and in almost any other configuration one could imagine. It may be young and have thin shells, old and have thick shells; the shell may be full of meat indicating a fat, plump oyster or it may be partially full, indicating a poor condition.

Because of this unpredictability, developing a machine that could insert a sharp object at the exact point needed to sever the two muscle attachments, without mutilating the meat, and allowing the meat to be removed intact has proven to be most difficult, so much so, that no machine has been developed and accepted by the industry as an efficient substitute for the skilled hand shucker. There have been several attempts, and to this writer's knowledge there are five mechanical or electrical versions of an oyster opener in various stages of development.

Oyster Shucking Machines

Mr. Sterling Harris was a renowned inventor of machines, some of which are in service today, but the one machine which defied completion before his death a few years ago was his version of an oyster opening machine. The Harris machine worked on the basis of inserting an oyster, hinge end up, in a clamp mounted on a horizontal rotating disc. As the disc rotated it would stop momentarily at various stations for a particular function of the machine. The first step was for loading of the oyster, the second step was for a rotary saw that sawed the hinge of the oyster off, leaving a small opening into the cavity. The third step was the insertion of two flexible knives which severed the two attachments of the muscle by following the interior countours of the shells, allowing the meat to drop through the now opened mouth. This machine has been around a long time, spending years in the research laboratory and short periods in shucking houses, but as yet has not been accepted by the industry as a viable machine, partly because of its complexity and partly because of its selectivity of certain shapes of oyster shells.

Another machine has been developed and experimented with by Dr. Fred Wheaton at the University of Maryland, College Park. This machine uses radiant heat to relax the muscle and gape the shell so that it can be pried off, one shell at a time. After one shell has been removed the oyster is flipped over so the heat can be applied to it in the same manner and then the meat is free to drop into a container. The meat does not seem to be affected by the application of heat, but other problems have kept this machine from being perfected to the satisfaction of the industry.

A third machine being developed is one by Carrie and Lilie Evans of Huntington, New York. This machine also uses radiant heat in its opening process, but again, according to experts from the industry, the heat does not affect the oyster meat and the meat is considered fresh. The Evans machine is targeted to shuck some sixty oysters per minute with eighty percent success. The Evans stress the philosophy that this is an oyster processing system rather than an automatic shucking machine. Those oysters which it fails to shuck are typically already opened and require minimal effort to remove the meat manually. This machine has been experimented with for several years by the Evans and was programmed to come to the Maryland area in 1977, but because of funding and logistical problems, it was cancelled. The machine was then supposed to go to Rhode Island for production tests, but at this writing no news has come from that area, leading one to suspect that all the bugs have not yet been worked out.

Still another machine has been in the works for several years in the Northwest and Canada. Of great interest to Maryland, this machine uses hydraulic force to shear one shell from the other, leaving one shell containing the oyster meat, with one muscle attachment intact. This half-shell style oyster would then be transported to a hand shucking station where the remaining muscle attachment would be severed and the meat deposited in a container. The machine reportedly worked fairly well in the Northwest, but when brought to Maryland for tests the results were less than satisfactory. At this writing the machine is in limbo.

Experimentation with microwaves which would release the muscles from the shell and allow meat to fall out automatically has proven unsuccessful to date.

The only technique used extensively to remove the meat from its shell is the so-called "steam and shake" method, which uses steam heat in a retort to sever the muscle attachment from its shell. But this results in a cooked product that cannot be used as a fresh oyster, therefore requiring processing such as in stews, soups and pies.

There are two methods of oyster processing now being used in several Mid and South Atlantic states that seem to ease the opening process and still result in an acceptable "fresh" oyster product.

Both methods use heat to relax the muscle, thus causing the oyster to gape so that inexperienced shuckers become proficient openers. One method uses steam, the other hot water to accomplish this feat, each used only long enough to relax but not cook the oyster. Although not totally automatic, this method does make it possible to use less experienced personnel.

The National Oceanic and Atmospheric Administration in its experiments has developed a process to steam heat shell oysters so they are almost equivalent to raw oysters in flavor and aroma, perhaps even better in appearance. The oysters are steam-heated to 140 degrees F. while in the shell, then cooled to 86 degrees F. by spraying them with water and then shucked. This agency believes that the oysters are virtually free of microorganisms that cause spoilage, and processing costs are only a little more than for raw oysters. It was demonstrated also that steam pasteurization made it easier to shuck the oysters and increased their shelf life by 50 percent when held at 38 degrees F.

A report done by the Maryland Department of Economic and Community Development entitled "Growth Prospect for the Oyster Industry in Maryland" addresses the hand-shucking problem and the benefits of mechanization as follows: In Maryland, where the number of shuckers is inadequate to process the state's harvest, the real issue is not whether the machine can save money compared to labor costs. This is not to say that cost efficiency is not important. More important, however, is whether the machine can process the volume required at a cost acceptable in the market. In order to calculate the magnitude of the need for shucking machines, it is instructive to look again at the magnitude of the shucker shortage as discussed above. In 1973, the Maryland industry was unable to process almost 13 million pounds of oysters which had been harvested in the state. The cost to the industry of this inability to process the total Maryland harvest has been estimated to have been in excess of 16 million dollars that year alone. Machine processing that quantity of oysters using a machine opening 60 oysters a minute, operating on one shift, would require 168 machines. It is estimated that some of the machines now under development might cost $40,000 a piece, requiring an investment of $6,720,000. This is not an insignificant capital investment. In appraising automated shucking systems and equipment as to their potential economic impact on Maryland's oyster industry, it is important to recognize that the processors are not, at this time, inclined positively toward making large capital investments in their industry. Of the ten industry representatives contacted in the course of this study, only one was contemplating a large investment in oyster processing.

A report by the Maryland Oyster Resource Expansion Task Force concluded that since shucking is seasonal employment, opportunities for year-round jobs are limited. Also, oyster shucking is inherently unpleasant work, shuckers are paid on a piece-rate basis, and opportunities for advancement within the industry are extremely limited. In short, the prospects for enhancing the labor supply in the processing sector appear very limited.

Prospects for the development of an economically feasible shucking machine also fail to be encouraging. Reducing the periods of under-utilization by reducing gaps in supply would help, but our impression is that this in itself would not be sufficient to justify the cost of developing a machine.

This task force concluded and recommended to the Maryland State Legislature ten steps to be taken to improve the Maryland oyster industry. One of those recommendations was that an intensive effort should be made to improve the industry's processing capacity by the use of machines—for example, devices which steam the oyster and shake the meat from the shell. To accomplish this, a program of long-term, low-interest loans should be initiated for Maryland processors who wish to invest in processing machinery.

And, because of a growing demand for ready-to-heat-n-serve products, it would appear reasonable to assume that the presently proven heat method may be the way to proceed.

In a follow-up to this report, we have put together a proposal that would create and fund a study team, made up of engineers, economists and industry people, to set up a demonstration of each of the machines now known, including each process, such as microwave or other heat applications. This team would analyze each machine or process as to engineering, economical and practical use and would study the present raw hand shucking process for comparison.

The results of this study would be published and made available to all interested parties, serving as the foundation for where findings would be explained in detail. It would also establish in one document the state-of-the-art of oyster opening.

Even though great strides have been made in the food processing world, the oyster remains a tightly closed subject.

More on Shucking Machines

William N. Shaw
National Oceanic and Atmospheric Administration

I think I would have retired ten years earlier if I knew the problems involved in trying to fund a project on shucking machines. In Sea Grant's research classifiction, we have an area called Seafood Science and Technology. It covers a number of areas including processing. When I asked Dr. Dave Attaway, Sea Grant monitor and seafood specialist, about the number of projects our office is supporting related to the development of processing machines, he stated, "Very few." In the past, we have supported research on a shark-skinning machine, a squid eviscerator, and have even worked with engineers on trying to line up shrimp in rows so their heads can be cut off. To date, we have not supported research on the development of an oyster shucking machine.

Our office has had conversations with persons connected with the three oyster machines mentioned in the previous talk. We have had correspondence from the late Sterling Harris, and his son would like to bring back interest in the machine. He has written me several letters about funding the further development of the Harris machine. Dr. Fred Wheaton of the University of Maryland has called our office several times about support of his machine, and I have not encouraged him.

We had a formal proposal from Marine Culture Systems, Inc. to demonstrate the Carey Evans machine which was described by Bob Prier. This proposal has a very interesting history which started back in 1975. We received a letter from the New York Sea Grant Program saying there was a fellow out on Long Island who was working on an oyster shucking machine, and was interested in a grant. I went up and saw the machine, and so did others in this room. Our office had an engineer from Delaware and a representative from Long Island Oyster Farm to see and evaluate the machine. The results of the evaluation were favorable enough that our office was willing to support a demonstration, if an oyster company would allow the machine to be placed in their plant. Meanwhile, PDA had been putting a lot of money into the machine —a couple hundred thousand dollars, I believe. A final grant from EDA for $38,000 was made to make the machine ready for demonstration. In 1976, Carrie Evans submitted a proposal to Sea Grant requesting $49,000 for five months to demonstrate this machine. Then came the problem of where to demonstrate it. At first a company in Maryland offered their plant, but that fell through when it turned out it was going to be quite an expense for the plant owner. Costs for installing the machine and supplying the labor and oysters were to be the company's responsibility. Evans eventually found a second company in Connecticut; then I don't know what happened. A year passed and then I understood the Connecticut company didn't want the machine. About one and a half years went by, and last fall I was informed by Carey Evans that a company on Long Island was interested in demonstrating the machine. A formal proposal with the name of the company is now in our office and is being reviewed. Briefly, that is the extent of Sea Grant's involvement in oyster shucking machines.

In the November 15, 1979 Federal Register an announcement appeared called the National Atmospheric and Oceanographic Administration Fisheries Development and Utilization Research and Demonstration Grants and Cooperative Agreements. On one of the pages it states quite clearly that the National Marine Fisheries Service is seeking to support fisheries development activities which will contribute to and support these goals. In general, NMFS will consider the funding activities for, and I quote from one section: "fisheries-specific programs designed to develop a new fishery or expand an existing fishery which has potential for growth. Such programs would describe all the various elements or work tasks in the areas of harvesting, processing, distribution, and marketing which relate to each other and which would be necessary for the development of fisheries." Interpret that to include support for the development of an oyster shucking machine. Again from the Federal Register: "Developing or demonstrating new or existing technologies, including new and more efficient handling, processing and preservation methods." Under this act, it appears that NMFS would consider projects like those related to the development of oyster shucking machines. I don't mean to say that Sea Grant won't support such projects, but my experience, to date, has not been too encouraging.

National Aquaculture Development Plan

William N. Shaw
National Oceanic and Atmospheric Administration

For the past six months, a Task Force containing members from each federal agency involved in aquaculture has been working on the first draft of a National Aquaculture Plan. The Plan will address such areas as:

- the advantages the U. S. has in developing aquaculture
- potential for aquaculture in the U. S.
- current support of aquaculture research and development in the U. S. and internationally
- commercial investment in aquaculture
- current sources of financial programs for aquaculture industries
- barriers to success of aquaculture in the U. S.
- proposed advisory and coordinating activities
- proposed education and information programs
- required financial programs
- annual cost to implement, plan, and conduct programs for the first 5 years
- long-term program needs
- expected benefits of the national program.

A major section of the Plan deals with proposed species development programs. In this section, there will be plans for 12 species: baitfish, catfish, clam, crawfish, largemouth bass, mussel, oyster, freshwater prawn, marine shrimp, salmon, striped bass, and trout. Plans include approaches to resolving the problems confronting commercial development of these species—programs of research, development, and funding. The National Plan is actually the first interaction of what will be a continuing process of updating and expanding the original plan document. The uniqueness of this plan, over all others previously prepared for aquaculture, is that it is a joint federal plan, not one written by a single federal agency.

This past September, the preliminary draft was reviewed at a workshop held in Washington, D. C. by some 200 members of the aquaculture community, including representatives from industry, academia, state and federal agencies, and congressional staffers. As a result of this workshop, the plan has been redrafted and is out for review by the aquaculture community. In essence, the Federal Government is a step ahead of the pending legislation which will call for a National Aquaculture Plan. If a bill is passed this year, the first draft of the Plan will have already been completed, thus giving us plenty of time to refine it.

Marketing

The Maryland Oyster

Carl Hooker
Giant Food

We at Giant Food feel that you are doing everything you can to support the sale of Maryland oysters. The Maryland oyster, is, in our opinion, the best oyster we can have in the trading area, and we will do everything we can to promote the sale of it. Continue promotions, cooperate with Gordon Hallock, cooperate with the industry, and we will get even further.

I came down here to compliment you and tell you how interested we are in what you are trying to do. We are willing to cooperate with whatever phase of industry you are in. We have no argument with packing, producing, distribution or pricing. We don't have any problem with industry at all. If I have any recomendation, it is for you to get the customer to try the oysters the first time, because once he has tried them, he will come back for more.

If the government, the trade association, the producers, and all the people interested in this business give every effort to promoting the sale of oysters, then when it gets down to us we have no problems. Pricing of oysters is high, but we are keeping in line with everything else.

I compliment you, encourage your efforts and wish you a lot of luck. You, as retailers, may have questions for me.

Question: Do you ever find there are times demand exceeds supply at your retail level?

Answer: Yes, but it is not an ongoing thing. If the production line says production is heavy, then we will do everything possible to move it. But I am not aware of anything extreme.

Q. What quality control is done on the retail packaging?

A. We do quality control on a continuing basis, rather than on every shipment or every week. We have not experienced, except very occasionally, the problem of excess free liquid, but as far as any quality problems, or account problems, we have not experienced anything significant.

Q. If you have a significant increase in your supply, and you volume of sales increased, would the return on the food-dollar increase or stay the same for you?

A. There would be a dollar return to us and a dollar return to you. I think it would probably be the same thing. If there is an excessive amount of supply, it is normal for the price to be reflected in that. There are only two types of customer resistance, if any. The biggest resistance is the customer who has never tried an oyster and the second is a high price. I don't care if you are selling oysters or rockfish--when the price goes down, it will move on the demand curve. We will take advantage of every opportunity that comes along to promote that product, so we know that Maryland oysters are a very high quality, very desirable item in our trading area. And we appreciate any opportunity to encourage a customer to buy them. When you promote and sell and item you will have a pretty good and pretty long residual effect of that sale. So when a customer buys an oysters this week, there is a good chance you are going to sell the next week and the week after.

Q. So you are saying that in order to sell an increasing supply of oysters the industry as a whole would have to increase?

A. We would appreciate any marketing efforts you could make, but we take it upon ourselves to do it without any gain from you. If we decide we are paying X amount of dollars for a fine oyster today, and we want to promote it tomorrow, we will price it at the wholesale point to stay the same. We will take a loss. But at the same time, any lowering of cost is reflected in the amount of products you do sell, regardless of which product.

Q. How does the cost of frozen oysters compare to the cost of fresh oysters?

A. I have to admit I do not have an answer to that question. We do not sell frozen oysters and we don't like frozen oysters, mainly because the customer does not like them. The customer makes the decision as to whether we should sell a product or not. The gentleman from Red Lobster Inn may be able to answer that question.

Q. What about something frozen like Oysters Rockefeller on the half shell in the supermarket? If you were able to sell a product like that, what would be the difference in the cost of keeping it on the shelf?

A. The cost in the supermarket--the cost of every liner foot --is necessary to move so many dollars in every linear foot based on an average (not to say that any one particular spot has to keep up with the next spot). You have to have a certain return to make stocking a product worth your while. Now I can say again, we don't make those decisions, the customer makes them for us. We present the product, and we have presented the product you are talking about, several years ago and in more recent years, and the customer did not want it. If they don't want it, we cannot warrant the space to handle it. Although I am sure the product is good, it appears our supermarket is not the area in which to sell it. We sell so many fresh products that when given the choice, the customer would rather buy fresh than frozen. Some believe that the time to develop a market for frozen oysters is when the fresh oysters are not available. But that doesn't work--at least not in the supermarket--because by the time fresh oysters are no longer available, the customers think, "It isn't the time of the year for oysters," and they just won't buy them.

Q. Do you request sell-by-dates on your products?
A. Yes we do, and we stick with them.

Q. In Easton, I notice that the grocery stores don't like to give oysters much visibility. Meats and chickens are well displayed with lots of signs, and off in a dismal corner are the oysters. Why do the grocery stores do this?
A. Anyone familiar with Giant Foods knows we give oysters very great visibility. We have a separate seafood department in all of our stores. The problem that you have in your area, as well as in other areas, is the seafood department is part of the meat, deli or other department. Unfortunately, the seafood takes a back seat to the meat in that case.

Q. What role do imports play in the sale of oysters?
A. I don't think with any significant role at all. We have tried oysters from all over, and we feel the most desirable oysters comes from right here.

Q. Would you give shucked oysters the same type of advertising you give other seafood products?
A. Yes, we do. We give the same type of exposure in every phase of display, merchandising, sales promotions, advertisements, recipies--we give them the full run. They are very valuable for us. We are a Maryland-based corporation and feel very much aligned with the whole Maryland seafood industry.

Q. Have you examined methods of packing--size of container, appearance in container?
A. Yes. You see many stores advertising 8 oz. cans of oysters. Now what anybody is going to do with eight ounces of oysters I don't know. Another thing too--to quote an old saying--there is nothing in this world that looks more like a bottle of whiskey in a brown bag than a bottle of

whiskey in a brown paper bag. Now, you have never heard of a customer coming in and asking for a bag of oysters or half-a-can of oysters. A lady comes in the store and says she wants a pint of oysters. Our experience has been that packing in glass--quarts and pints--has been our greatest success with oysters. A can of oysters just does not fit with what it is supposed to be. A carton of eggs is supposed to look like a carton of eggs. I think that the most salient point to conclude with is that Giant Food is trying to do everything it can for this industry.

Your biggest problem is getting the supermarket operator, or the cornerstone operator—whoever you may be dealing with--to put the product on display in a fashion that is going to make it sell. Perhaps you need someone to make some sort of educational effort at the level with the supermarkets that are dealing with this is less-than-the-best way. You won't have that kind of problem with us.

Gordon Hallock: Thank you Carl. A few comments on what you said. In the beginning you talked about "free" liquor in oysters—it's not free, though a lot of people call it water. I have run across this a number of times through the years. I don't know what we can do about it.

Another thing that was mentioned was education. I don't know what we can do about educating people to eat oysters again. In my little shop some of the things we are doing are getting information into the school system to a degree; with films, talking about the oysters industry--hoping the children will go home and talk to their mothers and fathers and get them to buy oysters for the children.

Another thing that Carl talked about was the change he saw in the oysters in glass jars. This is one step in the right direction, so that people can get a better look at what they are buying. It is something we may all want to think about. If we sell the product the way we did 50 years ago, maybe the product will develop. We have been working with the laboratory in Crisfield—Mike Paparella and the other fellows there

—they have been a lot of help to us. We don't have any great inroads yet in product development. What we think we are looking for is something that a housewife could buy in frozen form, take home, and put in the freezer. When she is ready for it she removes it from her freezer, puts it in her oven, and goes off and does her chores. How far away from this we are I don't know. But this might be a step in the right direction. However, since Christmas Eve I received several phone calls from different packers in Maryland saying they were long on oysters. This happens to us every year about this time, especially if the weather is good. What we intended to do with the Midwest is educate these people that oysters can be eaten up until the end of March and in other forms, rather than just in oyster stew and stuffing for turkey. We saw some inroads—but nothing to brag about, but it all helps a bit. Carl and Giant Foods have always helped us when we have called them, and they have done a good job with what we have asked.

View from a Restaurant

Kress Muenzmay
Red Lobster Inn of America
(Seafood Restaurant)

Red Lobster is a relatively young seafood speciality restaurant company. We opened our first restaurant in Lakeland, Florida just twelve short years ago. Today, we operate over 260 company-owned restaurants in 32 states. We purchase, prepare, and serve in excess of 35 million pounds of seafood a year.

We are committed to the seafood industry. Our trademark, which has become a familiar landmark to millions of Americans, is a Maine lobster. We support the oyster industry by advertising "raw oysters" on many of the outdoor signs in front of each restaurant.

The majority of seafood that we serve at Red Lobster is fresh frozen. In areas where we can obtain high quality fresh seafood, we offer a "catch of the day" menu entree. Unlike most restaurant chains, Red Lobster does not have a standard menu. We use nearly eighty different menus nationwide because of our fresh "catch of the day" items and because people's tastes for seafood vary from region to region. You will be happy to know the preference for raw oysters is not regional. We offer oysters on the half shell in each of our 260 restaurants.

The major challenges we face in the seafood industry are market share and perceived value. Seafood is a protein source which must compete with other protein sources for its share of the market. It competes with such direct adversaries as beef, pork, and poultry. In the United States, we eat 156 pounds of beef, 65 pounds of pork, 51 pounds of chicken, and only 13 pounds of seafood per year. This could be termed an uphill marketing battle.

At Red Lobster we think seafood has the capability of making headway in this challenge. Americans are becoming more health conscious and responding to the nutritional benefits of seafood. We know we can control the quality to make seafood as delicious as possible, but we still must offer value to the consumer for seafood to increase its market share.

In recent years seafood prices rose so fast that many items are no longer considered values for the price. Red Lobster has always accepted the challenge of creating value. After all, it is the value that attracts guests. We must continually strive to be more efficient, better planners, and pursue the avenue of aquaculture to control prices.

We are optimistic about the future of seafood and plan to participate for a long time to come. Our committment is demonstrated in our 260 restaurants which represent an investment in excess of 200 million dollars. I think we can easily relate the challenge of creating a value for seafood in general to that of creating a value for oysters.

Red Lobster consumes in excess of 100,000 gallons of fresh frozen oysters per year. The packaging is specifically designed to quick freeze and to thaw quickly which minimizes damage to the oyster. In addition to the fresh frozen oysters, we consume about two cases per week per restaurant of fresh shell oysters. We find the biggest challenge in dealing with fresh oysters is in the distribution.

Many of you have related your feeling concerning fresh versus frozen oysters. I would simply say that the phenomenal growth in seafood in the United States has been related to the contribution of food service in utilizing fresh frozen seafood. I think future growth is dependent on our ability to advance technology in freezing and packaging and to educate the consumer that fresh frozen is as good as fresh.

In closing, I would like to leave you with this thought—seafood is never fresher than the moment it is caught. Preserve that freshness and be cost effective so we can present your products as a value to our guests, and we will be meeting part of the challenge of the '80s.

Conclusion: Leased Bottom And the Oyster Fishery

Leased Bottom and the Maryland Oyster Fishery

Mr. William Peter Jensen
Tidal Fisheries Division
Department of Natural Resources
Tidewater Administration

My subject today has to do with the laws of human beings as opposed to what we would call the laws of nature or the whims of nature and why these critters do or don't produce or reproduce and why they aren't there when we want them. We live in a world of change, and I think that everything that has been said today indicates what a lot of those changes are. If, in fact, the world we live in isn't physically changing, at least many of those things we are learning are changing our perspective of the world in which we live.

I keep a book by my desk for ready reference to keep a sense of balance when the frustrations of seemingly intractable problems occur on a daily basis. I keep it there just to remind me that many have preceded us and to keep me from trying to reinvent the wheel.

Since we are dealing with the laws of human beings, we sometimes have to remember where we came from. Even before the United States was here, and before England held domination, there were laws in effect that said wildlife was to belong to no one until it was reduced to possession. Then during the time we were under the jurisdiction of England, the King had the right to grant the franchise to harvest wild game and then through the evolution of time, of course, state and federal laws govern what we do. A free fishery franchise as it was called in England now takes the form of a license--or a lease—and the lease is what I am going to talk about today.

In the 13th century the granting of free fishing franchises, as they were known at that time, so impeded the navigation in England's waters that in 1215 the Magna Carta directed removal of all fish weirs throughout all of England. I don't know if we are coming to that in the crab-pot situation, but I think there are some examples of that happening before. In fact, one of the first cases heard by the Supreme Court in the United States was a Maryland case that challenged the right to harvest oysters in the public domain with a scoop or dredge. The law has evolved considerably, and in that case state ownership was upheld and the state had the right to control the harvesting of oysters. One other instance that impressed me in the history books is that statehood for Alaska hinged on the issue of fish pots. The sentiment was so strong in Alaska when the vote for statehood was taken that the issue of fish pots swung it in the favor of statehood—because they didn't like what the then provincial government was doing to regulate fish pots. Fisheries issues have had a strong impact on the way we have developed our laws in this country.

On a personal note, before I get into the issue of leasing, I would also like to add that sometime ago in my career as a public official, I became quite impressed with an incident where the uncertainty of what government does really raises havoc in the private community. Viewed from the businessman's perspective—and this is where I got a hard lesson—and the waterman's perspective, what the government does greatly impacts your activities. If there is any uncertainty as to what the government is doing to do, then you are forced to act in your own interest. If you are forced to act in your own interest, then we don't always have a comprehensive program. So I adopted, as a personal style, an attitude that we must address the issues frankly, squarely, and although we won't always agree, at least the issue will be on the table. And there is a popular saying about the man who was sent out into the swamp to drain it, came out very shortly and was asked why he didn't do the job, and he said, "Well, when you are up to your armpits in alligators, it is difficult to remember what your original purpose was." Well, everytime I mention leasing I feel like I am already up to my armpits in alligators, because I know what is going to happen. Use of the Bay bottom is probably one of the most controversial issues facing the Department of Natural Resources, and in most of the discussion in which I have so far participated there is instant polarization if there is an opponent and a proponent. There is no middle ground it seems in this argument. It doesn't have to be that way, and I hope we can move off of that polarization.

The leasing of the Bay bottom has been on the books for a long time and some of the people today have cited some of the figures, but I want to go through some of them again just to get us on the right track. There are over 9,000 acres of Bay bottom leased. There are 651 leaseholders, and they hold over a thousand separate leases. So in fact the state does have a leasing program. This program has been authorized, and the Department has interpreted the intent of the annotated code which governs this leasing program. When the Department leases land for the cultivation of oysters, even though there is a reference in one of the statutes to other shellfish, in practice we do it only for the practice of cultivating oysters.

Leasing, of course, is not an issue in isolation. Total acreage of Bay bottom is estimated to be over a million and a half acres and it is only one of many possible uses. Those who want to use the Bay bottom for cultivating oysters really are competing with other uses. Let me run through some quick arithmetic:

- natural oyster bars, over 270,000 acres reserved for public use.
- crab bottom, over 40,000 acres
- clam bottom, 6,000 acres
- military restricted areas, 43,000 acres
- greater than 30 feet in depth, 300,000, (generally not suitable for or available for oyster propa-

gation)
- leased, 9,000 acres
- off limits, 479,000 acres in six counties that under the law cannot be leased according to the Annotated Code of Maryland
- and, 85,000 acres in creeks, inlets, along the shoreline and adjacent to other classified bars.

Where do all these numbers leave us? Well, if you take them in the straightforward manner that they are given, that leaves approximately 175,000 acres out there in the Bay as barren bottom, available under the Annotated Code of Maryland for leasing. Not, it has been argued, and rightly so, that all of this 175,000 acres is suitable for oyster cultivation. Probably a more accurate estimate would be that in addition to what is leased and already committed for other purposes, there may be 25,000 acres of available land that could be used for oyster cultivation. Still, the Department has not undertaken any active program to identify or classify leased bottom. In addition, the primary policy of the State has been for a public fishery.

Because of the lease controversy--or the controversy about leased bottom—and the increasing demand for soft clam bottom some years ago, a moratorium on new leases was imposed in 1976. There have been no new leases since that time. There have been—and we are processing on a routine basis—all of the <u>renewals</u> for lease bottom. These are for twenty year periods.

Now, when we process these renewals, we are making some changes. As we interpret the intent of the Annotated Code, the purpose of the lease bottom is to cultivate oysters. We are not going to be satisfied in the future to have people simply pay rent and not use the bottom for this purpose. Every renewal of a lease includes a use provision, and we intend to enforce this. The requirment of the Code is that you cultivate, report on what you have done to plant the lease, and report the harvest figures.

At the same time that the moratorium was imposed, there was a formalized program to survey the Bay bottom. It was a program of great promise. But I am afraid the results came as less than satisfactory. Four years after that program was implemented, about one quarter of the bottom has been surveyed in one way or another. None of the forty-some-odd charts that comprise a map of Bay bottom have been completely mapped in four years. At that rate of progress I am afraid it is going to be another decade before we even finish the survey, and that of course is before we even start legal processes of reclassifying any bottom for any purpose.

The prospect of holding everything in abeyance for at least another decade is certainly not appealing. Less appealing is the prospect of facing any new classification actions in the 1990's on data gathered in the 1970's. I can imagine that if we were to keep on this schedule, we would simply be redoing what we have done in the intervening four or five years. I do not think that is a responsible position in light of the code of the statements of the legislature and the way we read the intent of the law. I do not think it is a responsible position to continue that rate of progress. So, during the past four months we have been taking a hard look at what we are doing, why we are doing it, and what we should be doing. As was pointed out last year, there has to be a better way--and we believe there is. To put it simply, the role of the Department is to carry out the intent of the laws for the State of Maryland. They include both a leasing program and a public program.

Although we have made no decisions, these are the things we are considering. We begin with the premise that leasing is an authorized use of the Bay. We also work on the premise that leasing of barren bottom—which does not involve any reclassification of public bottom or bottom set aside for any designated use—is consistent with the maintenance of a public fishery. And we believe, as many of the economic studies have pointed out, that properly done, a leasing program can benefit the whole industry.

I am aware of the strong feelings on the part of the public fishermen that the leasing program will, in time, replace them. But that simply is not our objective. We are going to modify our Bay-bottom survey procedures, and we are going to do it much faster. Based on an electronic reconnaissance, we will completely map the Bay bottom. We expect to do that in two years. After that, we propose to go back and take physical samples, and, if you read the law carefully, it provides some very tight time schedules for us between the time we take our physical samples and the time we go public with any classification actions. Another provision requires retaking of physical samples in the presence of any challengers. So, our first step is an electronic reconnaissance without any physical sampling. We propose that any changes, or proposal for changes in Bay bottom classifications, be done one chart at a time. This is the sensible way, I believe, rather than reclassifying the Bay bottom entirely at one time.

We also work on the premise that the state policy is to maintain a management program for a public fishery. There is no proposal before us; we are not giving any consideration to changing the current policy directed toward maintaining a public fishery. Nor are we considering any proposals to diminish or to do anything other than continue the public bar repletion and propagation programs that have existed for several years.

We are considering some changes which I would like to share with you and have you consider. We believe we can relax the moratorium, and we believe barren bottom can be leased and be a benefit to the entire industry. But this would require several changes in order to have a leasing program rather than having leases on which holders pay very small lease rates and don't utilize. We are considering an increase on lease rates and fees. We are considering a proposal to establish 50 acres as a maximum lease to avoid concentrations of lease grounds under one person's control.

We believe that if the state does have a program for leased ground, and a public program, then it is our responsibility, and our obligation, to aid and encourage the development of a hatchery. Whether you are a public oysterman or a private oysterman, you are still dependent on the health of the Bay and the vagaries of Mother Nature. If we do get into an increased leasing program, we intend to enforce the requirements for lease holders to cultivate and report what they are doing with that lease. In those cases where the lease holder is not meeting the requirments for the lease--and we think the Annotated Code is very clear--those leases must revert to the state.

We are considering a proposal that a severance tax be imposed on all oysters harvested in the Chesapeake Bay. Some would ask: What benefit does the private oysterman (lease holder) get from the state? Well, I think there is a big benefit that speaks in favor of this proposal. The state has a tremendous investment in keeping the health of the Bay adequate for everyone to grow oysters. And, to the extent that the health of the Bay is adequate and considering what the state may do in other programs to stimulate the production of oysters, I think it is a fair proposition to consider that those who harvest oysters from the Bay bottom should pay severance tax equal to what the public oystermen are paying. Those are some of the things that we are considering. No decisions have been made. I hope we have time to discuss them. I don't know if everyone is so tired they want to go home now, but I will open the floor to questions.

Question: What does the State consider barren bottom?

Answer: Barren bottom is anything that is not reserved for some other purpose, i.e., clam bottom, crab bottom, public bottom, or military areas.

Q. What kind of survey equipment do you use to classify?

A. Essentially three methods are used. One is to drag an audio transducer across the bottom, which gives an audio record of whether one is on sand or shell the second is to use a pole which penetrates the bottom to get some feeling for what the consistency is, and third is, an EDO, a recording EDO depth finder, which can be read to tell whether it is soft mud or hard mud, sand or shell.

Q. Can clammers lease bottom that has not been classified as soft shell clam bed?

A. If it is not dedicated to soft shell clam then it is not classified as clam bottom, and then is, by definition, barren bottom. If someone asks for a right to lease that bottom, we would go public with the request and clammers would have the opportunity to come in and make their case on whether they could use it for clam bottom.

Q. You said each lessor would only get 50 acres. Do you foresee a grandfather clause for people who have in excess of 50 acres, making them surrender any thing over 50 acres?

A. When I said 50 acres, I am talking about an increase in the lease program above and beyond what we have now. Yes, I would anticipate a grandfather clause, at least for some period of time.

Q. Is documentation going to create more paperwork for us?

A. No, I think documentation is fairly straightforward. What did you plant, when did you plant it, and how much did you harvest, is really all we anticipate asking anyone.

Q. What would be your time frame for making a decision on what you are going to do with these policies you have been discussing?

A. I think we want to wipe out all the uncertainty that is in people's minds as quickly as we can. As soon as we've given everybody the opportunity to say what they would like about it we will go ahead and make our decision. That's an indefinite answer, but we are not going to rush into it.

Q. How about acreage in polluted areas?

A. That is one of the open questions. Right now, rent is abated on polluted grounds. Just because this land is polluted does not mean you cannot raise oysters. In fact, you can probably raise them fairly fat, but the question is whether you can market them. So I don't know what we are going to recommend. Whether rent should be abated, or whether the man taking the risk of leasing the ground is going to have to take that risk and pay. That is still an open question.

Q. Is the rent going to be increased?
A. There are two proposals being considered. One is to make it equivalent to the rates that are now charged on Worcester Bay which are $10 the first three years and $20 a year after that. And the other is a flat fee higher than $2 an acre. No specific number.

Q. Talking about the floating of oysters, by the laws of your state, does the bottom have to be under lease to be able to float oysters over that bottom? What law covers floating of oysters at various depth rates? I am trying to expand this a little bit because most of Maryland is just looking at the bottom and I think that some day they ought to look at all of it from top to bottom.
A. I agree. That is a good point. It is not part of the current Bay-bottom controversy.

Q. The severance tax is for oysters on public bottom?
A. Well, right now the severance tax is charged on oysters harvested on public bottom. The oysters harvested on private ground are exempted from tax. We are considering a proposal which will apply the severance tax to all oysters harvested on the bottom.

Q. Why would you apply the severance tax to privately grown oysters? After all, the state had nothing to do with planting them there. The leaseholder does that on his own and gets nothing back from the state.
A. The reasoning is that it is very difficult to establish what is an equitable return on a lease rate, a rental rate as payment to the citizens of the state of Maryland for private use of that bottom. We are all dependent on the quality of the water in the Chesapeake Bay and the state has significant investments in maintaining health regulations, many other regulations, and many controls that are put on other people's use of the Bay. If these controls do in fact contribute to increased production of oysters, then it seems an equitable argument to recover part of that cost through an increased tax.

Q. The same could be said for rock fishermen or boating people. You are charging leaseholders for the rental of the property and on top of that you are charging a variable tax on how much we harvest from that.

A. I won't argue with you too strongly on that point. It is one of the most difficult things we have had to wrestle with, and that is, how do you judge or how do you fix a fair rent rate? What is it worth for someone to take a business venture and lease bottom for these oysters? There is just no economic data available to use that tells us what is a fair price to charge everybody. A compromise position is to tax production, which is not an uncommon approach.

Q. What about the counties you cannot lease in? What about the land there?

A. You mean the six counties we can't lease in? Well, that will be up to the legislature because they imposed the restrictions. It is hard for me to respond to that.

Q. Are you considering that land too?

A. For the time being we disregarded it because it simply is not there. We can't even think about leasing it. I think if we can demonstrate that the Department has a fair and reasonable plan for releasing it, and it is compatible with the public fishery, then I would hope the legislature would look at our program and reconsider whether they should or should not prohibit leasing in those six counties.

Q. Have you considered auctioning off parcels where the demand for that parcel is strong?

A. Yes, we have considered that. Only it is not under consideration right now. I am plenty willing to debate that as a possible way of making lease bottom available. But it is a totally different procedure. It means then that the state would in fact have to go out and in effect classify bottom and say, "Here it is; it is marked off; here's the acreage," and put it up for bids. It is quite a different procedure than we are willing to consider at this point.

Q. Three years ago your department got a bill to allow the Department to present a comprehensive management program/plan for Worcester County. When you present this completed plan to control all of Worcester County waters, do you have an area for input from residents of that country before presenting it to the legislature?

A. No, we would not put it through the legislature necessarily. I think the law is clear enough, that before we adopt any management plans, or before we reclassify any bottom, we have got to go to the public, whether the law said we had to or not. The answer is yes, we will go to the public before adoption of a plan.

"I am for aquaculture; I think that this is going to be a plus for the Bay. It is going to be a plus for us all...."

---Harold Kennerly
H. B. Kennerly and Son
Seafood
Nanticoke, Maryland

Appendices

APPENDIX I

FINANCIAL ASSISTANCE ORGANIZATIONS

1. <u>Bank for Cooperatives:</u>

For those watermen interested in forming an aquatic cooperative for handling, processing, and marketing of aquatic products, the Baltimore Bank for Cooperatives will be pleased to provide advice and direction in establishing and financing an aquatic cooperative. The address is:

Baltimore Bank for Cooperatives
P. O. Box 1555
Baltimore, MD 21203

(301) 628-5500

Richard A. Crowgey, Jr.,
Assistant Vice President
Dallas O. Adams, Assistant Vice
President

The Baltimore Bank for Cooperatives services the five-state area of Maryland, Virginia, Delaware, West Virginia and Pennsylvania.

II. Regional Federal Land Bank (FLBA)/Production Credit Associations (PCA):

The FLBA/PCA has money available for a variety of marine trades (excluding recreational boating and sport-fishing). It considers aquaculture to be agriculture for its lending purposes, and can finance vessel purchase and repair and equipment such as tongs, crab pots, etc. The FLBA currently has more than $283,000 in aquatic loans in force. Most of this money has gone to operations outside the Chesapeake Bay, according to one of the regional directors (a Carribean shrimp boat operation, for instance), though applications from area marine businessmen are most welcome.

MARYLAND

	Counties Served
FLBA of Bel Air/Towson PCA Headquarters P. O. Box 648 Bel Air, MD 21014 Telephone: (301) 838-4242 General Mgr.: Paul A. Newcomer	Baltimore Cecil Harford Howard
FLBA/PCA of Denton (Headqrtrs.) Box 279 301 Randolph & Third Streets Denton, MD 21629 (301) 479-2323 General Mgr.: J. B. Jarrell, Jr.	Caroline Dorchester Queen Anne's Talbot
Chestertown (Branch Office) P. O. Box 250 High Street Chestertown, MD 21620	Kent Northern Portion of Queen Anne's

Telephone: (301) 778-0757
Asst. Mgr.: Stephen L. Hollenbeck

FLBA of Salisbury/Marva PCA (Headquarters) P. O. Box 1658 540 Snow Hill Road Salisbury, MD 21801 Telephone: (301) 742-7191 General Mgr.: Joel Boren	Somerset Wicomico Worcester
Pocomoke (Branch Office) 1504 Market Street P. O. Box 270 Pocomoke, MD 21851 Telephone: (301) 957-1181 General Mgr.: E. Philip Whitman	
Southern Maryland FLBA/PCA of Hughesville (Headquarters) Box 97, Route 5 Hughesville, MD 20637 Telephone: (301) 274-3167 General Mgr.: J. Maguire Mattingly, Jr.	Calvert Charles St. Mary's
Upper Marlboro (Branch Office) Box 157 14713 Claggett Bldg. Upper Marlboro, MD 20870 Telephone: (301) 627-3596 Loan Officer: Frank A. Ruballa	Anne Arundel Prince Georges

VIRGINIA

FLBA/PCA of Richmond (Headquarters) Box 27485 1417 Brook Road Richmond, Virginia 23261 Telephone: (804) 644-2979 General Mgr.: H. Earl Longest	Charles City Chesterfield Fluvanna Goochland Hanover Henrico James City King William Louisa New Kent City of Newport News Powhatan York
Exmore (Branch Office) P. O. Box 607 Bank Street Exmore, VA 23350 Telephone: (804) 442-6001	Accomack Northampton
Tappahannock (Branch Office) Farm Credit Building Queen Street Tappahannock, VA 22560 Telephone: (804) 443-3351 Asst. Mgr. Maurice E. Carpenter	Caroline Essex Gloucester King George King and Queen Lancaster Mathews Middlesex Northumberland Richmond Westmoreland

FLBA/PCA of Warrenton (Headquarters) Box 381 Warrenton, VA 22186 Telephone: (703) 347-3344 General Mgr.: Tim E. Tarr	Fauquier Prince William Rappahannock Spotsylvania Stafford
Leesburg (Branch Office) P. O. Box 1398 Route 15 Leesburg, VA 22075 Telephone: (703) 777-3311 Asst. Mgr.: C. Carroll Laycock, Jr.	Fairfax Loudoun
Orange (Branch Office) P. O. Box 267 Main Street Orange, VA 22960 Telephone: (703) 672-3644 Asst. Mgr.: Gordon D. Haines	Culpepper Greene Madison Orange
FLBA of Waverly/Southside VA PCA(Headquarters) Box 67 Bank Street Bank Street Waverly, VA 23890 Telephone: (804) 834-2274 General Mgr.: J. Browley Cox, Jr.	Cities of Hopewell & Petersburg Dinwiddie Prince George Surry Sussex

Courtland (Branch Office) P. O. Box 71 Main Street Courtland, VA 23837 Telephone: (804) 653-2600 Asst. Mgr.: Robert E. Vinson	Greensville Southhampton
Suffolk (Branch Office) 221 W. Constance Road Suffolk, VA 23434 Telephone: (804) 539-5481 Asst. Mgr.: Richard A. Davis	Cities of Chesapeake, Suffolk, and Va. Beach

DELAWARE

Delaware FLBA/PCA of Dover (Headquarters) P. O. Box 418 South State Street and U. S. Route 13 Dover, Delaware 19901 Telephone: (302) 734-7534 General Mgr.: J. Wayne Cooper	Kent New Castle
Georgetown (Branch Office) P. O. Box 570 U. S. Route 113 Georgetown, Delaware 19947 Telephone: (302) 856-9081 Assoc. Mgr.: George G. Betton	Sussex

III. Farmers Home Administration (FmHA):

The FmHA has offices in all tidewater counties and has money available for loans to cover the cost of workboat purchases, repairs, oyster aquaculture and some refinancing. For more information, contact:

Mr. William D. Whalmsley
Farmers Program Specialist
Farmers Home Administration
Rob Scott Building
151 East Chestnut Hill Road
Newark, Delawre 19713

Telephone: (302) 573-6694

IV. U. S. Small Business Administration (SBA):

The direct lending capability of the SBA has been severely curtailed in the last year, and no direct loan activity can be expected for the foreseeable future. Bank loans guaranteed by SBA up to 90 percent are still available, however, if applicants can line up the banks to assist them. One of the problems applicants face, according to loan officer Vernon Bradford, is the banking community's unfamiliarity with small marine businesses. For more information, contact:

Mr. Vernon Bradford
Senior Loan Officer
U. S. Small Business Administration
630 Oxford Building
8600 LaSalle Road
Towson, MD 21204

Telephone: (301) 962-2150

APPENDIX II   APPLICATION FOR A LEASE

TO THE FISH AND WILDLIFE ADMINISTRATION OF THE STATE OF MARYLAND

THIS APPLICATION MUST BE ACCOMPANIED BY APPLICATION FEE OF $25.00

The application of ....
(Please print full first, middle and last name)

a resident of ...., in the State of Maryland, respectfully shows:
(give complete address)

1st. That this applicant is a resident of Maryland.

2nd. That in accordance with the law, he intends to use the grounds hereinafter described only for the purpose of planting and cultivating oysters or other shellfish.

3rd. That he is the minimum age of eighteen or over.

4th. That he will accept lease subject to all the provisions of Chapter 711, of the Acts of 1906, and amendments thereto, as well as the specific provision that he will release and forever discharge the United States, the State of Maryland, or any political sub-division of the State, its agents, contractors, and assigns from any and all manner of actions and damage, whatsoever, whether in law or in equity, which he, as lessee, hereafter can, shall or may have, or which his heirs, assigns, executors or administrators hereafter can, shall or may have against the United States, the State of Maryland or any political sub-division of the State, its agents, contractors and assigns for, or by reason of, any damage to the oyster bed described below that may be caused, directly or indirectly, from dredging, mining, or any public improvement project as well as subsequent maintenance thereof.

The undersigned, therefore, request hereby, that said Administration lease to .... to the name and on behalf of the State of Maryland, ... acres of ground, located under the waters of the State of Maryland, which ground is more particularly described as follows, and which I have marked by placing not less than four stakes, one of which bears my name,

to wit:

....

....

....

....

....

....

....

....

....

....

....

....

....

Dated at ...., Maryland, this ....

of ...., in the year one thousand nine hundred and ....

....
Signature of Applicant - must be same as above

APPENDIX III

DNR - 154

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TAWES STATE OFFICE BUILDING
ANNAPOLIS, MARYLAND 21401

Recording Fee: $ 5.00

Transfer of Leased Land
PART I
(To be completed by Assignor)

For value received, I hereby ASSIGN AND TRANSFER

to ______________________________ of ______________________________,
Maryland, all my right, title, claim, interest and estate in the within lease and of the oyster lot therein mentioned to wit:

____

____

____

____

Recorded in Liber ____________ Folio ____________
Witness my hand and seal this ____________ day of ____________ ______ in the year 19______

______________________________ ______________________________
(Witness) (Signature of Lessee)

______________________________ ______________________________

PART II
(To be completed by Assignee)

The undersigned hereby accepts the above mentioned Lease, subject to all provisions of Chapter 711 of the Acts of 1906 and the amendments thereto, as well as the specific provision that he will release and forever discharge the United States, the State of Maryland, or any political sub-division of the State, its agents, contractors, and assigns from any and all manner of actions and damage, whatsoever, whether in law or in equity, which he, as lessee, hereafter can, shall or may have, or which his heirs, assigns, executors, or administrators hereafter can, shall or may have against the United States, the State of Maryland or any political sub-division of the State, its agents, contractors and assigns for, or by reason of, any damage to the oyster bed described below that may be caused, directly or indirectly, from dredging, mining, or any public improvement project as well as subsequent maintenance thereof. And, in accordance with the opinion of the Attorney General that a minor must be of minimum age of eighteen to obtain valid title to oyster ground lease, I hereby swear that as of this date I am eighteen years of age or over.

____
Signature - full first, middle and last name.

Date: ______________________ 19 ______

This assignment form must be completed in duplicate and forwarded to the Department of Natural Resources, together with the old lease and recording fee of $5.00, for recording in order for such transfer to become valid.

APPENDIX IV

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES

PRIVATE OYSTER GROUND CONSOLIDATION FORM

I/WE ______________________________ of

______________________ Maryland ________ do herewith release

to the State of Maryland, Department of Natural Resources, the following

described private oyster lease which is located in __________________,
(water body)

________________, and consists of ______ acres and further is
(county)

identified by the Department of Natural Resources identification number _____

for the purpose of consolidating this lease into a larger lease.

This existing lease being retired and combined for renewal under

the name/s of ____.

____,
(mailing address & zip code)

and containing _____ acres to be combined as required by the Department of

Natural Resources.

It is requested that the above described lease be combined with

the lease of _____ acres and further identified by the Department of

Natural Resources number _____ to form a new lease of _____ (total) acres.

______________________________ __________
Signature/s of Consolidated Lessee Date

______________________________ __________
Signature/s of Original Lessee Date

Fees: Recording $5.00
Resurvey $20.00 (when requested)