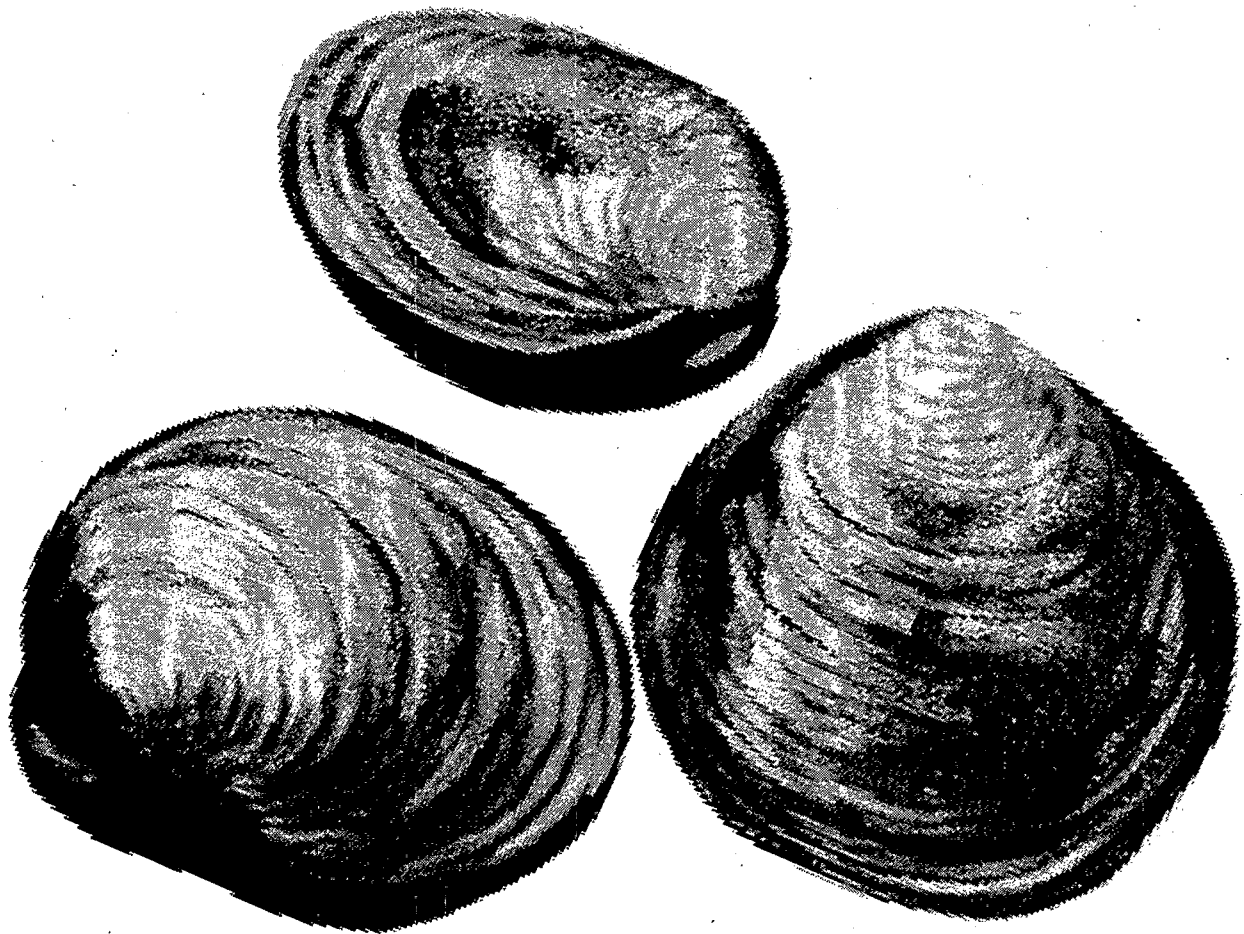
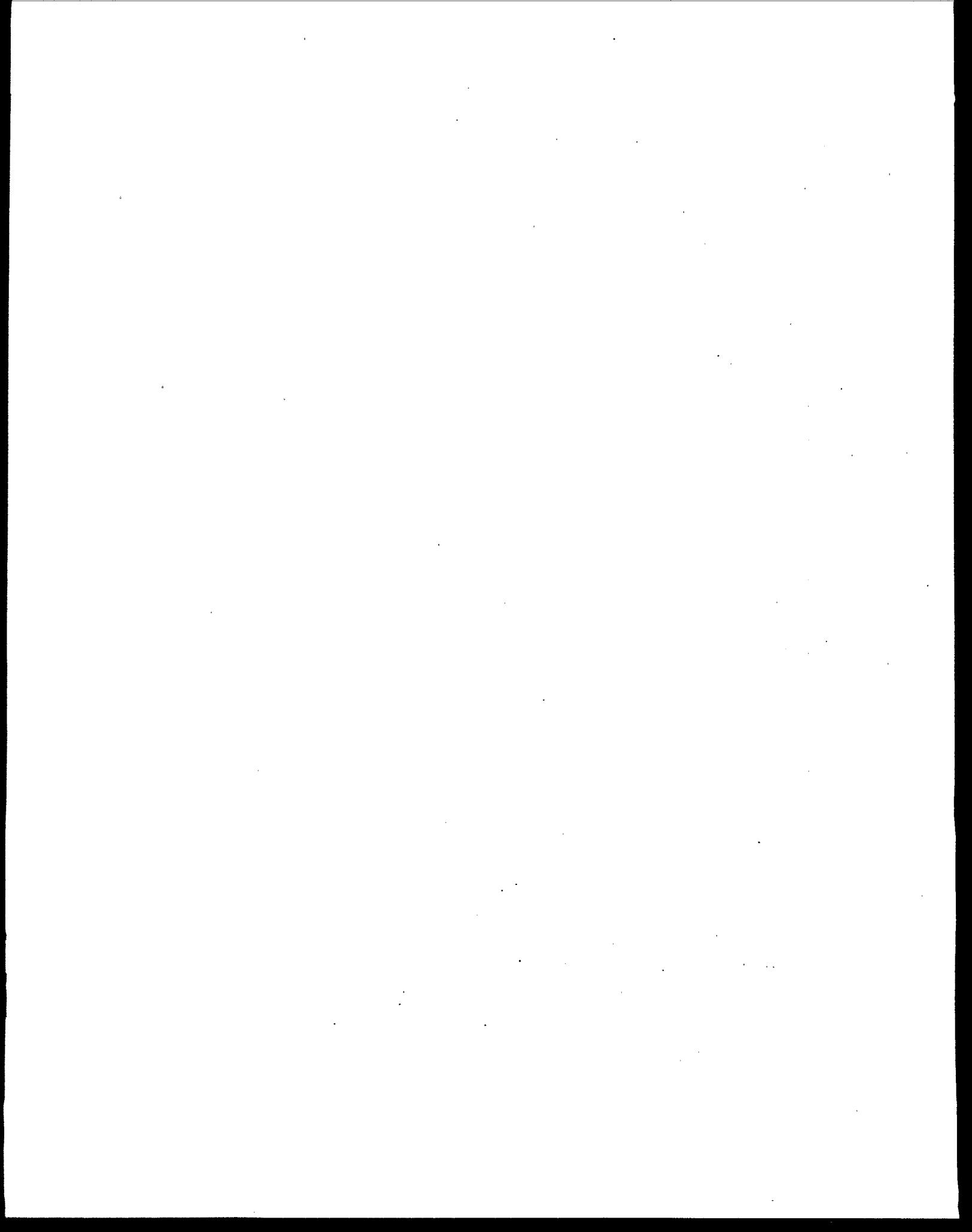




Office Of Water Proceedings

Hard Clams: Getting Scarce Or Just Hiding (1996 International Conference On Shellfish Restoration Panel Discussion)





HARD CLAMS: GETTING SCARCE OR JUST HIDING

1996 International Conference on Shellfish Restoration panel discussion

(Edited by James C. Woodley of EPA and Gef Flimlin of NJ Sea Grant)

Moderator: Gef Flimlin, N. J. Sea Grant Marine Advisory Service

Panelists: Arnold Eversole, Clemson University

John Kraeuter, Rutgers University

Charles Peterson, University of North Carolina- Chapel Hill

Stephen Fegley, Marine Maritime Academy

Sandy Macfarlane, Town of Orleans (Mass.) Conservation Dept.

Bob Pfeiffer, Oyster Recovery Partnership, MD

Assessing Population Dynamics of Hard Clams

RATIONALE: Management of any fishery resource is an exercise in manipulating natural populations. It follows that information about the commercial species population characteristics (growth rates, carrying capacities, critical life history stages, temporal and spatial variations in abundance, etc.) is necessary to enable us to maintain harvestable populations and assess whether they are in decline, stasis, or growth. Without understanding how rapidly a population will recover, what biotic or abiotic factors play a role in recovery, and what a viable population looks like, how can we ever hope to make informed decisions about whether or how to harvest?

PROBLEM: Hatchery and aquaculture interests have led to an impressive array of technical information on clam spawning (in artificial surroundings) and the effects of predation on juvenile clams. Ecological studies have extended our knowledge on the importance of many factors, including higher order interactions impacting hard clams in their natural habitat. Indeed, data is available from field-based experiments to address local fishery-related issues. Consequently, we have a large amount of information about specific factors that affect hard clam survival, growth, and reproduction. However, a recent review of the literature has convinced me that we know virtually nothing on large-scale (100's of meters and greater) and long-term (several years) patterns of hard clam populations. Hard clam landings gathered by management agencies provide little reliable information on hard clam populations. What little census data exist reveals only marginally useful insights into gross spatial variation in clam population densities. No rigorously designed, long-term or large-scale studies are available that document changes in hard clam population abundances. Integrating the specific information on hard clam survival and reproduction that we have cannot be done convincingly in the absence of quantitative information on how hard clam populations behave. We may have success in producing and maintaining hard clam populations in specific locations where experimental results or trial and error have led to an appreciation of local factors affecting clam survival. However, extension of that success to even nearby locations will likely be limited until we have a more comprehensive

understanding of hard clam population dynamics.

SUGGESTED COURSE OF ACTION: I argue we should proceed along two lines of inquiry. First, an effort must be made, using efficient sampling designs and sampling methods, to document changes in hard clam abundances over a range of hard clam habitats in several areas of the eastern U.S. coast. It is important that the sampling focus on all benthic stages of hard clams, juveniles as well as adults. Second, several areas of hard clam life-history need investigation using field-oriented experimental methods including the following.

- ▶ The role of adult dispersion patterns in hard clam spawning success.
- ▶ Determination of realized age- and size-specific fecundities of clams from different habitats and regions.
- ▶ The importance of embayment flushing rates to hard clam recruitment.
- ▶ Examination of factors affecting, pediveliger settlement success.
- ▶ The effects of lateral advection on hard clam juvenile survival and distribution.
- ▶ The relative effects of different harvesting methods on juvenile survival.
- ▶ Determination of the proportion of juveniles that are progeny of the local adult clams.

SUMMARY

This is a summary of the panel discussion ("Hard Clams: Getting Scarce or Just Hiding?") held at the 1996 International Conference on Shellfish Restoration. From this panel discussion, a task force has been established to develop a strategy to address issues presented during this discussion as well as others related to hard clams. A grant from EPA is partly funding this task force.

During the 1994 and 1996 National Shellfish Association meetings, the status of hard clams was beginning to be addressed. From those meetings, it was determined that something was happening within the hard clam fisheries because the stocks were not as viable and strong as they had been previously.

The reason for this decline had not been determined. However, the clam industry, at that time, was concerned about the following areas and their impact on the decline of hard clams: (1) use of bay waters for cooling electric power plants; (2) impact of CCA treated lumber and dock building; (3) impact of bottom paint (copper & TBT) on vessels; (4) churning of outboards in the summertime when the spawns are in the water; (5) watershed management and agricultural run off; and (6) over fishing or over clamming the areas.

This presentation will address:

- ▶ The Role of Reproductive Capability of Hard Clams Potential Problems
- ▶ Predation
- ▶ Higher Order Interaction
- ▶ Management of Quahog Fishery on a Local Level
- ▶ Process for Addressing The Status of Hard Clams

The Role of Reproductive Capability of Hard Clams Potential Problems

Hard clams are dioecious (there are male and female animals) and they have equal sex ratios. They began breeding when their shell length is approximately 35 millimeters. The reproductive cycles are annual to semi-annual and are often episodic.

There are many gaps in reproductive information that needs to be addressed. The types of diseases that impact hard clams as well as where and when those diseases occur is a vital piece of missing information. For example, there is information that gonadal neoplasia affect hard clams but whether or not it impacts reproductive output as in soft clams is still unclear. The relationships between breeding size, larval density and setting has to be better defined. It is also unclear whether the population or spatial organization within hard clams play a role in reproductive success.

Predation

Hard clams provide significant economic resources to States and local political subdivisions. For example, in New Jersey, ocean quahogs and surf clams provide about 60 to 80 million dollars a year worth of landings. Yet there is very little data on stocks. There is significant data on predators, though. Most of that data is generated from hard clams that are at least 1 millimeter in length. For the large clams, the predators include some snails (Conch genus *Busycon*), starfish, lobsters, some bird species, and some fish species. For the juvenile clams, which are smaller, the list of predators is longer and the rate of ingestion by these animals is much higher. This list includes snails, hermit crabs, blue crabs, and shrimp. Crustacean predators probably impact hard clam seed in most habitats and should be considered in the kind of restoration that is proposed. More information is needed on predation of larva. There is virtually no long-term data sets on hard clams other than oysters. The landing data for oysters is currently insufficient.

Higher Order Interaction

Hard clams have a long shelf-life and a current low disease rate. Because hard clams are not harvested annually, they are a kind of capital in the bank. However, as these clams become bigger, their market value decreases. Predators such as whelks, herring gulls and stone crabs eat large hard clams. An evaluation of hard clam (26 millimeters or less) data recorded from a 50 square meter plot of the central North Carolina coast during 1978 to 1983 revealed the range of recruitment being only 2.1 to 2.7 individuals per square meter. During this period the big chowder clams were removed because of higher prices in the North East. These clams were probably the spawning stock. Similar data collected between 1994 and 1995 revealed a range of recruitment of 1.0 and 1.6 individuals per square meter. These data suggest that the reduced clam recruitment was because of the reduction of spawning stock. The quantity of egg production and release apparently are a function of clam size.

Higher order interactions other than human interaction and predation associated with whelks, herring gulls, and stone crabs include siphon nipping by fish. Siphon nipping varies as a function of habitat. It is reduced if the clams are in sea grasses. This sort of injury to the hard clams often result in reduced growth rate of the population. There are hydrodynamic factors that are important to consider as well. The flow of water across the bed and the scale of the bed are important factors, as are the location of the hard clam bed within an embayment. The alternative prey in a system also provide valuable information about the predator/prey relationship. The alternative prey if it is not market-valuable can often reduce the impact of the predator on the market-valuable hard clams.

There is no fishery-independent stock assessment for hard clams. Harvesters often bypass the dealers and go directly to the market with their product. This bypass often result in valuable quantity and quality data being lost.

When considering restoration and management of hard clams, the general economic conditions and quality of life in the local area, State, or region should be considered. Management measures could include the retention of spawning stock by keeping them in areas that are off limits to harvesters.

Management of Quahog Fishery on a Local Level

In the Town of Orleans, there are three estuaries. The waters are open for shellfishing by a State designation under the Interstate Shellfish Sanitation Conference. The State has given the local government the authority to manage the shellfish resource under whatever means available. One of the management decisions was to develop and implement a planting and seeding program. The area of concern for the local management was the survival of the planted stock in the natural environment that is unprotected. Predation is a significant problem for the survival of the transplants. A combination of siphon and foot nipping has been observed during transplanting. It has been determined that transplanting should be done during November when the bait fish and green crabs are more inactive.

Other concerns include recruitment, predation and problems associated with land use. In order for local or town governments to manage shellfish resources, it is important that the beds are kept open. That is done by maintaining water quality that allow shellfishing to occur. It is also important to keep the town managers and residents involved in the management process.

Process for Addressing The Status of Hard Clams

The Oyster Recovery Partnership (Oyster Round table) of Annapolis, Maryland, resulted from a decline in landing numbers. It was determined that there was very little information about the role of the oyster's habitat in its survival, the role of the oyster for water quality indication, and the role of the oyster as a benthic community. The Oyster Round table developed a strategy which is designed to integrate the concerns of the environmental community with those of the resource management community. This is accomplished by establishing a dialogue between the two groups, determining the issues, and selecting common issues to address. Four objectives were identified by this process. They were:

- ▶ to maximize and enhance the ecological benefits of oysters;
- ▶ to maximize and enhance the economic benefits derived from harvesting in the public and

- private oyster fisheries;
- ▶ to maximize the ability of government to respond effectively to the magnitude of the problem;
- ▶ and to obtain sufficient funding for all aspects of the program recommended.

Transcription

(Readers, please note that verbatim transcriptions make it very hard to make exact quotes of speakers, since we tend to ramble or use incorrect speech patterns which we would never do on a written page. Therefore kindly understand that all phrasing and some of the proper names or words may not be exactly as the speaker intended, although this has been edited. Eds.)

Introduction

Gef Flimlin

Good morning my name is Gef Flimlin, I'm a marine extension agent with New Jersey Sea Grant Marine Advisory Service. For those of you who are not part of the American bureaucracy, the Sea Grant Program is part of U.S. Department of Commerce and within the National Oceanic and Atmosphere Administration. The Sea Grant Program is modeled after the Department of Agriculture's Land Grant College where there are agents either County Agriculture or County Marine Agents like myself who serve as liaison between industry and the research and management communities. In this role, one of the things I am supposed to do is deal with industry, industry problems, and relate those problems to the research community. They're supposed to do research on them. Then, I'm supposed to return the results to industry. In eighteen years that actually worked once. For a whole different number of reasons, it is not a process that I've enjoyed a whole lot of success in the way it was originally designed. But the process is something that we need to look at and there are many ways of getting things done. This is a little example of it.

A number of years ago I was driving around Trenton, the State Capital, on Route 295 which kind of skirts the city itself. I was in the fast lane, as I usually am and in the middle lane there was a Dodge Aries that had a "TD" license plate, representing the State Transportation Department. There's a fellow driving it. In the passenger seat, there's a guy kind of leaning and his head is nodding like this. Then in the back, behind the driver, there is another guy. He's just sound asleep with his head back on the head rest. On the back of the trunk, there was a sticker that said "Road Roughness Survey". So I figured if they hit a pot hole and it woke up the guy in the front but didn't wake up the guy in the back, they didn't have to fill that one in. But if the guy woke up in the back then they would write it down and come back with the black top later on to fix it.

So, the idea here is that in the hard clam fishery we've had a couple of sessions at National Shellfish Association meetings in 1994 and 1996 where we talked about hard clams. We talked about restoration projects in '94 when the meeting was in Charleston. Last year in Baltimore we talked about hard clam fisheries from New England down through the South. Dr. Mike Rice from the University of Rhode Island talked about New England and I talked about the Mid-Atlantic. Jack Whetstone from South Carolina Sea Grant talked about the Southern areas. It was the general belief that something was happening in the hard clam fishery. The stocks were not as

viable and strong as they had been in the past. We looked at landing. Then we found out that a lot of us don't have a lot of faith in landings, but it gave some indication of what was going on. We've seen a growth in aquaculture of hard clams and that might indicate that the people who are involved in aquaculture are the people who were involved in hard clam fishery. So they're changing their ways to stay involved in being on the water by using aquaculture. We see that change getting larger and larger all the time.

What's the reason for this stress within the hard clam fishery? I don't think we really know. It's probably a whole group of things. Pete Peterson, in his talk just a couple of minutes ago alluded to a lot of different things. If we look at some cases in New Jersey, for example, some of the Bays which were highly productive, have hardly anybody working in them anymore. The industry thinks about a whole lot of things. They're concerned about the use of Bay water for cooling electric power plants. They're concerned about the impact of CCA treated lumber and dock building. They're concerned about bottom paint on vessels. They're concerned about the churning of outboards in the summertime when the spawns are in the water. They're concerned about watershed management and run off. They're concerned, and even some might admit to it, about over fishing or over clamming the areas. So there is a whole lot of things that go into the problem. Identifying them in a broad spectrum is easy, but pinpointing one of them is the hard task. So, what we're trying to do is to have the people here who are pretty much clam people address some of the issues.

We will go over a few different areas, such as the role of reproductive capability of hard clams potential problems, predation, and higher order interaction, whatever we decide that may be. We're going to talk about the importance of the management of quahog fishery on a local level. Then we're going to talk about how would one go about addressing a large problem like this. What is the process? Then we want to make this interactive and have the audience discuss this and maybe come to a decision whether or not to move forward with this initiative. We might develop a collaborative effort or leave it alone. But, in my role I want to bring my industry's feelings to the research and management community to see how you feel about this subject and then we'll go from there.

Our first speaker is Dr. Arnie Eversole of the Department of Agriculture, Fisheries and Wildlife at Clemson University in South Carolina.

The Role of Reproductive Capability of Hard Clams Potential Problems

Arnold Eversole

Well, let me tell you a story. We're in the South so I can tell you a story. I'm a runner. Some of you may know that. When we run we discuss things. While we were running ---- and I was running this past week with a friend of mine who is an environmental assessment engineer. I told him my problem of coming down here and I hadn't given this talk any thought. He said,

"By the way Ernie, what do you know about reproduction?" I said, "not much my son is 28 years old."

Let me give a couple of bits of facts and tell you where my concerns may lie. You may or may not agree with me. But just let me briefly go through this and bring back some information to the front of your mind. First of all, as adults, hard clams are dioecious. They have equal sex ratios. They start breeding around 35 millimeter in shell length. Reproductive cycles are annual to semi-annual. On average for spawning season, according to my calculation and literature search, is around 7 million eggs per female per season. Fertilization is external, the probability of fertilization--I should say--is based on the concentration of gametes as well as the age of the gametes. The reproduction cycle whether it's successful or not is episodic, in other words it's not an annual thing, sometimes we don't see recruitment. In other words, there are missing blocks of information.

I've done some calculations on these things assuming recruitment rates and the reproductive size. Let me just give you the bottom line. A female can, on average, [this is what I determine as a successful specific natality rate which we use in wildlife biology] produce from 0 to one egg per year, actually it's .02 eggs per year base on the data. What are some of the concerns? With indifference to oysters, clams don't get many diseases; but, there are some they do get, like some parasites that affect reproduction. We've noticed recently there seems to be an increase in such things as gonadal neoplasia. We know this from the work of Bruce Barber and others that this affects the reproductive output in soft clams. I assume it does the same in hard clams. We also know that there is no or little relationship between breeding size on larval density and also larval density on setting. But we don't know what population density and spatial organization have to do with reproductive success. So this is one of the concerns that I have. Does a certain population or spatial organization or [I will use the term] dispersion have something to do with reproductive success? I think we need to consider that.

Another concern is that we need better information on larval recruitment and setting. And I made two slides that I was going to show. One shows a survivorship curve from eggs, larva, and spat to adults. I called the first one density factor continuum. If we go across here, you will notice that in early life cycle there are basically independent factors. Then later on in life it's dependent factors. My second slide is what I call the knowledge continuum. What do we know about these things? If you look carefully at that too and if you can make a mental picture of what you get from survival, eggs, larval, spat and adults, it will become obvious that we know very little, believe it or not, very little about egg survival. We know very little about fertilization in nature. We know very little about survival in the early stages. What is an effective concentration of sperm and egg in nature? We know in culture roughly 1800 sperms per egg. To avoid things like poly-spermy and things like that. But we know very little about these things in nature.

So these are some of the things I think we need to address as far as reproduction is concerned and to see if things are successful. Briefly that's what some of my concerns are. I think it needs to be an integral picture and a model that will try to explain these things within the context of the topics the other speakers are going to talk about.

Gef Flimlin

Thanks Arnie. What Arnie was saying about those two curves is the kind of thing we see in the larger adults and we don't know what's going on earlier on. John Kraeuter and I, John is with the Haskin Shellfish Research Lab in Rutgers, have been working with hard clammers in New Jersey, the wild clammers and the aquaculturists. We found that various things were going on in different places. Again the whole problem points more to what we don't know than what we know. John will talk about the impact of predation on hard clams.

Predation

John Kraeuter

You heard from Pete this morning. He gave us a really good series of examples of the kinds of information that we need. Unfortunately for hard clams, given the value of the resource, we don't have good numbers of harvest or value. I did try to compile it up and down the coast because it's a very dissected fishery. When we think about the value of fishery, you start looking at individual states and it doesn't look like hard clams are worth very much. The big clams in New Jersey are ocean quahog and surf clams. You're looking at the 60 to 80 million dollars a year worth of landings. Very, very significant poundage. When you look at hard clams, it looks almost insignificant particularly in the pounds of clams on a coast-wide basis. And yet the value is absolutely equivalent to the surf clam and ocean quahog fishery. So it's an enormously valuable fishery. It has huge numbers of people involved in it and that's part of the problem. We have virtually no data on stocks. We have no long-term data sets like we have on oysters anywhere in country that I am aware of. If anybody has any, I would be really interested in it.

You've seen oyster stock data, going back to the eighteen hundreds. We have data in our laboratory on Delaware Bay of oyster seed beds from 1956 through present and yearly samples on all the Delaware Bay seed beds. We did a summary, Steve Fegley, who was there a few years ago, did a summary looking at the 1989 data along with Susan Ford and me. The numbers are rather startling. The average set on the bay-wide basis per bushel, based on dredge samples from the bottom, in the winter of the year, was 51 spat per bushel. The peak year of 1972 had a booming success, the bay-wide average was 2100 spat per bushel. That's a factor of 40. Say, why are you bringing that up? This is a period from 1956 to the current, almost 40 years, maybe a little bit more. One set sustained the fishery for about 7 to 8 years despite disease and everything else. Our memories as scientist; our memories as fisherman, fishers if you will; and our memories as managers do not tend to span 40 years. Without the numerical support, we simply can not say anything about stocks of hard clams. The landing data are worst than the oyster data. So we have virtually no support for anything we wish to say other than the experimental kinds of things that Pete has done. That's a real serious problem for hard clams because the recruitment there is even lower than oysters. You're dealing with an animal where it is very, very difficult to find the seed.

There is a study by Steve Malinowski up in New York, where he did some shell sectioning, looked at recruitment, and things like that. He determined there were 0.21 clams per square meter per year, peaking at 1.7 clams per square meter per year, in Long Island Sound. We started looking at the formidable logistics of trying to get enough samples to say anything. It's very, very difficult. So perception is part of the problem. And it's perception, not reality. I think there is no doubt in some areas, in some states, in some times, we can easily deplete these resources. If we are talking about recruitment. That's low. You're talking about maybe harvesting one clam per square meter per year, on average. If you do more than that, you're going to over fish it. There's almost no doubt about it with those kind of levels. So that's the problem.

Now, I am suppose to talk about predation. One thing we do know about hard clams is that there are a whole host of predators that work very effectively on seed clam. That's maybe why we don't see very many. We, as Arnie pointed out, have almost no data on larva. We have no data on predation of larva in nature. We have no data on post set predation in nature. The data really began when the clams reach about one millimeter. Then virtually everything else out there bigger than they are eat them. I'm trying to compile all this right at the moment. For large clams, it's much easier. There are only a few major predators for large clams up and down the coast. Conch genus *Busycon*, by-and-large, are able to handle large adult hard clams. In the New England area, possibly starfish and maybe lobsters are the main predators. When you get into the intertidal zones, you've got a few bird species. Oyster catchers surprisedly can be remarkably efficient as well as sea gulls. By the time you get into the subtidal, you've got a few fish, cow nose rays, and things like that. That's your adult predator. For the juvenile clams, the smaller the clams, the more predators you can list.

Some of these rates are extraordinarily impressive. If you look for things like snails, they're not very impressive at all. You're looking at the range of 0.1 to 0.5 clams per snail per day. That's the across the broad range of drills and conchs and things like that. By the time you get to crustacean, you've heard Pete allude to the crustacean problem, it really depends on if it's a very strong size thing. Hermit crabs, most people don't think of hermit crabs as being important, rates up to 240 one-millimeter seed per day.

Now, I am hesitant to add laboratory experiments. We have a serious problem with this, particularly when you get to things like blue crabs. If you extrapolate some of the short term studies that have been done, you can get things up to 1400 five-millimeter seed per day. Very unrealistic because they are 6 hours experiments. But they ate something like (this is some of Bill Arnold's data) they're eating 885 clams in 6 hours. That's in a bare tray by the time you add the gravel that's down to 180 clams. That's five millimeter seed. If you go to 10 millimeter seed in a bare tray, instead of 885 clams it is 220 clams in 6 hours. But, if you're in gravel, it's down to 90 clams. If you get up to larger seed, 15 to 20 millimeter, those things began to drop down to 10 or 1 clam per crab per day. Supporting the stuff that Pete told you this morning. But there is a whole host of other things. You have *palaemonetes* shrimp, which can consume 50 one-millimeter seed in 24 hours, about the same rates. You can talk about green crabs in New England. So, we have plenty of data to suggest crustacean predators are probably the limiting

thing on hard clam seed in most habitats. The sweep of predators out there will very definitively affect the kind of restoration you wish to effect. How you control those is problematic because, of course, most people would not want to use pesticide and things in the environment. Although it has been proven to work very well in certain areas.

I think I am just going to stop there. Other than to say we have the techniques to direct restoration programs. Shelling the bottom and other things do work. But we can't use any of these technique with any confidence because we do not have the replicated experiments that are necessary in order to make any kind of recommendation.

Gef Flimlin

Thanks John. Helping the industry is paramount in my job. And one of the most interesting things is recently a group of hard clammers from Northern Mammoth County area, where approximately half of our total state production of hard clams come from now through a relay and depurating process, are starting to get worried about the stocks that are in their area. These are clammers, who are making over \$50,000 a year yanking on a rake. Some of the numbers go up higher than that. They're concerned about what's going on there and how they can be part of what they need to do to make themselves sustainable. They contacted me. I sent them to Gregg Rivara and we talked. Gregg said, "Did you see Pete Peterson's article?" And I said, "Well it's in there. I haven't gotten to it yet." He said, "Well there is some information in there these guys might be interested in." Well they've taken some of Pete's work and taken a look at that and are actively pursuing grant funds to try to do restocking programs on their own (with some of our help). And it's interesting now that the industry is standing up to the plate and they're getting ready to do something.

In the lower part of New Jersey that has really not happened yet because those guys looked in a different direction. They looked at aquaculture to keep themselves on the water. But it's now interesting to see that industry is actually making an effort on their own. And I wouldn't doubt that if there where money involved for participating, they would start participating in rehabilitation and sustainability of their area. Pete's talk this morning--I think it was one of the best I heard in a very long time--brought up a awful lot of points. I don't know whether you will review some of those again or if you are going to get on to something else because you have been copiously taking notes doing the past talks. Pete Peterson is with the Institute of Marine Science at the University of North Carolina in Chapel Hill. He is going to come back on again now.

Higher Order Interaction

Charles Peterson

Gef caught me waiting until the last minute to write this one. I want to make a number of assertions that I feel have some validity, certainly in North Carolina, but I think more broadly.

They can serve as a template for us to have some arguments. Either now or later. I'm largely going to agree with the guys who came before me and probably the folks that come after me too. Here's the thing about hard clams. There is no fishery independent stock assessment for hard clams. It's a little bit technology-limited. And I got a buddy who was at Tracor who's an absolute genius with acoustics. He developed an instrument that he could pull behind the boat and actually measure that abundance of buried clams with the tool over the swath that you pulled it across. Maybe we should think about getting that thing up and running and try to get some funding to put into play so that we can develop a fishery- independence stock assessment tool. He offered it to me. I could not figure out how I could get the state of North Carolina to pay for the thing. So that's where it died. But in any case, I think that is a real possibility.

Landings, I agree with John, are almost worthless in trying to track the resource abundance. I think in North Carolina there is a big pattern that shows in landings. But beyond that, I think they're almost useless to use as an abundance criteria. Part of the reason is we don't have an effort number to match the landings. So we really can't get a sensible effort number to divide these. Other reasons are that the effort fundamentally varies tremendously. And varies among different groups too depending upon social and economic issues, such as a price that is particularly high or if other fisheries are closed, so that clamming is your only option.

The clam in our state has historically played a really important role as a social safety net. The clam is not an annual crop. So it's not like penaeus shrimp and the scallop which are basically harvested each year. But the clam sits out there for some length of time. So it's kind of like capital in the bank. So if you don't over harvest it, it can sit around and be the safety net for fishermen and small boat fishermen can turn to when the other fisheries are tanked up for one reason or another. They have something to survive on. It historically played that role which means that actually the clam ought to be more conservatively managed by agencies than it is. It ought to be left out there. Now there's a problem with that. That is, we all know as the clam get bigger it's value per unit goes down. So that the economics need to be taken into account. The point is, the clam is really an important resource from a social perspective because it sits there for some time. It's not immune to predation as it gets bigger, but predation risk certainly is reduced. Whelks can eat big ones, but frankly whelks are eating everything that is in sandy settlement anyway. However, there's not much that will get them. Before the large size, other things such as herring gulls and stone crabs can take them. Stone crabs, by the way, are increasing. I don't know if it's a global warming phenomenal or not. But in North Carolina, we've got valuable stone crab fisheries now. Some of you folks might not even know about it. You can actually go out and target stone crabs reasonably and some of the fishermen do.

There are bottom surveys that are run in our state and others. But bottom surveys take so long to run by the time you finish it, the beginning samples are irrelevant. Particularly in our system, it's probably a decade that it takes you to start it and finish it. So what value is that really to management of clam stock. It may say something about habitat and where they were; but, it certainly does not give us an index. So, for clams, we don't have one of the basic tools for fishery management, which is any kind of stock assessment and certainly no fishery-independent stock assessment. What we've got in landings is confounded by aquaculture landings which may

or may not be included in the totals depending upon the vagaries of the state.

One of the reasons that the commercial fishing industry--which is largely driven politically by the dealers-- has not embraced aquaculture adequately in our state is that the clam growers bypass the dealers. They go directly to the market by virtue of the quality, quantity, and predictability of the product that they supply. So they earn a lot of money from that; but the dealers are not all together happy with being bypassed economically in the system. But in any case that bypass can often include a bypass in data recording. Furthermore clams are an important part of recreational fishing and one of the things we need to think about is the value that shellfish provide to the local economy. That is increasingly, in the South East, becoming an economy driven by retirement. And folks like to be able to go out there and do a little bit of what they've historically done. Take their grand kids out and grab a rake and show them where a shellfish lives and catch a couple to bring home. That increasingly needs to be incorporated in our thinking for restoration and management. We need to protect these areas because they are so vital to general economic conditions and the qualities of life. A great deal of harvests goes basically unrecorded and a substantial and growing fraction of what clams as a resource provide to our system doesn't show up is cause for great concern.

Going through all these issues, we see that we don't have a good measure of what the clams stocks are from year to year. As a result, what do we have in the way of management? Basically nothing. Clams just sit out there and managed themselves with a prayer. That's basically the clam management scheme. They are very important product for the social reasons that I've talked about. But also they're important by weight as John was arguing that they've got a long shelf-life and low disease at the moment. Although there is worry--with the density of aquaculture operations--about the inductions and evolutions of disease, that might be a problem in the future. But the clam is a high value product. It is one for which the hatchery work and the raising is well established and we don't have problems in that as a rule. I think there are significant problems downstream with our clam fisheries in the potential for stock recruitment relationships. I spoke earlier about bay scallops and the real potential there because bay scallops tend to fall in basins that are dictated by the hydrodynamics that move between them. That means you can deplete a basin and have a serious problem for hard clams. They've a more continuous habitat over a broader area and long larval life span. So the potential for this is on a larger scale if it does exist.

If we reduce the adult spawning stock, we're going to see an effect on how much recruitment we've got. That's basically the question I think we need to ask. Historically, shellfish managers and biologists have never asked that question. They've assumed that there is no relationship in part because of the high fecundity of invertebrates and in part because if you try to analyze historical data you'll have difficulties detecting any relationship. But the historical data aren't too wonderful. Furthermore, the future is going in directions that history has not traveled. So as we move ahead we start to deplete these clams and affect their environment. We're not in an area where the past gives us a guide, in absence of an extrapolation, which is always irrational. Now in the limit, there is obviously a stock recruitment relationship. That is, if you've got no spawners you're going to have no recruits. At some level, you've got to agree that's going to

happen. But what we're talking about is more practical levels. Here as we have low levels and not 0, some of the problems that Arnie alluded to become really important. These are in fertilization. Will we have adequate getting together of the sexes so that we can continue to have adequate reproduction? That becomes a big problem.

What I have done in this regard is that I've got a fairly long-term data set. I have an eighteen year data-set on a single spot which is central to the hard clam area of the central North Carolina coast. I've gone in by hand and sieved out on one millimeter mesh the hard clams in about 50 square meters at the bottom. I repeated that over eighteen years. Someday I'll publish it. Maybe because I actually got a printout together for these, it will be sooner rather than later.

Here's the story, from 1978 to 1983 the average abundance of clams--these were clams that were 26 millimeters or less, measured in October, sieved out on these mesh things in over 50 meters of the bottom, was 2.1 to 2.7 individuals per square meter. So it didn't vary much. Here's what I'm saying. Here's a period of six years and the range in recruitment over that time period was only 2.1 to 2.7. So it's a fairly predictable level of recruitment that we've had over that time frame. Now from then till now, we have had, in North Carolina, a major removal of clams in the central coastal region like Core Sound, Back Sound, and maybe Bold Sound. That was the consequence of higher prices in the North East. A whole bunch of people going into clamming with a method called clam kicking in North Carolina that was extremely efficient. It removed these big chowder clams that people never touched before. The prices were high enough then that made them worthwhile to take. So there is tremendous enhancement of the catches that is real and a depletion, I think, of the spawning stock. So, I wanted to repeat that. The last two years '94 and '95 the clam recruitment has been 1.0 and 1.6 individuals per square meter. The difference statistically is significant when I grinded those numbers. So it's not down to nothing, but I think it's a sufficient wake-up call that we have a very real potential to have reduced clam recruitment by the reduction of spawning stock. Now, I think as John mentioned, keeping a lot of these big characters in polluted areas and in places where we don't touch them has an important value. The number of eggs goes up as a function of clam size and keeping these monster around in some areas where we don't harvest so they are helping reseed other areas is entirely reasonable. There's a public health problem with that because if we've got that in a polluted area and they're loaded with bacteria, viruses, heavy metals and everything else we've got, the public health agencies would be yelling to go in there dredge them up and put them in the land fill so that the risk that they enter the market is reduced. That is clearly an issue that needs to be balanced. But I think that this issue of stock recruit relationship with the clam is a serious one.

I'm also supposed to talk about higher order interactions. And they are really interesting and some of them are probably relevant. But they are so borderline relevant, let me just mention a few and you can go read about them and then I won't burden this discussion with them. The higher order interactions that come to mind are siphon nipping. A number of people have been doing some very nice work showing the level to which fishes go around nipping siphons of clams therefore determining net growth rates. It's really significant so that the context, the environmental context, in which the clams exist is critical to their growth. And if we sat there

and looked at phytoplankton alone and some other food index, we would fundamentally fail in understanding growth patterns because the growth is getting grazed off by these siphon nippers. That varies as a function of habitat whether you are in sea grass or out of sea grass and varies probably as a function of geographics, whether you're sitting in the India River or whether you're sitting up in the Chesapeake Bay region. There is a lot to learn about that sort of interaction that's not predation, it's grazing. It's not killing the prey, it's just taking the egg laid by the golden goose and letting the goose keep on laying.

Then, we've got hydrodynamic factors that are important. In fact, I think a number of us practically realized that. You've got a bed that you're planting and you try to look to the quotas and the Castagna bible on how to plant clams and what density to use and even updated by a few of the most recent papers. You find that it doesn't always work. You've got to look at the local environment and see what the flow of water across that bed is. If you've got more flow, you can plant at a higher density without a penalty on growth. And furthermore you've got to look at the scale, if you've got a big bed at that same density, you're going to have more density dependence if you've got smaller beds. Then you've got to look at the geographic habitat orientation of what you're looking at. If you're in an embayment and you've got flow coming in at one end and restricted at the other, you have the potential for the arcuson, in the French experience, of actually depleting food within that embayment. And that has relationships to where you want to do your culture; where you want to have your leases; and also the density at which you plant clams on the lease that you've got for one reason or another.

So, what I am saying is that there's a broader environmental context here that includes a landscape scale that's important to consider for shellfish reasons. In my judgement, it is not being considered and should be. Finally predator/prey interaction we heard from John. They exist in the context of alternative prey for all of these predators. So, to know what impact the predators have on the clams, we have to know a lot about the alternative prey in the system. And whether some of that predation is being diverted to something like several specific clam populations in our systems for which there is a small, not very valuable fishery. They may be taking the brunt of the predation by some of the whelks, at least smaller ones, and therefore protecting the hard clams. On the other hand, there are interesting higher order interactions where the presence of one prey can suck in predators and support them at a higher level. Which then dings the guy you'd like to protect from predation. So, the processes by which predator and prey interact are not simply one species doing it but the broader context of alternative prey and alternative predator is vital in ecology. We've got wonderful experimental data sets on rocky shores but have not explored that adequately in soft sediment at all.

So with that, I will just bail and say that there are a whole suite of questions which from other environments that suggests we need to develop and study them in soft sediment as they apply to clam fishery. We really don't have much money to deal with. Clams are not supported by research dollars from industry or from government to the degree that they are valuable in the fishery. And with these sorts of data that I have been collecting suggesting that we're doing damage to the stock over a longer period of time, I think we'd better wake up. That's sort of my pitch on these guys.

Assessing Population Dynamics of Hard Clams

Gef Flimlin

I have a good friend who is a retired clammer. He worked for many years on the bay to support his family of eight, in fact he worked on both sides of the badge. He was a shellfish warden. He taught his family how to work on the water so that they would always have the skills to earn a day's pay.

One day he called and asked if I had seen the article in the North Carolina Sea Grant quarterly newsletter about the clam farmer who had a "pick your own" or "rake your own" operation for clams. He said, that's a great idea. He said put the clams out there so people can go out and get all the clams they want. They would be guaranteed to get them, it's wonderful. So he just hangs up and that was it. Three minutes later he calls back and says, "You know what they ought to do. They ought to take one clam and paint it gold and put that one clam out on that bed. Then if you're working that day and you get that clam, you get your clams free for that day. It would be a great marketing tool". Then after about a minute of discussion, we both agreed that on some days you'd even put that clam out there on the lease.

Steve Fegley, who was a student of Pete Peterson, was formally with us at the Haskin lab in New Jersey for a few years. He's now at the Marine Maritime Academy. He was invited to be with us and because of a number of reasons he is not able to be here. He was going to talk about assessing population dynamics of hard clams and he sent me something down here in which he talks about the rationale and the problem with the whole fishery.

But really what I want to focus on is something that we've touched on a couple times before; but I think we should reiterate. And this is what he talks about for a suggested course of action. He says, (Read from letter) "I argue that we should proceed along two lines of inquiry. First an effort must be made using efficient sampling designs and sampling methods to document changes in hard clam abundances over a range of hard clam habitats in several areas over the Eastern U.S. Coast. It is important that the sampling focuses on all benthic stages of hard clams, juvenile as well as adults. Second several areas of hard clams life history need investigation using field-oriented, experimental methods including: (1) the role of adult dispersion patterns of hard clams spawning success; (2) determination of or realization of relative age and size specific fecundities of clams from different habitats and regions; (3) the importance of embayment flushing rates on hard clam recruitment; (4) examination of the factors affecting pediveliger settlement success; (5) the effects of lateral advection on hard clam juvenile survival and distribution; (6) relative effects of different harvesting methods on juvenile survival; and (7) determination of portion of juveniles that are progeny of the local adult clam." Steve wants to remain part of this process and work with us if we go further.

One of the interesting parts about management, is we look at management on various levels in terms of fishery. We have Federal Management Plans on certain species. We have State Management Plans on certain species. And, in some right field, in a very enlightened city, they

actually have a Town Management Plan on certain things. I use to think Town Management was a strange type of process, but the more I've been exposed to it, the more interesting I find it. Yesterday John Volk and I were talking about a situation in Connecticut called the West River in Guilford where there was a whole bunch of old banana shape oysters. They decided they would do a relay program in which they would move these old oysters out. It was, as a matter of fact, not even in approved waters. So they sent some guys to work on it and the town decided this was what they would do. The fellows were able to go out and work on the oysters and dredge them up. They were getting about seventy-five bushels a day. In small skiffs like you saw on John Clark's talk this morning, specifically Brockway Skiffs, they were taking these oysters and 10% were put out into a public area for recreational harvest for people who wanted to go and access them for their own uses. The rest of them, were being relayed up to Cape Cod for a period of purging for thirty days or so and then being marketed.

As time went on what was interesting was that the town had the foresight to do this. They started to see the dock owners along the West Rivers, where the sediment had filled in tremendously, were coming out giving bottles of liquor to the guys who were oystering. Asking them to come and pull their dredge in front of their docks so they could deepen the area at their dock. As the flushing rate got better in the river, people started bringing their boats back into the river and the dock builders got more work because there was a need to repair things. Biological consequences were that there were nice sets of oysters coming back into the river. Reports of winter flounder showing back up in the estuaries and the ospreys even returning to the trees around the marsh. So it was one thing that went on following another. I always point to it as a really good example of how Town Management can be effective. Because those local people see the economic importance of the shellfish there, they have the were-with-all to make the decision and to move forward.

Sandy Macfarlane, who's with the town of Orleans Conservation Department Cape Cod in Massachusetts, in her previous position with the town had been Shellfish Constable Warden, protector, cheerleader, and has seen this process work in that town and she's going to talk a little bit about the importance of management of quahog fishery to local economy. Now, if she says "quahog" just remember that's hard clam there--a little translation problem.

Management of Quahog Fishery Impact on Local Economy

Sandy Macfarlane

Thank you Gef. Yes we do say "quahog" in Massachusetts. In Orleans which is in elbow of Cape Cod if you are familiar with Cape Cod as the arm of glacier deposits sticking out into the Atlantic.

We are fortunate to have three separate estuaries. In those estuaries, we have soft shell clams, quahogs, muscles, and bay scallop. The clam, scallop and muscles have traditionally had up and down abundance and you can tell that by taking the harvesting statistics as well as by just

looking out there. There was a ten year gap in the forties when there were absolutely no soft shell clams around at all. But the backbone of the economy has always been the Quahog. It has had the stabilizing influence for the fishery for the Cape. The Cape is a tourist area. We heard early about the importance of recreational fishing as well as commercial fishing. We have over 1500 to 2000 recreational permits issued per year to individuals within our town. They can be residential permits where people pay a nominal fee of five dollars. They can be in-state residents or out-of-state residents. Which means that anybody, who comes to our town, can actually go to town hall, get a license, and go get some shellfish. This is a really important aspect. It is an important aspect of the fishery, it is also an important aspect of the economy of the town and the whole tourist industry. Our town is almost completely classified as open water. That is open water by State designation under the Interstate Shellfish Sanitation Conference guidelines. That means the State gives us the authority to manage the shellfish resource under whatever means we want to--by charging the fee for the licenses or by having harvest quotas. The only thing that we can't change is the size limit which is established by the State. If, by chance, we have any contamination, it then reverts back to the State for that management.

Well, we've seen that the harvest statistics, which are poor, are declining as John and Pete have shown. The only difference is that those harvest statistics are based on actual observations at a local level and although our system maybe odd to many of you, we collected the information on a local level. Who is best able to see what is going on in the water but a shellfish constable who is there every single day, and in some cases that shellfish constable is also the harbor master? So he literally is on the water everyday and if he has a pen and pencil with him and a piece of paper, he can actually check who is out on the water and what they are harvesting. He then can take a look at the average of what they harvest over a period of time and get a sense of, if so and so is out on a good day, you know he going to get his daily limit. If so and so is out on a bad day or bad tide, then his harvest may drop and you really get a better sense of this. We also may rely on catch records from the individuals. These records are really poor because there is a little bit of false reporting, we might say. But if you take a look at the combination of the two, you can get a pretty good handle on what is going on with the fishery itself.

With the decline of the fishery and with our management tools, we've been charged by the State to do the best job we possibly can in managing these resources. In our cases, the best job we possibly can has been in developing and implementing enhancement programs at least for the quahog. As I said, quahog is the backbone of the industry. So, we have taken it upon ourselves to initiate a planting program and a seeding program that started back in the mid 70's. We were using hatcheries to raise quahogs to try to augment the natural supply. That means that we had an awful lot of area to try and cover. We had to make some management decisions as to how we were going to augment that supply. In some of the areas that we have taken data for, they have been fairly naturally productive and we wanted to keep that production up. Other areas had been declining for years and we wanted to try to get back some of production in those areas. I was really glad to hear Pete's talk this morning about recruitment. However, not just recruitment but the survival of planted stock in the natural environment that is unprotected. I have been doing that for years myself. I know that some of the stock I have put in has survived.

About three or four years ago we had an influx of people from Great South Bay moving into our area. They had to be resident of the town for up to six months to a year, I can't remember, in order to get a commercial license. They were used to bull raking, using the long handle rakes in Great South Bay Long Island, NY, which was a method of harvest that had not been used in our town for years. Since a real serious decline in one particular area of our estuaries, these guys went out into a place called the town Cove and started raking in quahogs literally like mad. Well, of course, the word spread. It spread back to Long Island. Hey, we've got a gold mine up here come on down or come up so to speak. A lot of people started moving in. A lot of local guys went back, got their bull rake and started raking. Well, when you look at it the harvest probably was 50% of the stock were notatas and there were no notatas except for the seeding program that we put in. So we know that this seeding program in an unprotected area does work to some degree. But it is costly. There are no two ways about it.

That leads to what will you do with that cost and the economics of it? Are the people willing to put that cost into their normal budget? Well they are to a point. The problem with Quahog is that they have a fairly long time in our area before they get to be mature to harvest and in some cases that can be upward of 5 to 7 years. Now in my case as a manager, I didn't care how long it took these to be legal size all I care about is whether the thing survived. If they survived, then primarily they would be of a size that would then go into the reproductive stage. So my main concern was to try to get quahogs into the fishery that would survive and that would then start to procreate and hopefully expand the natural production. Unfortunately people are impatient. When you put something in the ground that is half an inch maybe and you say you've got to wait five or so years before we get any results from this. They look at you and say sorry Sandy that just don't cut it. We don't think this program works. So eventually the program we had started and gotten up to a million seeds planted per year was abolished. I was asked to move on to a different position. The person who took over after me started a modest program of 300 thousand and now were back up to about 750 thousand to a million planted and in a completely different method. It doesn't really matter what the methods are as long as results are the same and as long as you're getting something out into the fishery.

The economics of this is incredibly important. Because the people in the town, such as the property owners are a huge group. They are nonresident property owners who come from some place else (New Jersey) and buy property on the Cape, spend their two weeks, three weeks, or whatever it is. They have some of the high rent districts. It is important to them to be able to go out and pay their high taxes, but go out when they are here to get their shellfish as well. When they come around for town meetings on the budget, it's the shellfish and the shellfish propagation that usually get some funding because people feel that this is an extremely important item. Whether or not they even participate in the fishery, the fact they can go down to town hall, pay five bucks, get a license, and go out and get shellfish is incredibly important to them and therefore is incredibly important to the town as a whole. So with this backdrop of all of the talk that has gone on before me, yes we are very concerned about the recruitment. We know very little about it as Arnie has said. We are concerned about the predation. We have the same predators that John spoke about. We don't have the blue crabs but we do have a nice crop of green crabs. We also have (I am glad Pete mention this also) the nipping of the siphon that has

been observed elsewhere. Actually it is a different phenomenon. It's a combination of the nipping of the foot and/or nipping of the siphon. You can see that when you're transplanting. If we do our transplants in September, which is when we would like to do it to stop babysitting them, we are going to lose almost everything. And we're going to lose them because of bait fish not because of crabs. Bait fish will come along and basically what your doing is providing chum for the bait fish. They're going to come along and bite off a piece of the foot or a piece of the siphon and the Quahog is left on the top. And it eventually dies. If we plant them later on in the year, usually in late November when it is cold and miserable, the water temperature has cooled off substantially so that the predators are inactive or are more inactive. The predators are sort of hunkering down for the winter and aren't as interested in food. That seems to work. That's what we usually end up doing-holding off until mid November for our planting. Unfortunately that usually is the scallop season too. Lately we haven't had to worry about that because we haven't had many scallops, so we get to do the planting. I think I will stop there and just say that the management on the local level, as odd as it may seem to many of the people in this audience, seems to work for us. We've got people who are there all the time watching what is going on. We have the will of the people who are running the town and who are the voters to continue the shellfish propagation and to continue to try and keep the water quality high enough to allow that harvest to take place. Which is also an important issue that is not only for the shellfish harvesters themselves and that part of the economy; but, it's the land uses and the economic factors that goes along with that as well as the will to clean up their act, so-to-speak, to ensure that the shellfish continue to be harvested. Thank you.

Gef Flimlin

Thanks Sandy. Yesterday there was a real interesting discussion about Gulf of Mexico Program Shellfish Challenge. I really enjoyed that and I think that the publication that was put up from it (that's the Shellfish Challenge Plan) is a quite interesting document because it goes through a good method of trying to identify what's going on and put together some good identifiable strategies. There's another document that is part of Maryland's Oyster Round Table Action Plan. This was put together in 1993 and yesterday I spoke with my good buddy Mr. Cynic, Mutt Meritt from Maryland. I said, "What do you think of this? What do you think of the way this thing worked?" He said, "Geffy the thing I like about this thing was there was a great set of ground rules when it all started. They said they were going to get together and were going to talk about oysters. We said, 'hey we've done that before' and they explained that there was going to be a whole different set of rules in this ball game. The interesting part about the rules were that they had a facilitator and if there was one person who didn't agree with one of the strategies, the whole process would completely stop. Kind of like the UN; one veto would stop it. It caused people to really think about not just themselves but the resource and to think about how this whole thing need to go forward. What they did was to break this down into three objectives The objective was to maximize and enhance the ecological benefits of oysters." I said, "Well that's a given." He said, "It took us three hours to write that one sentence." The objectives became, to maximize and enhance economic benefits derived from harvesting in the public and private oyster fisheries, maximize the ability of governments to respond effectively to the magnitude of

the problem, and the fourth thing, which I felt was very important in this whole thing, was that effort should be vigorously pursued to obtain sufficient funding for all aspects of the program recommended.

That is something that many of us deal with in strategic plans and watershed management plans. All these nice ideas got put down. How many times have we heard these phrases? "This is going to be a living document." "It's not going to sit on a shelf some place and gather dust." Well, I've got a lot of dust gatherers in my office. I don't know about yours; but I think that the key for the funding part is something that's really important. Bob Pfeiffer is the director of the Oyster Recovery Partnership out of Annapolis. I invited him because I thought that if we were going to talk about doing something with hard clams that we ought to be able to look to another collaborative effort which is ongoing and has moved along into other things. And have him to discuss a little about how that whole thing worked. What was successful about it? What was not successful about it? Then after Bob talks, I think we're going to open it up to you people. To ask questions, to make comments, and see where we go from here. Okay.

Process for Addressing The Status of Hard Clams

Bob Pfeiffer

As the oyster person with all these clammers, I'm going to try and keep my comments short given the time frame. I know we want to open up for questions. Although landings have been beaten up from the people here at the table. The landings decline in Maryland ultimately lead to oyster round table. By 1993, our landing numbers were virtually pathetic and you were looking at a fishery that was either in or almost in total collapse. It was at that point of time that one of the leading environmental organization, Chesapeake Bay Foundation, began to call publicly for a closure of the fishery. There had been some successes early on. It has now demonstrated quite a bit of success with the rock fish recovery by virtually closing the fishery and by applying the rock fish model to oysters. This was the route that the bay foundation was suggesting. We also, however, had a very strong public voice in the commercial industry to keep the fishery going to try to find some other ways or means to get out of this box. The president of the Maryland Watermen's Association was even quoted as saying, all we need is one more good spat set. So with that kind of background, the round table got together. Gef explained the mechanics, but out of this there's a interesting buy in. The Fisheries Management in the State of Maryland up until 1993 had been process driven. I'm probably going to tick off some people when I get back to Maryland. There was a virtual non-recognition of the role of habitat, the role of the oyster for water quality as an indicator, and the role of the oyster as a benthic community. This document allows the environmental community into the process and then by allowing in the environmental community you get the link to the land. So when I go out to talk to people, they may not really care about landing or the economics. They might not think about that in there day-to-day lives. But they do understand the role of the oyster's habitat. They do understand that they like to go fishing with there kids, not necessarily digging for clams. They like to go fishing for rock fish. So they understand the emphasis of this program. But what they hold my feet to the fire for is,

that we make sure that in the process of the development of this document, you don't lose sight of the habitat piece when we're five years out and we've started to rebuild oyster reefs in key areas of the bay. So to implement this document, the round table recommended that a nonprofit co-venture of waterman, environmentalists, and aquaculturists be formed to implement the document; go hire an idiot that will be willing to keep all these forces together (whew); and away we go. We've been at it for two years. I'm giving a talk this afternoon at 2:30 to kind of explain some of the projects we've got on-going. It's not been a bed of roses. It's a process that I think Maryland is committed itself to for at least the next five years to see what happens with the fishery and also with the environment. That's, I guess, kind of where I'm coming from.

Gef Flimlin

Thanks Bob. Part of the commitment, which was interesting, was that everybody who was on the panel literally signed the document. So as time goes, if someone says, I don't like that part of the action plan--that's too bad. You've already signed off on it. You have to live up to your commitment to have this thing go as we agreed upon when it began. I thought that was a real interesting catch to the way the whole thing worked. Now it's your turn. Anybody here who would like to make comments, additions, or whatever, this is the time to do so.

Questions and/or Comments From the Audience

[Asking the group for comments or questions.]

Gregg Rivara

I would like to put in my prospective. I think we'll go back to the Great South Bay in 1976 where the majority of hard clams in the world came from. Sandy mentioned it too. That's why they're all at your place. Because there were no clams left. But in any case, after 1976 the manager, the town, and the State said what are we going to do about Great South Bay. We had this big set of clams. Where did they all go? I think they took all of the chowder when they took all of the little necks because there is no maximum size limit. I don't know of any State or any town who has a maximum size for hard clams. We've talked about in New York for two decades into the eighties and no one wanted to even think about it. Why? Chowder is chowder you tell fisherman. They don't get the message--high fecundity, high egg viability, and sperm viability they don't want to hear it they think -- it's a clam. If I don't take it, the next guy is going to take it. That's the tragedy of the commons. Now if you go to Raritan Bay, where for the last eight or so years we've had a relay program. The relay program last year moved about 60 thousand bushels of hard clams. About 1/3 of New York state production in about six months. Not even a year-round thing. There is an economic law at work here that leaves the chowder where they were and the fact is that the relayers don't want those big clams. Most of the relayers are using cages or racks. Chowder clams are of low value and take up a lot of space in the racks. They leave them alone. They won't pay for chowder and you can just take these clams home. They have to go on a sealed truck and our DEC is responsible for that. You look at the landings, they remain pretty high for at least 5 to 8 years. Our DEC, just Monday night, said the stocks are

great. This may go on forever hopefully in Raritan Bay. Why not make it something for the rest of state? That's all I have to say.

Gef Flimlin

Thanks Gregg. The clammers in New Jersey are now petitioning the Corps of Engineers (COE) for the Raritan Reach, which is the large shipping channel running through Raritan Bay, to have the clams that are on the sides of the channel removed before the maintenance dredging is done. They want to move them to some other place, let them sit for a period time, and then either harvest them or leave them alone. There has been a lot of talk up in Kill Van Kull, behind Staten Island, where there is a large set of hard clams in very polluted waters. The clammers like that. They like them sitting. They think that those are the brood stock that we talked about that are allowed to spawn for the rest of the bay. Go ahead Pete.

Pete Peterson

I just have a quick response. I think your point is really well taken and we ought to think about so called slot limits in fishery management. That is to say identify a range of clam sizes that is harvestable and leave those big ones alone. Your system, by virtue of the other constraint that people don't want a big clam in their basket taking up room, is serving that function. But that's not observed every where. Of course, in the wild harvest areas, they are probably still taking them, whether or not there subsequently depurated. But, I think that's something we are to take back to our states and put into the process of thinking based on just the kind of comments you're making. Thank you.

I hope we don't have to start v-notching chowder clams though.

Dale Leavitt

I have a concern. Sandy mentioned when they went into Town Cove and started digging up the clams that were in there. They were 50% notatas. I work in a harbor in our state where there are 25% to 30% notatas. You asked Mike Hickey and he said, "75% notatas". Are there any people concerned about that?

What I think of what I saw of the one's coming up, I don't think they were the one's of a natural population of that point. Because the timing was wrong. I think they're actually the ones I planted. I think we've got to worry about that and turn to the salmon as an example of our fin fish counter part. The salmon production from the Pacific North West has held about constant, while the hatchery-raised salmon has increased tremendously. If there is, as some have argued, a carrying capacity for salmon in the system then what we are essentially doing is flooding the system with a single or with a very few genetic stocks of salmon at the expense of the genetic diversity of the wild stock. A key critical issue in genetic diversity is a measure of a species subsequent ability to respond and evolve to environmental challenges as well as removing a set of information that we may be able to act on and use in breeding programs in the future. So I

think we do have to think about that very carefully. Sort of genetic diversity of wild stock of clams. There's a bit here at issue of how much aquacultured clams actually get to spawn and contribute to that wild stock. Of course, since the contribution is proportionate to the clams' size. After the particular size, Arnie was saying like 36 millimeter in length, that they were reproductively active. It is still a dribble compared to what they do later on. But one of the benefits (we actually had a little discussion about that at lunch the other day). We were differing in our opinion about how much aquaculture of hard clams were actually contributing to a recruitment of those clams in uncultured beds in the public bottom. I think if you've got enough 12 years old out there breeding, they're going to, every now and then, have a baby. But the point is, if you have 24 year olds out there breeding, and I'm talking in a human analogy age class term, you have a heck of a lot more reproduction going on. That's what John's going to talk about.

John Kraeuter

No I'm not. While I think there is an important point here, I would tend to agree that the aquacultured clam is not going to contribute very much because they're harvested at a fairly young age. But if you are using the hatchery for a restoration program, then I think you have to think very seriously about this and you should be using stocks from your wild population in your native area and take those into the hatchery for restoration program. Do not buy just the run of the mill hatchery seeds, that are somewhat inbred at the time, depending on the hatchery, there's certainly a lot of diversity still within the hatchery system. But there is a distinction between the two and I think Pete's cautions are important here. If you're doing a restoration program, use wild stocks from the local area for your hatchery broodstock. If you're lucky enough to have your own hatchery, and you're doing your enhancement, yeah, sure you can use all of your native population as the progeny. However if you don't have the luxury of that and you're forced to go outside and use a hatchery, I just don't see it happening on a wide scale for a practical point of view. Unless you can make an agreement with the hatchery operator, which is going to be kind of tough, to get your particular million or five million, whatever it is you want of seed from the particular spawning of a particular animal. That's an argument for having a number of state hatcheries or localized hatcheries, which I think is a very important one.

Many of the commercial hatcheries will spawn if you provide the brood stock at least for oysters and other things. They're doing it right now. A number of commercial hatcheries will take your brood stock and produce seeds for you from those. I think they probably do the same for hard clams.

Skid Rheault

Since my guys are cavorting around the Philippines, I've got to speak up for Rhode Island. We at one time produced 50% of hard clam harvested in U.S. Ninety percent or seventy percent of clams produced in Rhode Island are behind pollution closure lines. Something like 10 to the 9th clams in the Providence River are putting out 10 to 11th larvae every year. None-the-less, we still have a rather startling decline in our landings. I think that we ought to consider some of the

other factors that are affecting survival other than larval abundance. Perhaps we've seen a big change in the ecology of the bay. Starting, if you look back at the nineteen hundreds, with the invention of the flush toilet, the oyster industry which was as big as Connecticut's is now disappeared. Then hard clams became the big fishery. Now in the last three years we've seen huge oyster sets and the figures are telling us that recruitment of hard clams is down. Maybe we're doing too good of a job cleaning up the water.

I think that there are a lot of factors that are playing into this. If I can answer you real quickly Judy McDow at Wood's Hole has been doing work on the reproductive consequences of artificial organics, that are polluting our estuaries system, on clams. She's been working mostly on *Mya*, but I think -some on *mercenaria* too, and the substantial reproductive impairments that are occurring because the levels of PCB, dioxide, and other pollutants that we have in these estuaries. She focused on Boston Harbor but beyond that and other systems as well. So I think that is another area of concern. It may be as simple as silt.

Tom

Well I have two questions. One which will fall on that question. First of all is, Dr. Hughes you mentioned some recruitment numbers in 1973, 1983 then for 1994 and 1995. Do you have the same numbers for the brood stock that would show us a relationship between those recruitment success in brood stock condition? The second one. If soil silted in the broodstock is the factor because I always managed the same opinion that maybe the environmental and habitat factors are more important to the recruitment success in the public brood stock not saying that we won't be able to apply this to other broodstocks, but these are the ones we should pay attention to. If we are concerned about broodstock, then Sandy, instead of putting money into buying seeds to plant in your area, why not buy the large clams from the clammers then tag them in some way (paint them or grease them or something like that), put them into your area, let them reproduce. That will save from your hatchery's purchase of seeds. That may be a better way of enhancing your clam operation.

Pete Peterson

I'll answer your first one. I do not have numbers on brood stock abundance over that time. What I do have is the feeling that there was a tremendous removal of clams. There were certain places in that system where we had sampled before this clam kicking occurred. Before the price went up in the market. Before all the clammers from New Jersey moved to North Carolina to start catching them. There are areas that we basically can't find a clam. These areas had solid volleyball size clams prior to 1980 when they were about. But I don't have a reliable number and I can't relate that pattern definitely to this. The localized habitat I have controlled for is in a very nice environment which I think is unaltered. It's in NOAA's NERRS systems, the Rachel Carson National Estuarine Research Reserve Systems' Plots and certainly hasn't been altered in any gross way. But there are other aspects of the environment that could be changed.

Sandy Macfarlane

Gef could I answer the next question? From 1975 to about 1985 maybe a little longer than that, we were doing both, Tom. We were buying large size quahog from Cape Cod Bay of our own area and transplanting them to our estuaries at some time simultaneously with the hatchery program. We do not have any good indication that the breeder stock that we bought did anymore benefit or less benefit by not doing it. It made us feel good that we were putting some broodstock in our estuaries. I think the problem that we had, in particular, is that the estuaries are large. We were trying to enhance a fishery over a very large area and not concentrating on one particular area and the fact that these programs take an awful long time before you see any results. That time frame is a real important thing for quahogs in our area. People just have to be patient and sometimes it just doesn't work.

John Kraeuter

The timing is of critical importance. As I got back to the early thing 20 years between the massive set that we had in Delaware Bay. Going back I had some numbers from Steve Malinoswki's dissertation. He cranked all his information into a model based on *young* versus *old* survivalship. There is a two-order magnitude difference in survivalship. His conclusion was that the model indicated removing 970 out of a 1000 adults will be the equivalent to increasing the juvenile survivalship from 3 to 7 per thousand. Now, if you're going to put your money somewhere, then you want to enhance a stock in a natural area assuming that the background levels are not high, as Bob Rheault just said, background levels of mercenaria are often very high. That is why the spawner recruit things do not work and plus we don't ever follow up with enough intensive sampling. But, if you're going to do it and if you can protect the juvenile clams, you would have a better response in a small area. If you're trying to do something the size of Narragansett Bay, personally none of techniques are going to ever be able to detect anything. The independent variation out there is so high. We are just going to be sitting out there waving our hands forever. In small areas where you can protect the seed, you will get a very definitely response.

Arnie Eversole

They did a series of studies in Great South Bay that indicated that. They were discussing things like transferring breeding stock to Great South Bay and that it was not economically feasible nor ecologically feasible even at the highest recruitment rates. The key thing, which I may not have underscored about the importance of population density and spatial organization, is that since they spawn, and the eggs and sperm are in the water, you'll need animals together to synchronize these activities. And, the second thing you'll need is optional gamete concentration to get to the base, if you want to have fertilization going on. So that's why we are talking about these things. About brood and breeding stocks sizes and things like that. That's the first step we're trying to achieve. And I think we're carrying it one step further than we need to on some of these questions. I maybe short looping you. I don't know if I am or not.

[I've like got time for one more question.]

Steve

Well actually it's two comments, three comments. One was that, in considering some of the factors that do effect clam populations, one of things that has been pointed out to me in discussions with people who work at the Blue Point Hatchery in Great South Bay and Long Island is that hydrographical conditions of the Bay has changed considerable over the years. Now they have terrible growth rates of their clam stock. What effect that may have on reproduction is another area of concern. Just one small point. I agree totally with John's concern over transplanting hatchery stock into the wild as something that augment from hatchery stock; but one of the things some of town hatcheries use as justification for the records is to transplant notatas to show people that we did harvest notatas and that we took them from our hatcheries. We tried spawner sanctuaries in New Jersey. We brought chowder clams. We had prisoners paint them red. We took them out and dumped them into sites where they all looked like a maroon painted with big rollers all over them. Then the industry went back out at night and reharvested them. Took them and power washed them and sold them again. So the economic benefit was there you see since they got paid twice for it.

Gef Flimlin

I like to thank the panelists for sharing there time and expertise with us. We had support for this program today from USEPA. James Woodley is here. He's going to be putting together a report about today's program. And now the question and it's going to have be kind of a quick answer. Is this something that we should take further? Should we model an examination of a hard clam population on something that has been done with the oysters or should we let this die with this panel decision right now? Dale's going like this (nodding yes). Anybody else want to go like this or does everyone want to go like this (nodding no). Okay then, we should put together a formal collaboration bringing together some state agencies, federal agencies some of the environmental groups. Great!