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Bay Scallop Fishery: Problems and Management

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Edited by

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Technical Report

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ABSTRACTS

GROWTH AND REPRODUCTION OF BAY SCALLOPS IN
SHALLOW AND DEEPWATER EMBAYMENTS

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Although bay scallop populations are most abundant in shallow embayments, large populations are occasionally found at depths of 4.5 to 12 m in Buzzards Bay, MA. Concomitant with large offshore sets are significant increases in the harvestable yields for towns exploiting offshore shellfish beds. Little is known of the frequency of offshore sets, the extent of offshore beds, or the breeding periodicity, growth rates and other life history characteristics of offshore Argopecten irradians populations.

Comparative studies on the reproductive cycle and growth of bay scallops from shallow and deepwater embayments are currently in progress. A bay scallop bed at a depth of 9 m was selected in the northwestern end of Buzzards Bay, southwest of the Red and Black Gong, and, for comparison, an inshore site was selected at Wings Cove at a depth of 2 m. At both locations collections were made every two weeks for analysis of growth rates and gonad development of bay scallops, in addition to monitoring temperature and water quality parameters. For continuous temperature monitoring a microprocessor temperature recorder was deployed.

Histological analysis of bay scallop gonads taken from the offshore station reveals that offshore populations are ready to spawn earlier in the year than inshore populations and have an extended spawning season.

During 1981 and 1982, offshore populations appeared to be ripe and spawning during early June, whereas inshore animals had just attained maturity. Offshore animals also remained competent for spawning until early September, whereas spawning activity had ceased among inshore populations. Little post-spawning mortality was also noted among offshore populations, unlike inshore populations, and the more stable temperature regime at the offshore site probably accounts for this reduction in post-spawning mortality.

By examining the gonad and adductor muscle indices of bay scallops collected from offshore and inshore stations, a preliminary comparison of the gametogenic:somatic energy budget can be made. From May through June both inshore and offshore populations showed a marked increase in gonad index and a marked reduction in muscle index, indicating a greater percentage of energy being channeled into gametogenesis in both populations. During early June, inshore populations of bay scallops had a significantly higher gonad index than offshore populations, possibly due to either spawning activity or reduced reproductive output of the latter population. The reduction in adductor muscle index indicates that energy reserves stored in muscle tissue are being mobilized for gametogenesis. During the late summer and early fall, a marked decrease in gonad index is noted and a significant increase in adductor muscle weight is apparent. As offshore animals are still spawning in early September, marked increases in muscle weight continue through October, after the opening of harvesting season on 1 October. During 1981 offshore bay scallops generated a 20-50% greater muscle weight for the season than inshore bay scallops.

HATCHERY AND FIELD CULTURE OF THE BAY SCALLOP ON MARTHA'S VINEYARD

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Hatchery and field methods for the culture of the bay scallop were reviewed. Procedures include the culture of phytoplankton, spawning, and the rearing of larval, post-set and juvenile bay scallops. As part of our hatchery work, we crossed orange-shelled scallops in hopes of developing a genetically-tagged scallop to be used as a research tool in studying larval movements and survival of seed in the field. About 80% of the F generation of orange parents exhibited orange shell color. Almost 90% of the F¹ generation were orange.

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A SIMPLE SPAT COLLECTOR FOR BAY SCALLOPS, ARGOPECTEN IRRADIANS

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A simple, inexpensive spat collector for bay scallops, Argopecten irradians, was made using old onion bags stuffed with discarded fine mesh netting. Preliminary work in the summer of 1982 using 35 bags put out at various times caught over 5000 scallop spat, with the heaviest set occurring in early July.

During the summer of 1983, 90 bags were hung out which caught over 40,000 spat. The set in the bags ranged from 0 to 1568 scallops, with the heaviest set again occurring in early July. In 1982 most bags were put out in July after the major spawning period; in 1983, however, most bags were deployed in June thus catching a heavier set.

Upon reaching 10-20 mm the scallops were transferred to floating cages where they were grown until they reached 40-50 mm. Afterwards the scallops collected were scattered in good growout areas in Nantucket Harbor and off Tuckernuck Island, areas noted for their high meat yields.

DISEASES OF WILD, CAPTIVE AND CULTURED SCALLOPS

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Although mass mortalities of wild scallops have been frequently reported, the causes for such mortalities have not been clearly defined. While the longevity of some species of scallops has been estimated, the life expectancy for the bay scallop (Argopecten irradians) is controversial. A review of scallop health-related considerations is presented.

In the wild, health, fecundity, survival, and growth of scallops have been related to the physical and chemical features of the natural environment. These include ranges of water temperatures, salinity, turbulence, physical conditions of the natural habitat and nutrient availability. The qualitative and quantitative characteristics of a specific year class, in a specific geographic environment, have been related to population density, depth of the aquatic environment, individual size range, seasonal temperature cycles, success of migration, degree of gonadal development, success of spat fall and metamorphosis, and nutrition. Year class failures have been specifically related to abnormally high fecundity and overpopulation, extremes of temperature, siltation, and reproductive failures.

Predation by starfish, crustacea, molluscs and finfish have been responsible for serious losses. The gastropod, Odostomia spp., and the polychaete, Polydora spp., are especially important causes of mortality in captive or cultured scallops.

From the standpoint of commercial fisheries, direct and indirect traumatic injuries result from mechanical dragging, dumping, culling, shovelling, drying, inserting one scallop into the other, and excessive water turbulence.

Both wild and captive populations are subject to infections and parasitism. Bacterial infections, especially vibriosis, is very common in larval scallops. Rickettsial and protozoan infections (including flagellates, sporozoan and ciliates) are common but of questionable economic importance. Worm infestations (tapeworms, trematodes and nematodes) are of public health concern since some are transmissible to humans. Pea crabs inhabit the pallial cavities of scallops and can be harmful. Fouling of the mantle and valves may produce shell deformities and mantle separation.

In cultured scallops, crowding, fouling, malnutrition, and gas-bubble disease are common causes of mortality. Specific diseases can be observed in cultured scallop populations, and may be of great value in our understanding of diseases of wild scallops.

Observations of the pathogenic effects produced by a specific dinoflagellate (Prorocentrum sp.) upon juvenile bay scallops is presented. Similar problems may exist in the wild.

This study has been supported in part by a grant (No. 1-40-PR01333-03) from the Division of Research Resources, National Institute of Health.

SCALLOPS IN PLEASANT BAY, ORLEANS, MASSACHUSETTS:

A QUESTION OF LARGE SEED

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Environmental questions surrounding the viability of large bay scallops (Argopecten irradians) being harvested in January 1980 but exhibiting no well defined raised annual growth ring as prescribed by Massachusetts General Laws were investigated. It was determined that all the scallops without a ring, including the large ones measuring 60-70 mm height and 65-80 mm width, were, in fact, seed and had not spawned the previous summer. Visual observations of gonadal development corroborated by histological analysis of the gonads performed by investigators at Northeastern University Marine Science Institute, revealed that a population of scallops found in 3-4 meters of water spawned three distinct times while those found in shallower water showed two major spawnings. Both areas showed spawning activity in mid-September. Overall mortality was estimated to be 20-30%. Meat yield from seed to adult increased by 30%. Socio-economic considerations were evaluated especially in regard to the possibility of establishing a size limit on scallops in addition to/instead of the present raised growth ring.

BAY SCALLOP RESEARCH AT THE MILFORD LABORATORY,
NORTHEAST FISHERIES CENTER

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Bay scallop research at Milford is directed at maximizing aquaculture production by increasing our knowledge and control of various life stages of this species. Areas of current work include larval feeding, strategies for hatchery seed production, intermediate culture in raceways and suspended pearl nets, and grow-out experiments using suspended lantern nets.

Our hatchery techniques are similar to those practiced for other bivalves. Early results from feeding studies indicate faster growth of larvae at constant low algal concentrations. Flowing seawater over shallow tables with vertical slats has been used to rear bay scallops from post-set to 3 mm. Raceways have been effective in rearing bay scallops from 3 mm to 20 mm at temperatures above 15 C. Suspension culture of bay scallops has been highly successful in both intermediate and final grow-out using pearl and lantern nets. Scallops deployed in pearl nets at temperatures as low as 5 C had high survival rates. Scallops held in pearl nets at densities ranging from 250-2500/m² had similar growth rates up to a size of 24-25 mm. Single-season growth to market size has been achieved using lantern nets. A mid-season handling of lantern nets produced better growth and survival than monthly

handling. Nets that were not handled during the growing season suffered high mortalities. Growth rates of bay scallops held in pearl nets at sites in Massachusetts, Connecticut, and New York are being compared.

UNUSUAL SCALLOP MORTALITY IN WEST FALMOUTH HARBOR

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This presentation deals with an eye-witness account of a mass mortality of a population of bay scallops during September 1981, in which thousands of seed located in West Falmouth Harbor were seen migrating across a protected shallow flat, across a deep channel, and finally beaching themselves by the thousands. This mass mortality persisted until October 1981 and no explanation as to the cause of this unique behavior can be offered. A three-minute film documenting this occurrence was shown.

SCALLOP CULTURE IN THE UNITED STATES:

A GREAT POTENTIAL THAT HAS YET TO SHOW ITS FIRST SUCCESS

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The biology and ecology of the bay scallop (Argopecten irradians) is reviewed and related to potential aquacultural techniques available to culturists at the local, state, federal, and private enterprise level. Problems facing the culturist are political, cultural, legal, technological, and biological in addition to problems in sales and marketing. Often only the biological and technological problems are evaluated in analyzing economic feasibility of various proposed aquaculture systems. Even in these studies, the scale factor is often grossly underestimated. Production facilities are so far at the other end of the investment scale that the aquaculture operation has little chance of duplicating the laboratory success on a production basis. Based on experience gained on a three-year scallop aquaculture feasibility study and four and one-half years experience at a commercial shellfish hatchery, current proposed aquaculture techniques are discussed and evaluated. The highly successful Japanese sea scallop fishery is briefly summarized and shown to have little practical application for bay scallop enhancement in the United States. It is concluded that production cost on a large scale (⁶>10 scallops/year) will exceed the market value of the scallop product if hatchery produced seed is required and combined with labor intensive use of small units

for field production, such as pearl and lantern nets, or pumped raceway culture that is dependent on ambient temperature and food levels. Pilot production facilities capable of producing a minimum of 10⁶ adult scallops per year are recommended to determine the overall practicality of scallop culture over a minimum five-year period. Corporate or entrepreneurial backing is strongly recommended for the pilot facility as it is concluded that current scallop aquacultural techniques hold little promise to enhance or support recreational or commercial bay scallop fisheries.

QUESTIONNAIRE RESULTS

PERCEPTIONS OF THE BAY SCALLOP FISHERY OF SOUTHERN MASSACHUSETTS:

ANALYSIS OF A QUESTIONNAIRE, OCTOBER 1983

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Introduction

We took advantage of the assembled interest and expertise at the Bay Scallop meeting on October 28, 1983 (Woods Hole, MA) to survey opinions regarding aspects of the local bay scallop fishery. The questionnaire (Appendix I) was designed to characterize the audience and to solicit opinion on the comparative harvest, or the potential comparative harvest for this season, which had just opened for most towns. The level of expertise and years of experience varied greatly among participants, from a commercial harvester with 56 years of experience, a recreational harvester of 35 years, a biologist who has studied the bay scallop for 45 years and a commercial hatchery operator with 20 years experience to new practitioners in all these areas. We present the results of this survey not as scientific facts, but rather as a synopsis of opinion, whether it be informed or uninformed. These results are, in fact, highly questionable scientifically, but they can provide insight of use to regulatory agencies, planners and others whose decision process must take into account public attitudes, as well as to those in the media and in public information who need to be aware of misconceptions where they exist.

Most of the respondents were from southeastern Massachusetts. Three came from Rhode Island, one from Virginia, two from Connecticut and one came from Bermuda. Table 1 indicates that nearly a third of the 57 respondents

regard themselves as "biologists", of which a significant fraction have more than 10 years experience. Included in this group are biologists in academia as well as from town shellfish departments. The next largest group was shellfish officers, of which the largest fraction were new to their jobs. This interesting finding suggests future meetings might more strongly address topics of special interest to this sub-group. Commercial shellfish interests, including both commercial harvesters and hatchery operators made up the next largest fraction and recreational harvesters of varying experience made up most of the balance. "Other" participants included respondents who did not characterize their interest. One Selectman was present.

Results

Bay scallop harvest - Twenty-six coastal areas were identified for comment by respondents to the questionnaire. For nine areas, respondents considered this year's harvest the worst in memory, with waters adjacent to Buzzard's Bay and the south coast of Falmouth conspicuous in this regard. The opinions of the shellfish wardens for the towns of Bourne and Falmouth were in

Table I. Characteristics of the respondent population for the WHOI Sea Grant Bay Scallop Questionnaire, October 28, 1984, Woods Hole, MA.

				Years of Experience									
	1	2	3	4	5	6	7	8	9	10	10		
Shellfish Officers (14)	5	2	1	1	1	1			1	1	1		
Recreational Harvesters (8)			2		3					2	1		
Commercial Shellfish Operations (10)	1	1			2					2	4		
Biologists (20)			3	1	4	2	1		1	2	6		
Other (5)													

Table 2. Summarized assessments of the 1983-84 bay scallop harvest (based on the WHOI Sea Grant Bay Scallop Questionnaire, October 28, 1983). Water bodies named were identified independently by respondents.

Water Body	Size of Harvest				
	best ever A	B	C	worst ever D E	
S.E. Massachusetts					2
Town of Falmouth					1
Town of Barnstable				1	
Town of Bourne				1	1
Duxbury Bay		1			
Cape Cod Bay				1	
Wellfleet Harbor			1		
Town Cove				1	
Pleasant Bay		3	1		
Stage Harbor				1	
Sippican Harbor				1	
Phinneys Harbor					1
Onset/Buttermilk Bay				1	1
Marion					1
Mattapoissett				2	
Acushnet River/Clark Cove				1	2
Westport River				1	
Buzzards Bay, Falmouth				1	
West Falmouth Harbor				1	
Popponesset Bay/Waquoit				1	4
Cotuit Bay				1	
Nantucket					
Nantucket Harbor		1	3	1	
Martha's Vineyard					
Menemsha Pond					1
Sengakontacket		1			
Tisbury Pond			1		
Connecticut					
Niantic River		1			
Poquonock River				1	

agreement with this sentiment. Fifteen coastal embayments were characterized as "worse than average" regarding scallop landings or potential landings, including the areas mentioned above as well as Cape Cod Bay, Stage Harbor, Chatham, and Town Cove, Orleans. Poquonock River in Connecticut was also included in this category.

Only six areas were rated "average" or "above average", and none was characterized as "best in memory". Average areas included Wellfleet Harbor (1 respondent), Nantucket Harbor (5 respondents ranging from above- to below average) and Tisbury Pond, Marthas Vineyard (1 respondent). The only bay rated above average was Pleasant Bay (Orleans and Chatham) for which the season had not yet opened. Judging from subsequent newspaper coverage on this issue, however, it appears the bay scallop harvest at Pleasant Bay was considerably above average. Other areas identified as above average by our questionnaire included Duxbury Bay, Sengakontacket (Marthas Vineyard) and the Niantic River in Connecticut.

Factors responsible - Opinions on reasons for the generally poor bay scallop harvest are tabulated in Table 2; they can be divided into four categories - fishing pressure; pollution, natural environmental factors and vicissitudes associated with the life history of scallops. Overfishing by commercial and recreational harvesters was identified as a direct cause of the generally poor harvest this year. Harvesting of seed (immature) scallops and damage to seed, presumably from trampling of beds and other mechanical damage associated with the harvesting process, were related causes also cited. In the category of pollution, general environmental destruction from increased human waterborne activities was identified as deleterious to scallops. Two

Table 3. Collated opinions on factors affecting bay scallop harvest in Massachusetts in 1983-84 (based on responses to the WHOI Sea Grant Bay Scallop Questionnaire, October 28, 1983).

Reasons for Poor Harvest

Fishing pressure

- Too many people
- Increased human activity
- Too many recreational harvesters
- Too many harvesters
- Overfishing (2)
- Damage to seed
- Taking seed

Pollution

- Pollution
- Oilspill pollution (2)
- Chemical content of water
- Environmental destruction

Natural Environmental Events

- Environmental
- Storm damage to seed
- Temperature too cold
- Codium (3)
- Weather
- Spring rains
- Rain kill of brood stock
- Runoff
- Water temperature
- Warmer than average (2)
- Cold water, no set
- Cold water stress, high mortality and subsequent late spawn
- Gulf Stream Changes
- Eel grass too thick

Life History Considerations

- Inadequate Seed
- No set
- Spat kill
- Poor 1982 set
- No natural set
- Predation (3)
- Conch and crab predation
- High Mortality rate
- Natural variation
- Settling stage mortality

Reasons for Good Harvest

- Good set, mild winter (Niantic)
- Good set (2)
- Seeding into Pond (Sengakontacket)
- Presence of eelgrass bed
- Recovery of eelgrass
- Reduced dragging, from Codium presence (Wellfleet)
- Mild winter (3)
- Deep beds
- Reduced oyster competition

respondents believe oil spills and other chemical pollution in Buzzards Bay are responsible for this year's poor harvest. On the other hand, many respondents feel natural environmental factors were responsible. Water temperature was commonly identified as an important factor, but interestingly enough, both warmer and colder temperatures were cited as deleterious to this year's harvest. Some respondents indicated cold temperatures were directly deleterious to adults and also had the effect of delaying spawning. Storm damage, presumably through mechanical agitation and stranding, and heavy spring rains were cited as important in seed mortality. Three respondents indicated growth of the green seaweed Codium has a deleterious effect on scallops. One respondent said eelgrass beds were too thick this year.

In the category of life history factors, failure at the settling stage (i.e., spat) was identified, without naming causes. "Inadequate seed" and "high mortality" were other problems mentioned. Four respondents listed predation as a cause for the poor harvest and, in one case, crabs and conches were specifically identified as the culprits.

In the few areas with average or above average harvests several surprising and interesting reasons were given. Four respondents indicated the mild winter (?) was responsible. Recovery or presence of eelgrass were other factors listed. One respondent indicated the presence of the green seaweed Codium prevented dragging for scallops and associated damage to the beds, with the result that the population and harvest were larger. Reduced competition resulting from elimination of oysters from the beds, seeding programs and the occurrence of scallops in deep water beds were other factors favoring improved scallop harvests that were identified by this questionnaire.

Remedies and Recommendations - Steps needed to improve the bay scallop

fishery listed by respondents are collated in Table 3. Research on all life history stages was cited as one needed activity. Also, more regulations and better enforcement were mentioned, with specific identification of both limited entry and limited effort (5 day harvest week). Several respondents mentioned environmental enhancement as a needed activity, including thinning of scallop beds, predator control, control of Codium, and the return of shells and gurry to the environment. Artificial seedinmg programs, with culture-based seed supplies was commonly identified as a remedy for a poor harvest, both in terms of providing a public resource and production of commercial stock on private grants. Deployment of natural spat collectors was suggested by one respondent. Finally, a number of participants responding to our questionnaire felt education, public information and closer ties among scientists, fishermen and public officials would improve the scallop harvest. No specific areas of information were given.

Discussion

Responses to the questionnaire characterizing the scallop harvest were sufficiently consistent that we feel they have probably accurately, although qualitatively, assessed the fishery. Perhaps the most surprising result is that a wide variation in harvest occurred in the adjacent embayments of Town Cove and Pleasant Bay. Since these bodies of water are similar in many ways and share a common climate, many of the common reasons given for poor harvest (such as identified by this questionnaire) could hardly be applicable. Much of Pleasant Bay falls within the same shellfishing jurisdiction as Town Cove and many of the same fishermen work both embayments. It is possible that some of the questions regarding the bay scallop could be especially tractable in these adjacent embayments where contrasting harvests stand out from their other similarities.

Table 4. Summary of opinions on needed actions to improve bay scallop fishery in Massachusetts (based on responses to the WHOI Sea Grant Bay Scallop Questionnaire, October 28, 1983).

Research

- Research on larval behavior
- Research on adult ecology
- Further study needed
- Life history research

Regulations

- More regulations
- Better enforcement
- Close seasons for draggers
- Establish controlled areas 2
- Limited entry
- Limited Effort - 5 day week

Environmental Enhancement

- Thin beds and counter strandings
- Put shells and gurry back in the water
- Predator control
- Protect breeding population
- Control codium

Life History and Culture-Based Remedies

- Hatchery seed to supplement natural set 3
- Set out spawning stock
- Use grants for nurseries
- Move seed offshore
- Mariculture at local level
- Spat collectors

Education

- Education
- Public information
- Ties among scientists, fishermen and officials

Causative factors for good or poor harvests were not always consistent. The seaweed Codium was identified as harmful to the scallop fishery, but was also attributed with preventing damage to beds (from draggers) in Wellfleet, with a resulting improvement in scallop survival and in the harvest by other means. Warm temperatures were given both as the reason for poor harvests and better than average harvests. The presence of eelgrass was identified as a benefit to scallops, but its overabundance was given as a reason for this year's poor harvest. Many of these seemingly contradictory viewpoints are, in fact possible in the complex estuarine system where scallops grow, and some of them have been treated in the scientific literature. For example, the same temperature conditions that favor spat survival may favor survival of future predators.

Bay Scallop Questionnaire
Woods Hole Sea Grant Program Bay Scallop Meeting
October 28, 1983

PART A

Name _____

Address _____

_____ Phone _____

Activity	()		Number of years
	()	Recreational Shellfisherman	()
	()	Commercial Shellfisherman	()
	()	Shellfish biologist	()
	()	Shellfish Officer	()
		(Town _____)	

PART B (Please fill out one sheet for each water body, and staple together)

Name of water body _____

Location (Town) _____

Bay scallop harvest this year (was) (will probably be)

- () Best that I can remember
 () Better than average years
 () About average
 () Worst than average years
 () Worst I can remember.

In my opinion, the factors that may be responsible for the bay scallop harvest are:

Things we might do to improve the Bay scallop fishery (use other side if necessary)

Other comments on Bay Scallops (use other side)

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PARTICIPANTS

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