MFR PAPER 1073

Rotation of harvest techniques might boost bay scallop production.

The Bay Scallop Makes Its Bed of Seagrass

GORDON W. THAYER and
HARVEY H. STUART

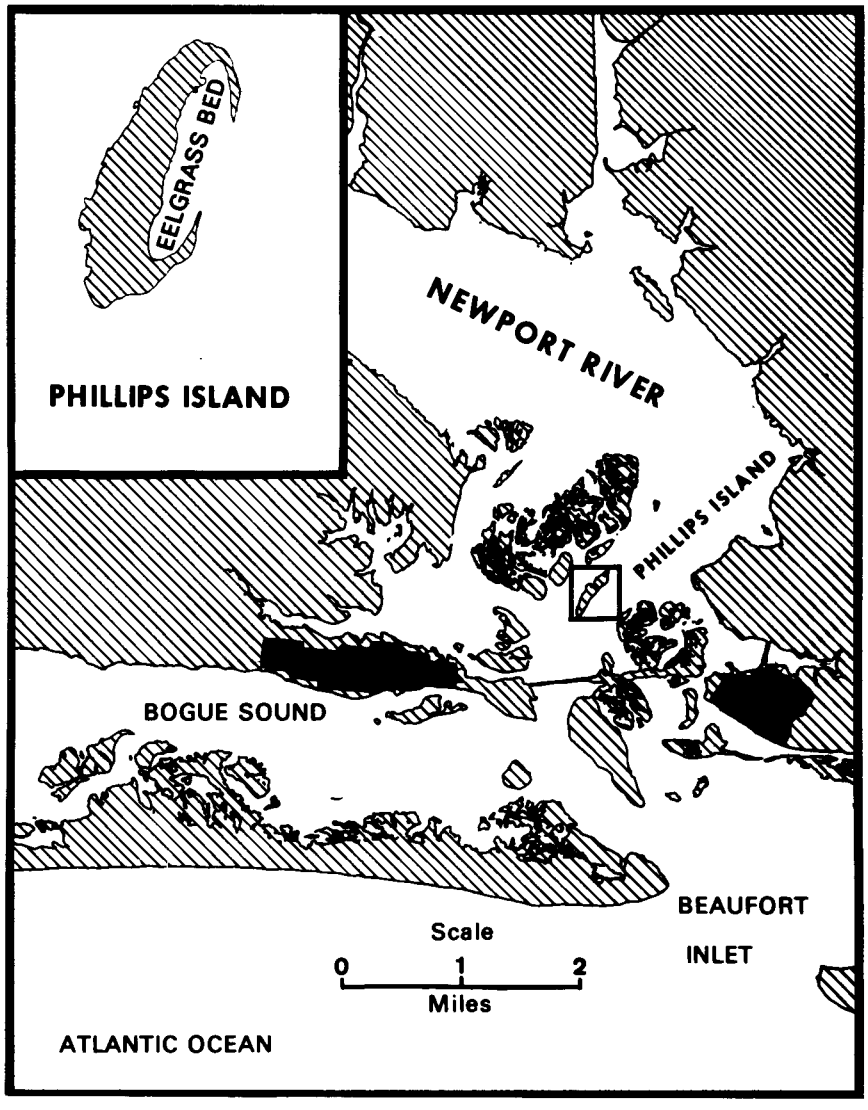


Figure 1.—Diagram of the Beaufort-Morehead City, N.C. area showing the location of the Newport River estuary and Phillips Island.

ABSTRACT

The bay scallop, Argopecten irradians, *an important commercial organism in eight Atlantic coast states, is most often found associated with seagrass. In North Carolina there have been numerous occasions when one or more years of good scallop harvest have been followed by several years of poor harvest, the most recent being 1970-1972. Commercial dredging and trawling for scallops and fish in shallow estuaries disrupt the vegetation and bottom, and this may impede the regrowth of the grass to which larval bay scallops attach. Preliminary data are presented which show that commercial dredging does significantly decrease both scallop and grass density, and it is suggested that annual or biennial rotation of scallop harvesting techniques might increase scallop productivity.*

Gordon W. Thayer is leader of the Ecosystem Structure and Function Task of the Ecology Division at the Atlantic Estuarine Fisheries Center, NMFS, NOAA, Beaufort, NC 28516, and Harvey H. Stuart is a graduate student at North Carolina State University, Raleigh, NC 27607.

The bay scallop, *Argopecten irradians*, has a wide distribution along the Atlantic and Gulf coasts of North America (Sastry, 1963, 1970) where it inhabits bays, sounds, and estuaries (Gutsell, 1930). In these areas it is most often found associated with eelgrass, *Zostera marina*, or other seagrasses. The bay scallop is important commercially in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Virginia, North Carolina, and Florida.

In the 42 years for which data on commercial landings of bay scallops in North Carolina are available (statistical surveys were not made in all years), the commercial harvest has fluctuated considerably both in pounds of meat landed and the dollar value of the landings (Table 1). During 1968-1969 the harvest averaged $392,000 but this dropped to $81,000 during 1970-1972. In North Carolina only Carteret and Onslow counties account for the total commercial landings.

Table 1.—Production and value of commercial bay scallop catches in North Carolina (Carteret and Onslow Counties). Table taken from p. 444 of the North Carolina Commercial Fishery Statistics Landings 1880-1970, Vol. 2. Data for 1971 and 1972 were provided by Statistics and Market News Division, NMFS, Beaufort, NC 28516.

Date	Thousand Pounds	Thousand Dollars	Date	Thousand Pounds	Thousand Dollars
1880	16	1	1952	254	126
1890	18	1	1953	65	33
1897	118	6	1954	72	26
1902	13	1	1955	78	39
1918	423	32	1956	125	63
1923	554	46	1957	109	37
1927	835	120	1958	169	58
1928	1,394	126	1959	128	51
1929	686	38	1960	69	27
1930	432	54	1961	106	42
1931	495	50	1962	168	67
1932	91	6	1963	321	122
1934	36	5	1964	340	173
1936	99	14	1965	379	196
1937	62	12	1966	399	184
1938	30	8	1967	387	211
1939	33	6	1968	639	402
1940	34	4	1969	613	383
1945	22	8	1970	130	91
1950	72	38	1971	60	42
1951	183	96	1972	128	110

Gutsell (1930) suggested that the association between bay scallops and seagrasses arises in part because the grass provides an above-sediment surface for the attachment of the scallop post-veliger larval stage. Later, the organisms detach, grow to adult size, reproduce within one or two years and then are harvested or die. This association also was recognized in the 1930's when pronounced decreases in abundance of bay scallops were observed following the disappearance of eelgrass along the Atlantic coast of North America (Stauffer, 1937; Dreyer and Castle, 1941; Marshall, 1947). The larvae are not solely dependent upon submerged vegetation since they will settle upon sessile animals and shells. Kirby-Smith (1970), however, noted that only those larvae settling on relatively stable eelgrass beds appear to form reproductively significant populations in North Carolina, whereas Marshall (1947) found that the Niantic River estuary in Connecticut has suitable substrate for their attachment in the absence of eelgrass and other submerged grasses.

The activities of commercial fishermen using bottom trawls in the bays, sounds, and estuaries frequently conflict with the success of eelgrass and thus, bay scallops. In North Carolina where bay scallops generally occur in conjunction with eelgrass, scallops are harvested by bar dredges (50 pounds maximum dredge weight) and hand rakes. Both methods tend to uproot the grass, but the former does so over a large area. Intense commercial dredging and trawling for scallops and fishes disrupt the vegetation and bottom and may impede the reestablishment of the eelgrass for the attachment of the post-veliger larval stage of the bay scallop. This activity stirs the substrate and promotes oxidation of the sediments so that recolonization by eelgrass and by scallops may be reduced (Wolfe, Thayer, and Williams, 1972).

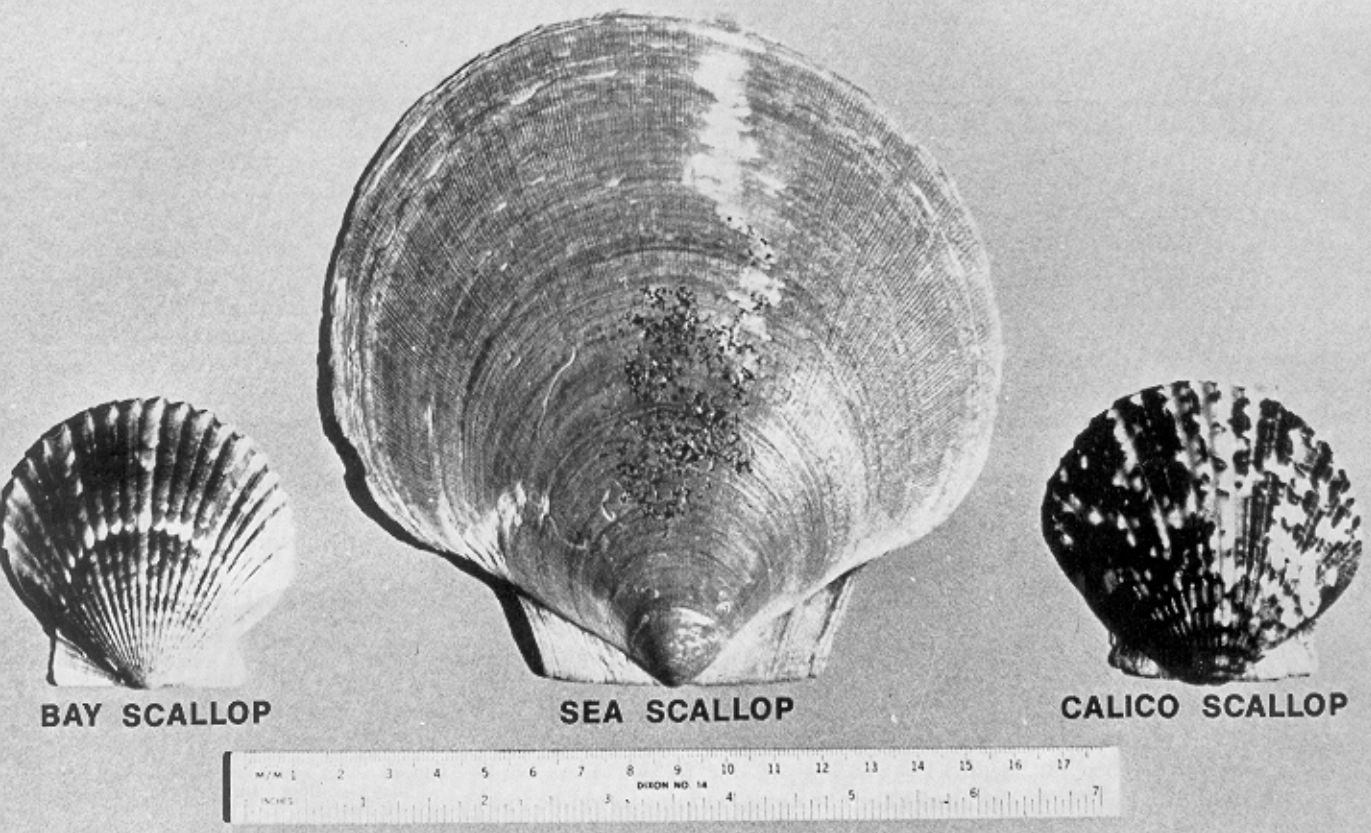
Since 1889, there have been numerous occasions when one or more years of good bay scallop harvest in North Carolina have been followed by several years of poor harvest, the most recent being 1970-1972 (Table 1).

Table 2.—Number of bay scallops/m² and dry weight of eelgrass (grams/m²) collected from an area of an eelgrass bed in the Newport River estuary where there had been commercial raking for bay scallops between December 3 and 17, 1973. Results for three samples on each date are shown.

	Date									
	Jun 25	Jul 11	Jul 25	Aug 8	Aug 22	Sep 27	Oct 31	Nov 20	Dec 19	Jan 16
Number of scallops	48	32	24	36	44	12	0	12	16	12
	36	12	32	28	24	48	28	16	16	16
	28	8	16	32	28	12	16	24	20	20
Average for June-November = 24.8/m²										
Average for December-January = 16.7/m²										
Dry weight of grass	302.0	247.2	195.2	168.0	248.4	84.0	6.4	71.6	62.4	78.2
	240.0	275.2	293.6	224.0	258.4	154.0	56.8	169.2	229.6	196.4
	260.4	287.2	293.6	264.4	280.0	109.6	58.8	177.6	120.0	156.6
Average for June-November = 196.9 g/m²										
Average for December-January = 140.5 g/m²										

Table 3.—Number of bay scallops/m² and dry weight of eelgrass (grams/m²) collected from an area of an eelgrass bed in the Newport River estuary where there had been both hand raking and dredging for scallops between December 3 and 17, 1973. Results for two samples on each date are shown.

	Date									
	Jun 25	Jul 11	Jul 25	Aug 8	Aug 22	Sep 27	Oct 31	Nov 20	Dec 19	Jan 16
Number of scallops	16	24	16	44	32	20	0	24	8	4
	4	20	12	20	36	8	24	16	0	0
Average for June-November = 19.5/m²										
Average for December-January = 3.0/m²										
Dry weight of grass	213.2	182.4	259.6	254.0	278.8	80.8	39.6	143.2	58.8	53.2
	188.4	229.6	193.6	225.2	195.6	54.4	61.2	153.2	125.2	80.8
Average for June-November = 172.0 g/m²										
Average for December-January = 79.5 g/m²										



Relative sizes of the bay, sea and calico scallops are indicated above. Though gourmets prize the bay scallop, the larger sea scallop is more often served. The calico scallop is regarded as "underutilized."

Usually, the poor harvests have been associated with poor crops of eelgrass, which in some instances may have resulted in part from low salinities after hurricanes in the area (1954-1956; 1960-1961). However, since the major hurricane season is during summer and fall, and the scallop season traditionally does not begin until December, hurricanes should influence the succeeding year's eelgrass crop and scallop harvest. Therefore, some other factor or factors must have been responsible for the poor scallop harvests during 1953 and 1960, as well as the poor harvests of 1970-1972 when North Carolina experienced only minor hurricane disturbance.

Since 1969, personnel at the Atlantic Estuarine Fisheries Center, NMFS, Beaufort, N.C., have been studying an eelgrass bed in the Newport River estuary (Fig. 1) to identify the species of the community and to measure their abundance and biomass. We also are determining the movement of energy and materials through the community (Thayer, Adams, and LaCroix, In press). Although bay scallops were present in this area throughout the study, they were not an important part of the community before 1973. Possible reasons for this are that: (1) the eelgrass bed is relatively new (it has only been a permanent feature since 1968); (2) the bed is the only one in the Newport River estuary; and (3) grass and scallop beds nearest to the Newport River are approximately a mile away. In addition, Adams (1974) has shown that young scallops are food for pinfish, boxfish, and toadfish, all of which are present in grass beds. Quantitative collections of organisms and eelgrass made during summer of 1973 indicated that bay scallops were a very important part of the community. Scalloping season opened in North Carolina on December 3, 1973, and during December 3, 5, 10, and 17, a number of commercial fishermen harvested scallops from the area. This enabled us to estimate the effect of commercial harvesting techniques on both scallop and eelgrass abundance.

Dredgers worked the eelgrass bed on only one morning and this was limited to one area of the bed, whereas raking occurred throughout the bed during the four days of scalloping. We estimated the dredging occurred for 2 man-hours and raking for 6 man-hours. Our data suggest that the small amount of time spent dredging one area of the bed had a significant influence on the abundance of both grass and scallops, whereas raking did not.

Table 2 shows the results of our collections in the area of the grass bed subjected only to raking. The number of scallops varied from 0 to 44/m^2 before the opening of the season and averaged 24.8/m^2, whereas after the estimated 6 man-hours of harvest effort, scallop density ranged

from 12 to 20/m² and averaged 16.7/m². Grass density decreased from an average of 196.9 grams dry weight/m² between June and November to a mean of 140.5 g/m² in December and January, a decrease of 56.4 g/m². Statistical analyses (analysis of variance and *t*-tests for collections with unequal sample sizes) indicated no significant difference between scallop or grass density in the raked area before and after the opening of scallop season.

The area that had been subjected to both commercial raking and dredging activities, even though the latter was estimated at only 2 man-hours, showed a statistically significant decrease in both scallop and eelgrass abundance. During the period June through November 1973, scallop density ranged from 0 to 44/m² and averaged 19.5/m², whereas after the opening of the season on December 3, densities ranged from 0-8/m² and averaged 3.0/m² (Table 3). Eelgrass density decreased from an average of 172 grams dry weight/m² between June and November to 79.5 g/m² during December and January. Thus, there had been a decline of 16.5 scallops/m² and 92.5 grams of eelgrass/m² during commercial harvest by both dredging and raking in this area.

The combined activity of commercial harvest by raking and dredging reduced both the scallop population and the substrate (eelgrass) upon which larval scallops are dependent for attachment, to a much greater extent than did raking alone. The information suggests dredging does the greater damage. Although thumbnail sized scallops (1-3 cm shell size) were present throughout the bed prior to the opening of the scallop season, they were not abundant, averaging 3.5/m² for the bed. There was an increase in abundance in mid-December in both areas, but in samples collected during January, thumbnail scallops were found only in the area subjected to raking and not in the area which had been subjected to both raking and dredging.

Low grass abundance and resultant poor scallop harvest (H. Davis and K. Harris, Statistics and Market News Division, NMFS, Beaufort, NC 28516, pers. comm.) may be due to repeated dredging and uprooting of the grass resulting in oxidation of the sediments which impedes regrowth of the grass to which the larval scallops attach. These preliminary data should be followed by supplemental information on rates of recovery and repopulation by grass and scallops in areas dredged. It seems clear, however, that repeated dredging in successive years will inhibit grass and scallop production. This leads to the conclusion that scallop productivity might be increased by an annual or biennial rotation of the type of harvesting technique permitted in a particular area. Portions of estuaries, sounds, and bays could be restricted to harvest by raking for a period of one to two years while the remaining portions would be open to dredging. Following this period the restrictions would be reversed to promote recovery of the area subjected to dredging.

The State of North Carolina has recognized the value of our research efforts on eelgrass communities and by proclamation has established the eelgrass bed in the Newport River estuary as a State-Federal research preserve. We plan cooperative efforts between the Atlantic Estuarine Fisheries Center and the Biology Section of the North Carolina Division of Commercial and Sports Fisheries, Morehead City, N. C., to study the dependency of many commercial and noncommercial, but ecologically important, organisms in seagrass beds in the Beaufort, N. C., area.

ACKNOWLEDGMENT

This research was supported through a cooperative agreement between the National Marine Fisheries Service and the U.S. Atomic Energy Commission. Harvey H. Stuart's support was provided by a Research Assistantship awarded by North Carolina State University. We thank Douglas A. Wolfe, Director of the Ecology Division of the Atlantic Estuarine Fisheries Center, for his critical review of this manuscript. We also thank Dennis Spitsbergen, North Carolina Division of Commercial and Sports Fisheries, and Kenneth Harris, National Marine Fisheries Service, Statistics and Market News Division, for information provided on the scallop fishery in North Carolina.

LITERATURE CITED

Adams, S. M. 1974. Structural and functional analysis of eelgrass fish communities. Ph.D. Thesis, Univ. N. C., Chapel Hill.

Dreyer, W. A., and W. A. Castle. 1941. Occurrence of the bay scallop, *Pecten irradians*. Ecology 22:425-427.

Gutsell, J. S. 1930. Natural history of the bay scallop. Bull. U.S. Bur. Fish. 46:569-632.

Kirby-Smith, W. W. 1970. Growth of the scallops, *Argopecten irradians concentritus* (Say) and *Argopecten-gibbus* (Linné), as influenced by food and temperature. Ph.D. Thesis, Duke Univ., Durham, N. C., 139 p.

Marshall, N. 1947. Abundance of bay scallops in the absence of eelgrass. Ecology 28:321-322.

North Carolina Commercial Fishery Statistics Landings 1880-1970. 1971. NMFS Division of Statistics and Market News, Beaufort, N. C., 470 p.

Sastry, A. N. 1963. Reproduction of the bay scallop, *Aequipecten irradians* Lamarck. Influence of temperature on maturation and spawning. Biol. Bull. (Woods Hole) 125:146-153.

Sastry, A. N. 1970. Reproductive physiological variation in latitudinally separated populations of the bay scallop, *Aequipecten irradians* Lamarck. Biol. Bull. (Woods Hole) 138:56-65.

Stauffer, R. C. 1937. Changes in the invertebrate community of a lagoon after disappearance of eel grass. Ecology 18: 427-431.

Thayer, G. W., S. M. Adams, and M. W. LaCroix. In press. Structural and functional aspects of a recently established *Zostera marina* community. Second Int. Estuarine Res. Conf., Myrtle Beach, S. C., 15-18 Oct. 1973.

Wolfe, D. A., G. W. Thayer, and R. B. Williams. 1972. Ecological effects of man's activities on temperate estuarine eelgrass communities. Background paper for the Coastal Zone Workshop, Woods Hole, Mass., 22 May-3 June 1972.

☆ GPO 799-421

MFR Paper 1073. From Marine Fisheries Review, *Vol. 36, No. 7, July 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*