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Fishery managers have increasingly sought to resolve the open-access and common-property problems in fisheries. Managers have been concerned, however, about age-at-entry or age-at-first-capture. Excessive harvesting of small fish causes economic waste and jeopardizes future stocks of fish. This was the case for the U.S. sea scallop, *Placopecten magellanicus*, fishery when meat count or size based regulations were imposed. Under Amendment #4, which eliminated meat count restrictions, fishery managers remained concerned about age-at-first-capture and recommended that the minimum size of dredge rings be increased from 3.00 to 3.25-inches between 1994 and 1996 and to 3.50-inches in 1996. Unfortunately, the New England Fishery Management Council (NEFMC) and the National Marine Fisheries Service (NMFS) had only limited information about the biological and economic ramifications of larger rings. As a consequence, NEFMC and NMFS supported a Virginia Institute of Marine Science research project, under a Saltonstall-Kennedy grant, on the efficiency and size selectivity of 3.50 and 3.25-inch rings relative to the standard 3.00-inch rings.

With assistance from John Bullard and the East Coast Fisheries Association, industry participation was obtained. Two vessels from the New Bedford/Fairhaven area and one vessel from Hampton VA conducted the first three trips between September and November 1993. The first research cruise was made on the F/V Nordic Pride owned by Roy Enokson and captained by Jim Kendall. The Nordic Pride worked areas off Cape Cod, Stellwagen Bank, the Northern Edge, and the Great South Channel. Drs. DuPaul and Kirkley conducted the experiment aboard the Nordic Pride.

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Two additional research cruises were made between October and November. One with the F/V Alpha and Omega II owned by Bobby Bruno and captained by Bobby Pendergast, and the other with the F/V Captain Malc owned by the Wanchese Fish Company and captained by Phil Beck. The Alpha and Omega II fished from Block Island to Assateaque Md, and the Capt. Malc fished off Virginia and Maryland. DuPaul was the research scientist aboard the Alpha and Omega II and Kirkley was the scientist aboard Capt. Malc.

Bag construction and gear configuration was done by commercial fishermen for all trips. Throughout a trip, crew were allowed to modify gear in any manner provided changes were consistent with Amendment #4. The 3.25-inch ring dredge was configured without the use of donut-spacers in the top (apron) of the dredge. The 3.00-inch ring dredge was configured according to the captains' fishing practices. One captain used donut spacers in the first 7 rows; the other two captains used donut spacers up to one row below the twine top.

Fishing practices were strictly at the discretion of the captain. This permitted evaluation of the 3.25-inch rings under normal fishing practices and with respect to many different fishing areas. Detailed information was collected on length of tow, bottom depth, volume and size of scallops retained for shucking and discarding, type of bottom, tow speed, Loran, and volume of by-catch and debris. Meat counts were taken throughout all trips and at off-loading.

Preliminary observations made during the first few days of the Nordic Pride trip suggested disaster for the New England fishery. Catch by the 3.25-inch ring dredge was 38% of the catch of the 3.00-inch ring dredge. After 246 tows between Stellwagen, the Northeast Peak, and the South Channel, the efficiency of the 3.25-inch ring dredge was 53%--43 bags from the 3.00-inch ring dredge vs. 23 bags from the 3.25-inch ring dredge. There was a slight difference in size selectivity (See Figure 1 which

depicts the shell height frequency for all trips). The dominant shell size caught by the 3.00-inch ring dredge was 3.1-3.5 inches; the dominant size caught by the 3.25-inch ring dredge was 3.5-3.75 inches.

The Captain Malc trip was off the coast of Assateaque, MD and Chincoteaque, VA and on soft bottom. Research results from this trip suggested little difference in the efficiency of the 3.00 and 3.25-inch rings. After ten days of fishing, the difference in total landings was 212 pounds of scallop meats. The 3.25-inch ring dredge was 90% as efficient as the 3.00-inch ring dredge in terms of landings. Relative to the total number of scallops caught, the 3.25-inch ring dredge harvested 12.0% fewer scallops than did the 3.0-inch ring dredge. Size selectivity was nearly identical for the two dredges (Figure 1); both ring sizes selected 2.4-2.5 inch (shell height) scallops which in October and November 1993 appeared to be the dominant size available in the Mid-Atlantic. The 3.25-inch rings reduced, but did not prevent, the catch of scallops smaller than 2.75 inches. For some tows, in fact, the 3.25-inch ring dredge harvested up to 25 baskets of small ($\leq$ 2.75 inches) scallops or the same amount as the 3.00-inch ring dredge. The crew, however, did not retain many scallops smaller than 2.75 inches. The average landed meat counts for the 3.00 and 3.25-inch rings were, respectively, 28.0 and 24.3 meats per pound.

The Alpha and Omega II trip was primarily off New Jersey and Long Island, but tows were also made off Virginia and Maryland. Relative efficiency of the Alpha and Omega II trip was 76%. The 3.00-inch ring harvested about 200 pounds more than the 3.25-inch ring. Size selectivity was similar to that exhibited by the Captain Malc relative to small scallops ($\leq$ 2.75 inches) (Figure 1). For scallops larger than 3.15 inches, the dominant shell size harvested by the 3.00-inch ring dredge was between 3.15 and 3.54 inches. The dominant shell size retained by the 3.25-inch ring dredge was between 3.54 and 3.94 inches. For scallops larger than 3.54 inches, the 3 and 3.25-inch ring dredges caught nearly the same number of scallops.

What can be concluded about the 3.25-inch rings relative to the 3.00-inch rings and prior gear configuration? Our limited number of trips, particularly given resource conditions, does not allow broad conclusions about size selectivity to be made. Depending upon bottom type, skipper practices, and resource conditions, the 3.25-inch ring advanced size selectivity. During each trip, the captain and crew became more familiar with the gear and either made changes to the gear (e.g., changing the length of the sweep chain) or altered fishing practices such as changing tow speed during a turn. Size selectivity and efficiency changed throughout each trip. When evaluating selectivity and efficiency, however, it is important to remember that the traditional configuration (e.g., chafing gear, donut spacers, and chaffing twine in the twine top) of the 3.0 inch ring dredge left little room for escapement.

Overall, the 3.25-inch ring dredge reduced harvest efficiency. Differences depended on fishing practices, bottom type, weather, and resource conditions. In some hard-bottom resource areas and during rough weather, the 3.25-inch ring dredge caught as little as 12% of what was caught by the 3.00-inch ring dredge and allowed escapement of large scallops ($\geq$ 5.0 inches). On some soft-bottom areas with large concentrations of surf clam and ocean quahog shells, the 3.25-inch ring dredge caught as much as 1350% (20.2 vs. 1.4 baskets) more than the 3.00-inch ring dredge. In the final analysis, the success of the 3.25-inch and subsequent 3.50-inch ring dredge to improve resource conditions will depend not only on the technical aspects of larger rings but also on behavioral practices of crews, other Amendment #4 regulations, weather and environmental factors, and economic conditions.

Summary/Overview

Additional analysis of catch per unit effort indicates considerable differences between the three experiments (Figure 2). First, no statistical differences in catch per tow or per hour could be found for the F/V Capt. Malc and F/V Alpha and Omega. Differences in landings between the 3 and 3.25-inch ring dredges were minimal for the two vessels. There was a significant difference in catch per tow or per hour for the Nordic Pride trip.

Differences in catch are likely the result of resource abundances and size distributions available in the resource areas and bottom structure or type (Figure 3). For example, there were few small scallops available in the New England resource areas and few large scallops available in the southern Mid-Atlantic resource areas. Most of the areas fished in New England had hard rocky bottoms while the Mid-Atlantic areas had large concentrations of

shells and were soft bottom areas.

Previous gear studies suggest that ring-size selectivity is not extremely size-specific. Selectivity appears to be as much a function of bottom sediment and structure, availability of resource, size distribution, weather, and captain skills as it is of the size of rings. The 3.25-inch ring dredge clearly allowed some escapement up to about 3.75 inches. Harvest levels were nearly identical for scallops larger than 3.75 inches. Reduced harvests by the 3.25-inch ring dredge appears, however, to be primarily the result of differences in harvesting efficiency rather than selectivity.

Figure 1. Shell Height Frequency Distribution
New England and Northern and Southern Mid-Atlantic Resource Areas

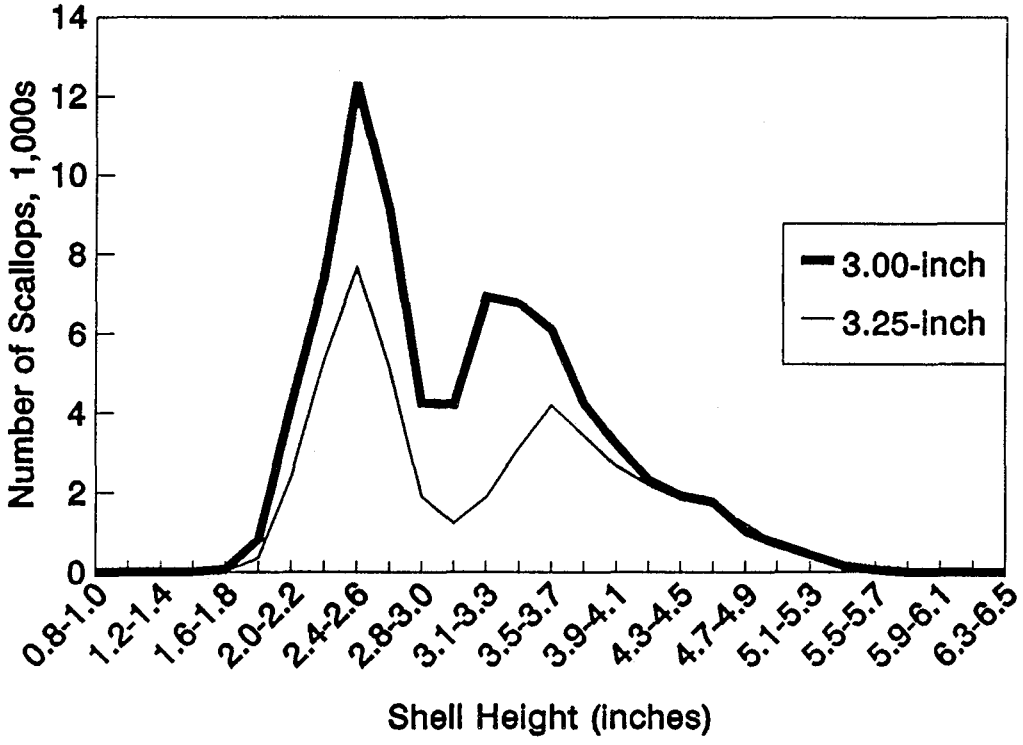

Figure 2. Relative harvest efficiency, 3.25 vs. 3.00-inch ring

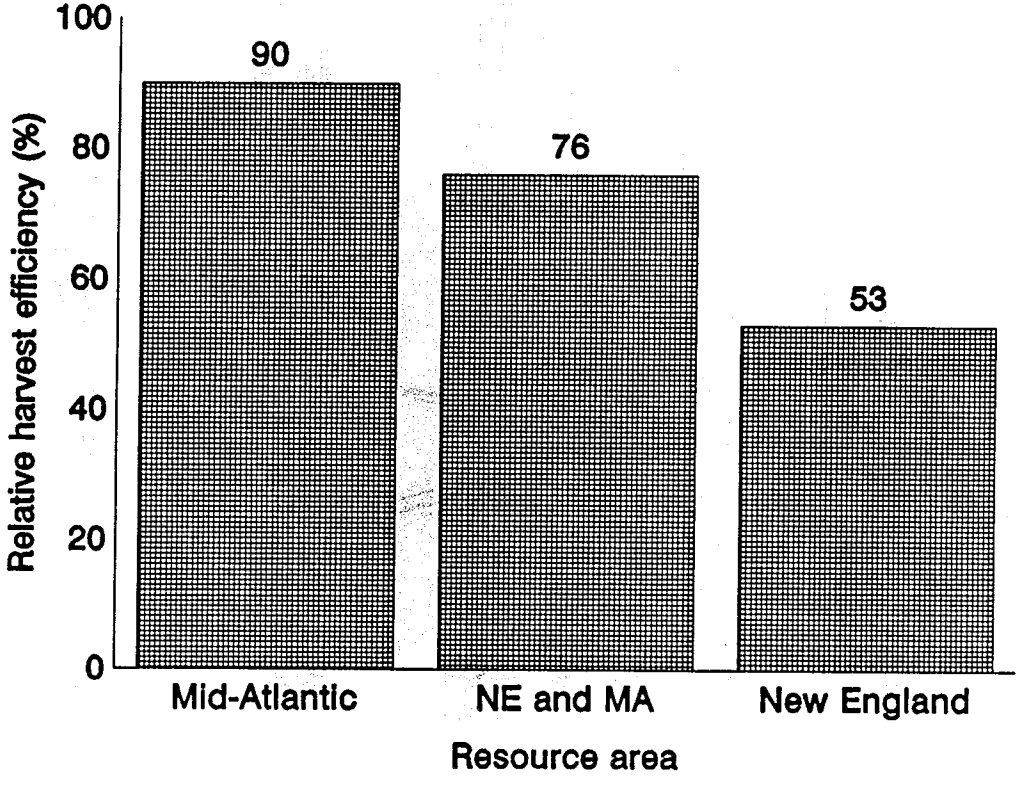

Figure 3. Shell-height frequency distribution by resource area