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The Effects of Different Escape Vents on the Selectivity of Lobster Traps

VERNON E. NULK

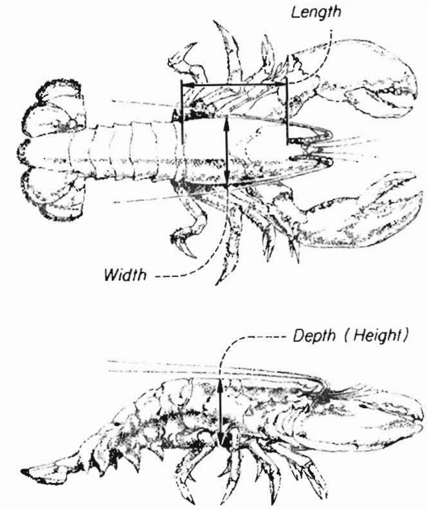

Figure 1.—Definitions of carapace dimensions of *Homarus americanus* and *Panulirus cygnus*.

ABSTRACT—A laboratory experiment was conducted to determine the American lobster's, Homarus americanus, *pot related behavior with respect to escape vent size, shape, and position. Carapace width has been correlated with length and found significant in predicting escapement from vents. The American lobster demonstrated an ability to significantly reduce its carapace width to escape through a vent. Data from the laboratory experiments were compared with data from a concurrent field experiment and means were developed to predict catch size distribution as related to vent size when the size distribution of the total population is known.*

INTRODUCTION

The lobster pot, or trap, used commercially to harvest the American lobster, *Homarus americanus,* on the New England coast is an example of gear which has been made size selective. Escape gaps, or vents, are commonly created on the sides of the pot by altering the spacing between lower laths, and are intended to liberate sublegal lobsters while retaining the legal catch. The advantages of sublegal escape vents in the northern lobster fishery have been summed up by Templeman (1958).

Much work has been conducted to study the effectiveness of escape vents. In 1943, Wilder (1943) performed size selectivity experiments on lobster pots varying the sizes of fishing rings, or head rings, and lath spacing. According to him, the use of wide lath spacing generally caught fewer "short" lobsters and more "canners" and "markets." Templeman (1958), in Newfoundland, performed similar experiments on lath spacing with similar results. Bowen (1963) also found size selectivity to be largely dependent on lath spacing in his spearwood crayfish, *Panulirus cygnus,* pots in Western Australia. He was able to calculate the critical retention rates for various escape gap (vent) sizes based on crayfish carapace depth (Fig. 1).

Vernon E. Nulk is with the Northeast Fisheries Center, National Marine Fisheries Service, NOAA, Woods Hole, MA 02543.

Ritchie (1966) in New Zealand conducted studies with crayfish caught in supplejack, or cane, pots. He experimented with lath spacing, an escape vent panel secured to the pot, and mesh size in an all-steel pot. He considered the total area of the escape vent critical in determining its effectiveness. Winstanley (1971) believed carapace depth in southern rock lobster, *Jasus novae hollandiae,* significant enough in size selectivity to conduct a statistical evaluation of the relationship between carapace length and depth.

Studies such as these have aided fishery managers in determining what regulations should be imposed upon the industry. However, each was generally conducted with a specific legal-sized lobster in mind. If legislation were enacted changing legal size limits, it would be difficult to determine what the new optimum vent size or lath spacing should be without reconducting lengthy research programs. It would prove useful, therefore, to investigate methods to more easily identify optimum vent sizes.

The intent of this paper is twofold: 1) Investigate the behavior of *Homarus americanus* relative to escape vents and define the parameters affecting escapement, and 2) develop a method whereby optimum vent sizes may be specified for each lobster fishery as varying legal size limits require.

Laboratory tests to establish a data base were conducted and the results combined with those from simultaneous field tests to compare laboratory observations with actual catch data.

PROCEDURES

Tank tests were conducted in the laboratory in three phases, each studying lobsters' reactions to escape vents varying in size, shape, and position. The tests within each phase are as follows:

Phase I

44-mm vent (1.73 in)

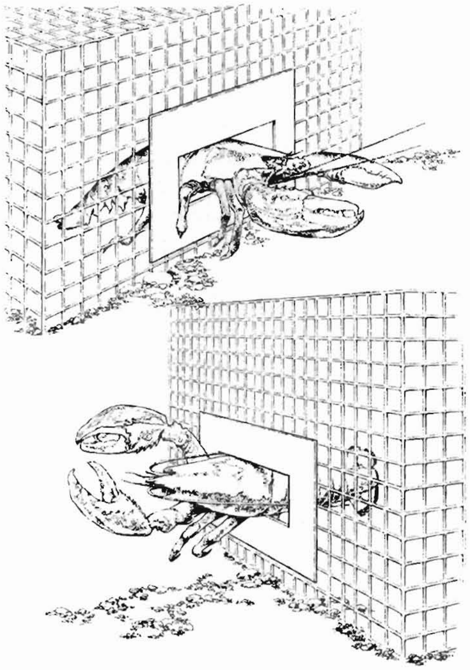

Figure 2.—Escapement as observed in laboratory. Top: "upright" passage through escape vent. Bottom: "on-side" passage.

Phase II
- 45-mm vent (1.77 in)
- 50-mm vent (1.97 in)

Phase III
- 47-mm vent (1.85 in)
- 47-mm vent with increased length
- 47-mm vent positioned high on the pot
- 60-mm circle vent (2.36 in)
- 70-mm circle vent (2.76 in)
- 80-mm circle vent (3.15 in)

Phase I

These tests were conducted from January through June 1973 in a 2,275 l (600 gallon) wood and glass display tank measuring 245 cm (8 feet) long ×125 cm (4 feet) wide ×95 cm (3 feet) deep in the National Marine Fisheries Service Aquarium at Woods Hole. A separate 875-l (230-gallon) wood tank measuring 245 cm (8 feet) long ×125 cm (4 feet) wide ×45 cm (1.5 feet) deep was used as a holding tank. The tanks were supplied with filtered raw seawater flowing approximately 19-23 l per minute. During the course of the experiment the temperature varied from 0.5° to 19°C. Lighting in the test area consisted of double 122-cm (4-foot) long "cool white" flourescent tubes running the length of the aquarium, 213 cm (7 feet) above the tank. A single 100-watt incandescent bulb 152 cm (5 feet) above the test tank provided the only illumination at night.

Thirty-seven inshore lobsters ranging in size from 52 to 92 mm carapace length, 69 mm mean length, were collected off the northwest side of the Weepecket Islands and used in this preliminary test. Their sex, length, handedness, and physical condition were recorded. Each was marked with numbered claw bands and placed in the holding tank. During the experiment the held animals were fed sea herring, *Clupea harengus harengus,* or redfish, *Sebastes marinus,* frames every 2 weeks.

A partition was placed in the test tank, separating one side from the other. The vent, measuring 44 mm high ×152 mm long, was cut out of ⅛-inch Masonite[1], then placed on the partition such that the center of the vent opening was approximately 12 cm from the tank floor.

In each test, one lobster was taken from the holding tank at 0900 hours each weekday, its number noted, claws unbanded, and then placed in the test tank. The lobster was encouraged to pass through the vent from one side of the tank to the other side, by various means of enticement. These means included bait attraction, floodlight avoidance, intimidation by a larger lobster, or confinement by moving the partition closer to the lobster to reduce its search area.

During the course of the tank tests, observations were made to study the lobster's reactions to various vents. Early in the experiment we noted that the test animal, when placed in one side of the partitioned tank, would pace the perimeter, randomly reversing direction, and seldom encounter the escape vent. When a lobster approached a corner of the tank, it attempted to climb straight up the wall, and, at times, climbing up the partition and walking its length to the opposite wall of the tank.

In passing through a vent, a lobster commonly went through, chelipeds first, positioning one on top of the other. It would then maneuver the carapace and tail through, using the legs to assist. Only in two or three instances was a lobster observed backing through a vent, and then only when retreating from another lobster. We found that a lobster too large to fit through the escape vent in an upright position would turn, after its chelipeds were through, and attempt to pass through on its side (Fig. 2). Such maneuvers indicated that carapace width limited a lobster's ability to pass through a given sized vent.

Previous escape gap studies on crayfish and southern rock lobsters consider the smallest outside dimension on the carapace, its depth, an important factor in determining each animal's ability to pass through an escape vent (Bowen, 1963; Winstanley, 1971). An investigation of the morphometrics of *Homarus americanus* revealed that carapace depth consistently exceeds carapace width. Tests were then made to determine the relationship between carapace width and escapement ability.

Lobsters with 44-mm carapace widths proved themselves capable of passing through the 44-mm vent. Therefore, lobsters with widths less than the vent size should likewise have been able to pass through. We refer to this class of "smaller than vent" lobsters as "SV." In Phase I, the percentage of passes occurring in this SV group proved to be lower than expected. In this test it was only 59 percent. A few lobsters with carapace widths greater than 44 mm also passed through the vent. We term these "larger than vent size" lobsters, or "LV." Thus it appears that some lobsters were able to compress their carapace widths to gain access through a vent.

We evaluated the enticement means used in Phase I in an effort to improve the passage of the SV group of lobsters. Where lobsters passed through the vent, we believed 5 percent responded to bait attraction, 21 percent to light

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

avoidance, 31 percent passed during the night, 21 percent passed over the weekend, and 21 percent passed through when placed in the confines of a modified lobster pot. Consequently, procedures for Phase II were modified to replace the partition with a lobster pot to employ further confinement and increased nocturnal activity as the enticement means. This pot is described in detail in Phase II.

Phase II

This phase was conducted from February through July 1974 in a 2,080-l (550-gallon) fiberglass tank measuring 185 cm (6 feet) long ×122 cm (4 feet) wide ×92 cm (3 feet) deep, in the Special Projects Laboratory at the Northeast Fisheries Center's Woods Hole Laboratory. The substrate in the tank consisted of sand and gravel. Two separate 305-l (80-gallon) fiberglass tanks divided into 18 chambers 45 cm (18 inches) long ×25 cm (10 inches) wide ×18 cm (7 inches) deep were used as holding tanks. The water supply was identical to that of the preliminary test. The water temperature varied from 1.5° to 22°C. The only lighting was sunlight passing around drawn blinds on the south side of the room.

One hundred and one lobsters, ranging in size from 54 to 91 mm carapace length (72.6 mm mean length) and 31 to 58 mm carapace width (45.7 mm mean width), were collected from the same area as before and vital data was recorded in the same manner. Their diet was kept the same, except lobsters to be tested within 5 days were not fed. Claws were not banded on the lobsters that were identified by placing them in numbered chambers in the holding tanks. The rest of the lobsters were banded, and evenly divided between two 360-l holding tanks.

Based on the evaluation of the enticement means used in Phase I, a modified lobster pot replaced the partitioned tank. This plastic-coated steel mesh pot measured 86 cm (34 inches) long ×56 cm (22 inches) wide ×35.5 cm (14 inches) high. The parlor head was sewn closed such that only the parlor section of the pot was utilized for the test. The parlor section measured 43 cm (17 inches) long ×56 cm (22 inches) wide ×35.5 cm (14 inches) high. Two sizes of escape vents were tested measuring 45 mm (1.76 inches) high ×152 mm (5.97 inches) long and 50 mm (1.96 inches) high ×152 mm (5.97 inches) long. They were cut in 3.1-cm (1.2-inch) Masonite and mounted, one at a time, on the end of the parlor.

Every weekday at 0900 hours, one lobster was placed in the parlor section of the trap and put into the tank. After a 24-hour period (longer on weekends), results were noted as to whether each lobster had succeeded or failed to pass through the vent. The test then resumed with another lobster until all lobsters were tested.

Phase III

Phase III ran from August through October 1974. The tests were held in a 2,080-l (550-gallon) fiberglass tank measuring 185 cm long ×122 cm wide ×92 cm deep, and a 2,006-l (230-gallon) fiberglass tank measuring 183 cm diameter ×76 cm deep. Both these tanks had a sand and gravel substrate.

The divided tanks used in the second experiment and two 360-1 (95-gallon) fiberglass tanks measuring 135 cm long ×75 cm wide ×38 cm deep were used as holding tanks. Water supply and lighting were the same as the second experiment. The temperature varied from 13° to 22°C.

Forty lobsters ranging in size from 60 to 92 mm carapace length (75.5 mm mean length) and 36 to 57 mm carapace width (46.2 mm mean width) were collected from the same area as before. Individual lobsters were coded for later identification by colored lobster bands placed on the upper part of the chelipeds. Fourteen of the lobsters were each placed in one chamber of the divided holding tanks with their claws unbanded. The 36 remaining lobsters were evenly divided between the two 360-l holding tanks with their claws deactivated by rubber bands to reduce damage from aggression. The lobsters were fed on the same diet and in the same manner as in Phase II.

The number of test pots was increased to four to increase the rate of data return. These pots were made from wire mesh lobster pots by severing the parlor from the kitchen sections and patching the open sides on each with wire mesh and synthetic line. Each pot was made so that a 28-cm ×28-cm piece of 2.5-cm mesh plastic-coated wire, on which a particular escape vent was mounted, could be moved from one pot to another. All vents were made from 3.1-mm Masonite. The characteristics of the four pots and vents are as follows:

Pot 1. 56 cm long × 56 cm wide × 36 cm high
- a. plastic-coated steel mesh
- b. standard vent—47 mm high × 152 mm long
- c. approximately 14 cm from bottom of pot to center of vent

Pot 2. 46 cm long × 43 cm wide × 25 cm high
- a. plastic-coated steel mesh
- b. lengthened vent—47 mm high × 228 mm long
- c. approximately 12 cm from bottom of pot to center of vent

Pot. 3. 46 cm long × 43 cm wide × 25 cm high
- a. galvanized mesh
- b. high position vent—47 mm high × 152 mm long
- c. approximately 21 cm from bottom of pot to center of vent

Pot 4. 46 cm long × 30 cm wide × 25 cm high
- a. galvanized mesh
- b. circle vent—80 mm, 70 mm, and 60 mm diameter
- c. approximately 14 cm from bottom of pot to center of vent

Four lobsters were arbitrarily chosen. They were identified, sexed, measured for carapace length and width, and their physical condition was noted. Then each animal was placed in one of the four pots. The standard and circle-vented pots were in the 530-l round tank, and the high-positioned and lengthened-vent pots were in the 550-l rectangular tank. Each weekday at

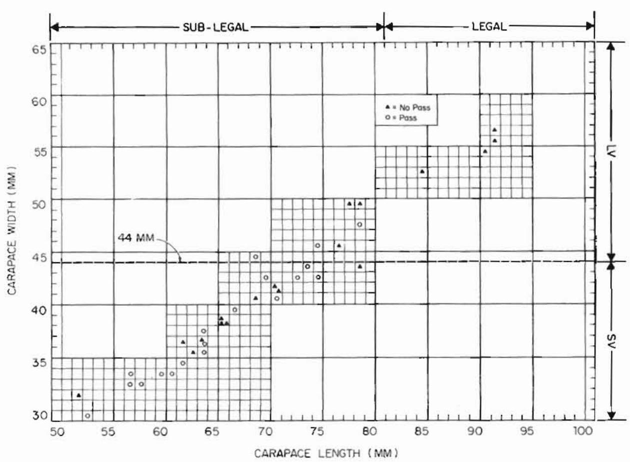

Table 1.—Phase I tank tests, 44-mm vent, 37 samples.

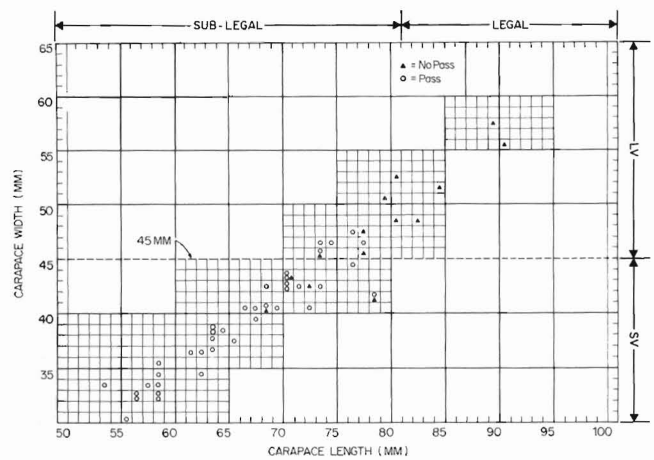

Table 2.—Phase II tank tests, 45-mm vent, 55 samples.

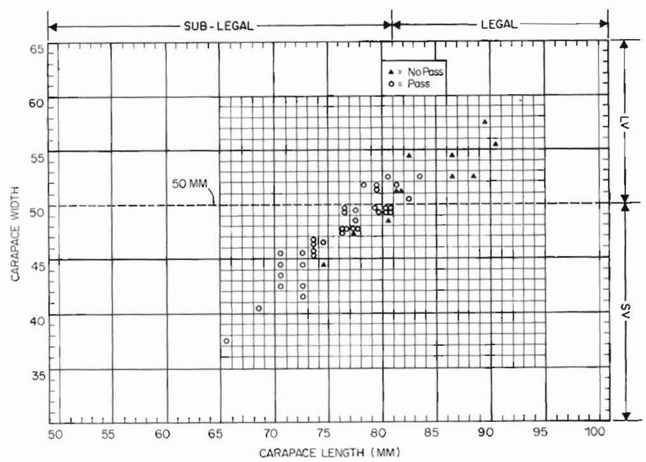

Table 3.—Phase II tank tests, 50-mm vent, 48 samples.

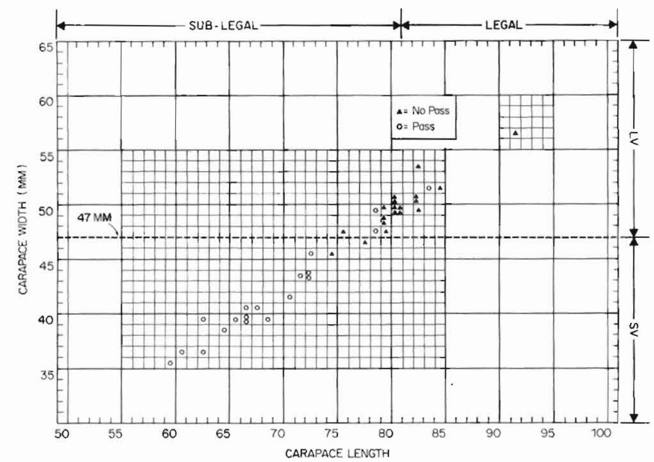

Table 4.—Phase III tank tests, 47-mm standard vent, 38 samples.

1300 hours the location of the lobsters (whether they had escaped through the vent or remained inside the traps) was recorded. Every day the lobsters were moved to different pots. After 4 working days the procedure was repeated with different animals.

RESULTS AND DISCUSSION

Tank Tests

The tank test results are expressed in terms of four basic categories of lobsters. The first two, most commonly used, are legal and sublegal. For the purposes of this study, we define legal lobsters as those with carapace lengths 81 mm and greater, and sublegal as those with carapace lengths 80 mm and less. The second two categories are "LV" lobsters with carapace widths larger than escape vent size and "SV" lobsters with carapace widths less than or equal to vent size.

Tables 1-9 plot individual lobsters tested by carapace length and width. Lobsters having passed through a given vent are identified by a circle, and those that did not, with a solid triangle. The vent size for each test is given and the division between legal and sublegal sized lobsters is indicated by a heavy dotted line.

Phase I

Thirty-seven lobsters, 27 with carapace widths smaller than or equal to vent size (SV), and 10 with carapace widths larger than vent size (LV), were tested in Phase I (44-mm vent).

In this test, there were 19 passes: 16 SV and 3 LV. The percentage of passes occurring among the SV group was only 59 percent when 100 percent should have been able to pass, based on observations made in this study. The largest LV lobster passing through the vent measured 4 mm greater than vent size. Of the 37 lobsters tested, 33 were classed as sublegal and 4 as legal. All of the 19 passes were sublegal and none were legal, resulting in 57 percent sublegal escapement and 100 percent legal retention.

Phase II

Phase II of the experiment tested two vent sizes, 45 mm and 50 mm. Fifty-three lobsters were tested in the 45-mm vent tests: 38 SV and 15 LV lobsters.

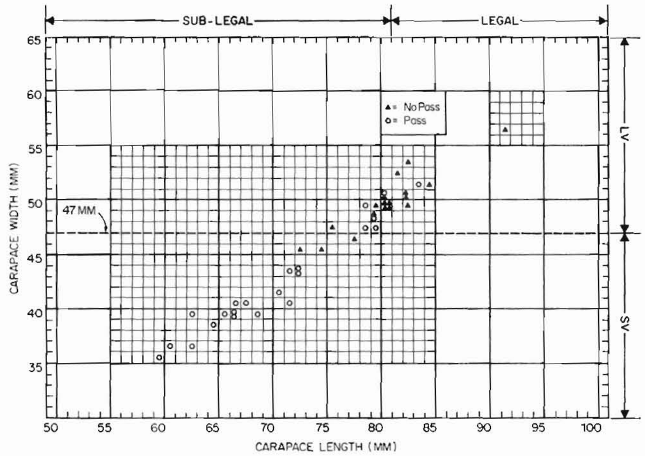

Table 5.—Phase III tank tests, 47-mm lengthened vent, 40 samples.

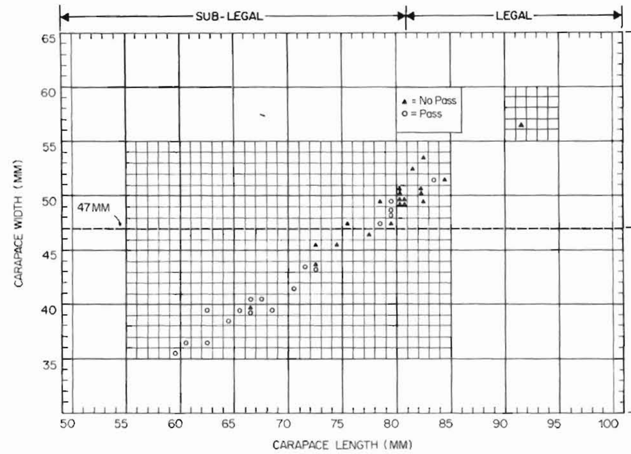

Table 6.—Phase III tank tests, 47-mm high-position vent, 40 samples.

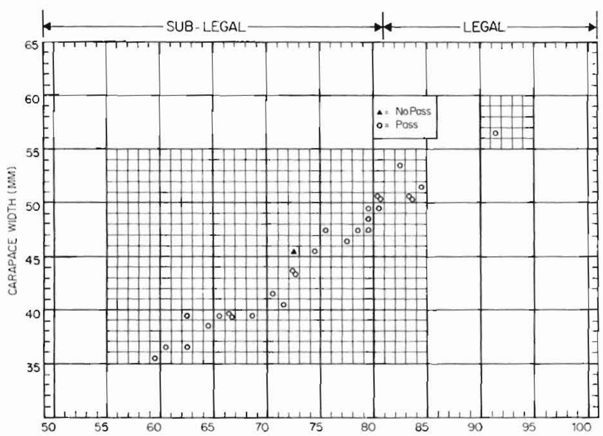

Table 7.—Phase III tank tests, 80-mm circle vent, 29 samples.

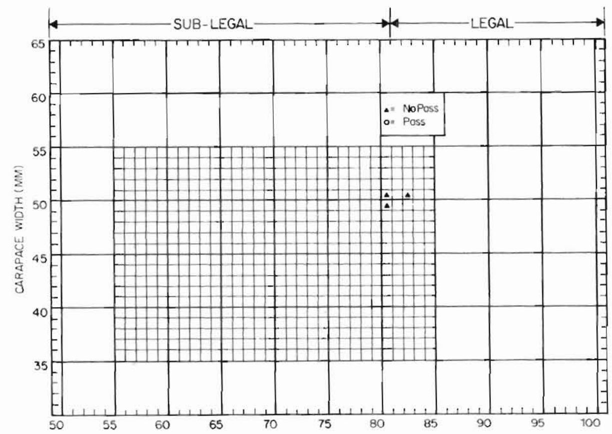

Table 8.—Phase III tank tests, 70-mm circle vent, 3 samples.

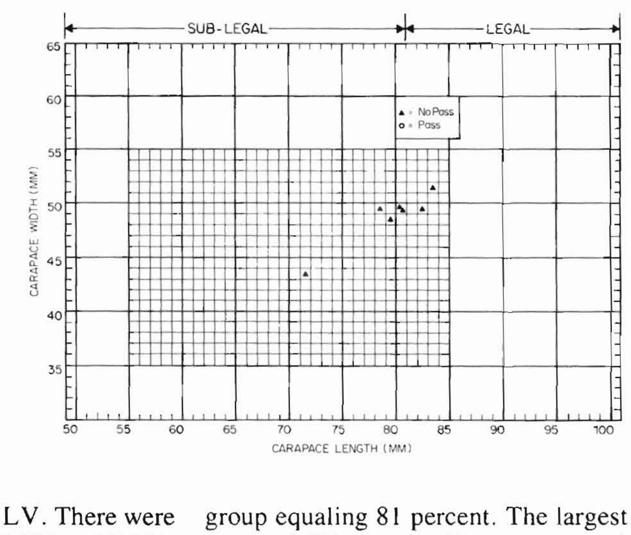

Table 9.—Phase III tank tests, 60-mm circle vent, 7 samples.

Thirty-four SV and 5 LV lobsters passed through the vent, totaling 39. The pass percentage of SV lobsters increased from 59 percent in the Phase I 44-mm vent test, to 89 percent with the 45-mm vent. We attribute this increase at least in part to the use of the modified pot (Phase II) rather than the tank partition (Phase I). The largest LV lobster passing in this test had a carapace width 3 mm greater than vent size.

Forty-seven of the 53 lobsters tested were of sublegal size and 6 were of legal size. Thirty-nine sublegals passed through the vent, equaling 83 percent sublegal escapement. None of the legal lobsters passed, resulting in 100 percent legal retention.

The 50-mm vent was tested with 48 lobsters: 33 SV and 15 LV. There were 37 passes in this test: 30 SV and 7 LV, the pass percentage occurring in the SV group equaling 81 percent. The largest passing LV lobster in this test measured 3 mm greater than vent size.

Of the 48 lobsters tested, 31 were sublegal and 17 were of legal size. The 37 lobsters that passed were comprised of 29 sublegal and 8 legal, resulting in 94 percent sublegal escapement and 53 percent legal retention.

Phase III

This phase consisted of six individual tests, three with 47-mm high vents and three with circular vents measuring 60, 70, and 80 mm in diameter.

The 47 mm×152 mm, or 47-mm "standard" vent test used 38 lobsters: 18 SV and 20 LV. In this test there were 19 passes: 16 SV and 3 LV. Thus, the pass percentage of SV lobsters was 88 percent. The largest of the three passing LV lobsters had a carapace width 5 mm greater than vent size.

Of the 38 lobsters tested, 25 were sublegal and 13 were legal sized. Eighteen of the 19 passes were sublegal lobsters. The sublegal escapement equaled 72 percent, while the legal retention was 92 percent.

The 47 mm×228 mm, or lengthened-vent used 40 lobsters: 19 SV and 21 LV. The 22 passes occurring in this test consisted of 16 SV and 6 LV lobsters. The percentage of passes among the SV group was 84 percent. The largest lobster passing through the vent in this test measured 5 mm greater than vent size.

Twenty of the 26 sublegal lobsters passed through the 47-mm lengthened vent, while only 2 of the 14 legal lobsters passed through. These passes yielded 77 percent sublegal escapement and 86 percent legal retention.

The last 47-mm vent, the high-positioned vent, was placed higher on the pot than in the previous tests. Thirty-nine lobsters were tested here: 18 SV and 21 LV. Passes through the vent totaled 18, consisting of 13 SV and 5 LV lobsters. The percentage of passes occurring in the SV group equalled 72 percent. The largest LV lobster passing through the vent was 5 mm greater than vent size.

Of the 39 lobsters used in this test, 25 were classed as sublegal and 14 as legal. All but one of the 18 passes were sublegal, yielding 68 percent sublegal escapement and 93 percent legal retention.

Three vent sizes were tested in the circle vent tests. The first size tested measured 80 mm in diameter. Twenty-nine lobsters ranging in carapace length from 60 to 90 mm were tested, of which all but one passed through. Consequently, the vent size was decreased to 70 mm in diameter. The first three lobsters tested, all legal size, passed and the vent size was again decreased, this time to 60 mm in diameter. Seven lobsters were tested, ranging from 72 to 84 mm in carapace length. None of the lobsters passed through this vent, and the investigation of a relationship between circle vent size and escapement was discontinued due to lack of time.

An ideal vent would, of course, retain 100 percent of the legal lobsters and release 100 percent of the sublegals. The vent tests in the laboratory indicated that, of the sizes tested, the closest approximation to the ideal size for our definition of a legal lobster was the 45-mm vent. This vent retained 100 percent of the legals and released 83 percent of the sublegals.

Ritchie (1966) concluded that one method of improving the effectiveness of a vented crayfish pot is by increasing the length of the gap (vent), and thus, the total escape gap area. The 47-mm "lengthened" vent test investigated the effect of increased vent area with the American lobster. In this test, the vent length was increased from 152 mm (47-mm "standard" vent—7,144 mm^2) to 228 mm (10,716 mm^2) yielding a 50 percent increase in total area. However, results from the 47-mm "lengthened" vent test showed no improvement over the use of the "standard" 47-mm vent.

During each of the vent tests, at least one lobster whose carapace width was greater than vent size passed through the vent. Although none of the lobsters tested was considered recently moulted, the stage of the moult cycle, i.e., hardness of the shell and amount of meat inside the shell, may have influenced the lobsters' ability to fit through a vent smaller than the lobsters' carapace width.

Field Tests

Strings of vented and nonvented lobster pots were fished in the Woods Hole vicinity as part of a concurrent ghost pot and lobster mortality study. These tests presented an opportunity to test the escape vent in the field. The decision to use 45-mm vents was made on two accounts. The first was the results of the 45-mm tank tests (Table 10) where 100 percent legal retention and 83 percent sublegal escapement was realized. The second was that lobster carapace dimensions taken during these tests showed that legal-sized lobsters (81 mm and greater carapace length) have carapace widths measuring not less than 46 mm. Having no previous indications that the "oversize" passes, observed in the tank tests, occur in the field, we concluded that most legal-sized lobsters should be retained by a 45-mm vent.

The first step taken to analyze data from the field tests, as they relate to the effectiveness of the 45-mm vent, was to assemble a population sample of the American lobster. Our sample totaled 1,523 individuals and consisted of lobsters collected from the Woods Hole area for Phases I, II, and III laboratory vent studies, the nonvented-pot field studies, and from a morphometric study conducted aboard RV *Albatross IV* in 1965. Individuals ranged in size from 54 to 98 mm carapace length, and are plotted in Figure 3 by number of individuals corresponding to a given carapace length and width.

Next, we assumed a lobster will be able to escape only through a vent equal in size or larger than the lobster's carapace width. Figure 4 is a plot of

Table 10.—Legal (81 mm and greater carapace length) retention and sublegal (80 mm and less carapace length) escapement percentages for each vent tested in the tank tests.

Vent size	Legal retention	Sublegal escapement
Ideal	100	100
44 mm	100	58
45 mm	100	83
47 mm standard	92	72
47 mm lengthened	86	77
47 mm high position	93	68
50 mm	53	94
60 mm circle	100	0
70 mm circle	0	No sublegals tested
80 mm circle	0	100

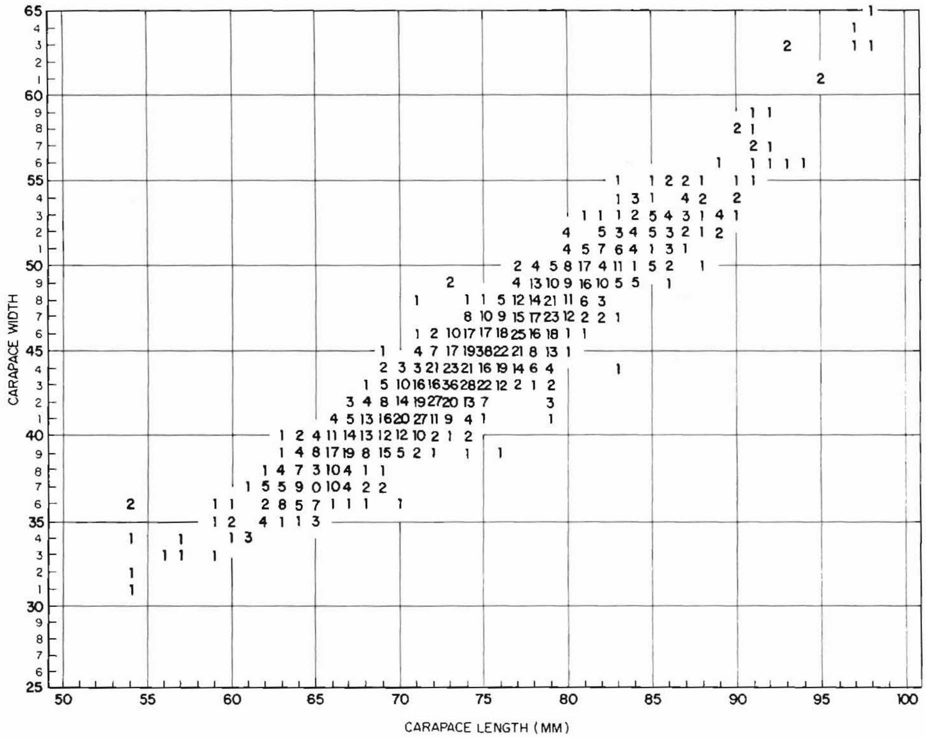

Figure 3.—*Homarus americanus* population samples from New England coast (lobsters collected from Phase III nonvented field tests, Phases I, II, and III tank tests, and from a 1965 cruise aboard *Albatross IV*—1,523 samples).

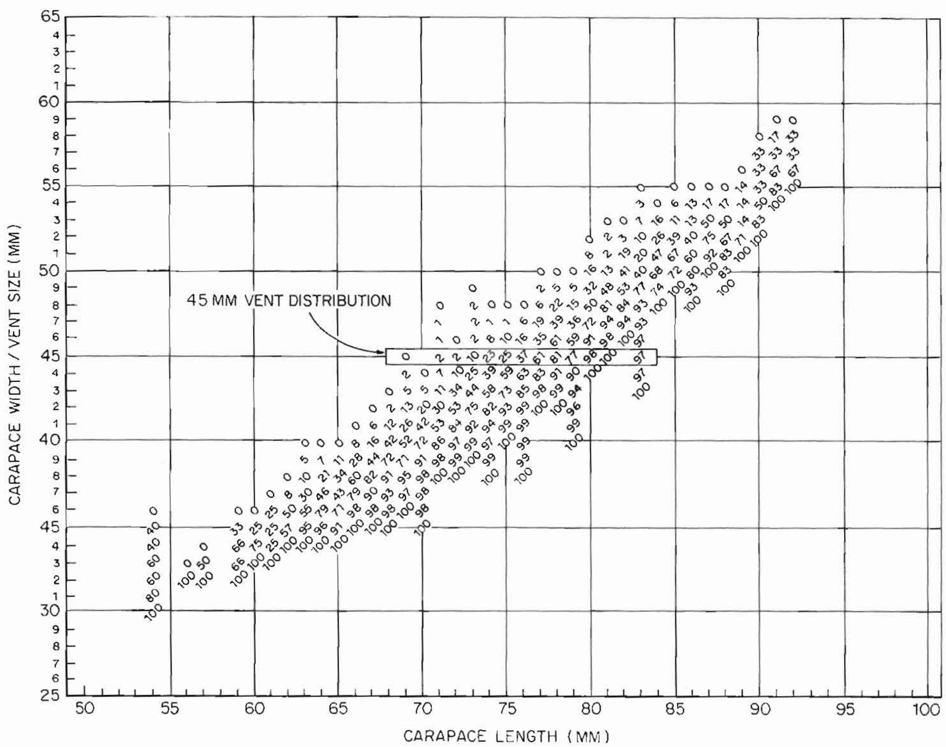

Figure 4.—Theoretical retentions for escape vents.

calculated retention percentages for each vent size by carapace length. These percentages were derived by examining the distributions of carapace widths for each carapace length in Figure 3. By calculating the percentage of individuals retained each time a vent size is considered within the column of a specified carapace length, a range of retention percentages is assigned to each carapace length. For example, consider the carapace width distribution at 65 mm carapace length. The number of lobsters occurring at 40 mm carapace width is four; but if we assume a 40-mm vent is used on a theoretical pot, all lobsters in the 65 mm carapace length column would escape as all carapace widths are equal to or less than vent size:

$$\frac{\text{No. lobsters w/carapace widths greater than 40 mm}}{\text{Total no. lobsters w/65 mm carapace length}} = \frac{0}{25} = 0\%$$

Retention of individuals at 40 mm carapace width and 65 mm carapace length would be 0 percent for a 40-mm vent (see Fig. 4; 65 mm carapace length ×40 mm vent).

Moving down the 65 mm carapace length column in Figure 3, there are eight individuals corresponding to 39 mm carapace width. If a 39-mm vent is now considered, all the lobsters with carapace widths 39 mm and less would escape, but the four widths of 40 mm would not:

$$\frac{\text{No. lobsters w/carapace widths greater than 39 mm}}{\text{Total no. lobsters w/65 mm carapace length}} = \frac{4}{25} = 16\%$$

Four lobsters retained out of the 25 in the column results in 16 percent retention (entered in Fig. 5).

Such retention percentages were calculated for the columns at each carapace length in Figure 5, and the distribution of percentages at 45-mm vent (outlined) was later applied to a theoretical escape vent.

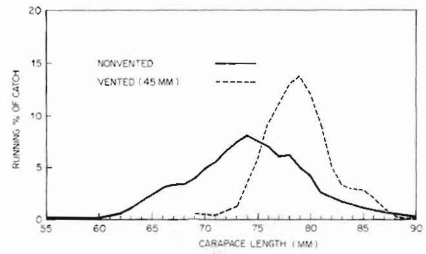

Figure 5.—Catch size distributions from nonvented and 45-mm vented pots fished in Phase III field tests.

CARAPACE LENGTH (MM)	COLUMN 1: NO. OF LOBSTERS NONVENTED POTS	COLUMN 2: % RETENTION FOR 45 MM VENT	COLUMN 3: NO. OF LOBSTERS THEORETICAL 45 MM VENT	COLUMN 4: NO. OF LOBSTERS ACTUAL 45 MM VENT
50				
1				
2	1			
3				
4	2			
5				
6				
7	1			
8				
9	1			
60	1			
1	1			
2	9			
3	15			
4	20			
5	32			
6	46			
7	44			
8	37			
9	53			3
70	62		0	2
1	75	2	2	2
2	78	2	2	2
3	106	10	11	6
4	106	23	24	9
5	102	25	26	33
6	83	37	31	39
7	87	61	53	53
8	64	81	52	60
9	89	77	69	62
80	39	98	38	63
1	35	100	35	38
2	25	100	25	21
3	23	97	23	11
4	16	100	16	14
5	11		11	14
6	13		13	9
7	9		9	5
8	5		5	
9	5		5	1
90	4		4	1
1	3		3	
2				3
3				1
4	1		1	
5				1
6				
7				
8				
9				
100				

Figure 6.—Summary of theoretical catch calculations and actual catches from Phase III field tests.

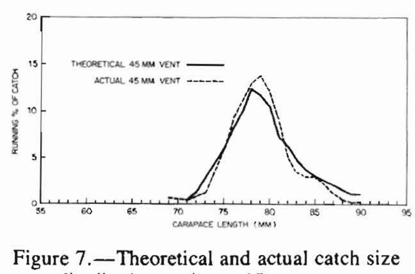

Figure 7.—Theoretical and actual catch size distributions using a 45-mm vent.

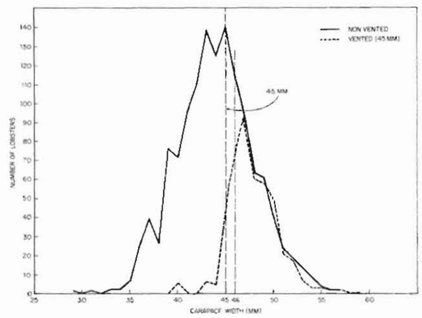

Figure 8.—Comparison by carapace width of catch size distributions from nonvented and 45-mm vented pots.

The field test catches were plotted in Figure 5, and we found a significant reduction in sublegal catch while retaining most of the legals by the use of the 45-mm vent. The nonvented catch totaled 1,304, 1,154 of which were sublegal and 150 legal. The vented catch totaled 454: 335 sublegal and 119 legal. Assuming the nonvented catch was representative of the lobsters entering the vented pots, the use of the 45-mm vent resulted in 71 percent sublegal escapement and 79 percent legal retention.

A theoretical vented catch (Fig. 6, column 3) was calculated by multiplying the 45-mm retention percentage for a given carapace length (column 2) by the number of individuals from the nonvented population (column 1) at the same carapace length.

Comparison of the actual and theoretical vented catches shows differences between the two in actual numbers of lobsters caught. The actual vented catch totaled 454: 335 sublegal and 119 legal. The theoretical vented catch totaled 458: 308 sublegal and 150 legal. However, when expressed in terms of running percentages (Fig. 7), the two catches compare favorably, indicating that our estimate of catch composition is fairly accurate.

Figure 8 illustrates escapement and retention characteristics of the 45-mm vent used in the field tests when examined in terms of carapace width. Here we found 92 percent escapement among individuals with carapace widths less than or equal to the 45-mm vent and 88 percent retention of those larger than vent size. The difference between the two curves at 46-mm carapace width is the first indication that oversize passes occur in the field, and that as much as 33 percent or 38 individuals with widths of 46 mm may have escaped through the 45-mm vent.

We considered altering basic assumptions in the calculation of theoretical catches to include probable oversize passes. However, because the tank tests included passes of up to 5 mm oversize, and the field tests indicated oversize passes only 1 mm larger than vent size, we decided to reserve any modifications in calculations until more information is available on the frequencies of occurence and the size ranges of oversize passes in the field.

Theoretical catch compositions were calculated for a range of vent sizes. Table 11 shows that the 47-mm vent would yield 97 percent legal retention and 90 percent sublegal escapement where minimum legal size is 81-mm carapace length. Vents larger than 47 mm would release more sublegal lobsters, but because substantial overlap of carapace widths occurs between legal and sublegal lobsters at 81-mm carapace length, the larger vents would begin reducing legal retention before 100 percent sublegal escapement was realized.

CONCLUSIONS

Our tests indicate that a lobster pot, fitted with a single escape vent measuring 45 ×152 mm makes the pot effectively size-selective where legal size is 81-mm carapace length. A 47-mm vent may greatly increase sublegal escapement without significantly affecting legal retention, but has yet to be tested in the field.

Ritchie (1966) concluded that by increasing the length of the vent, the effectiveness of the vented pot increases also. Our laboratory tests did not bear this out, but perhaps further tests, focusing on the effect of increased vent length on escapement, would determine if vents longer than 152 mm are advantageous.

The circle vent tests proved little more than to say that, if a circle proves to be an effective vent shape, considerable testing would be required to determine an optimum size.

Similar to studies by Bowen (1963) and Winstanley (1971), we found a relationship between carapace length and width significant in predicting escapement from vented pots. Laboratory tests show that lobsters may turn on their sides to escape through a vent otherwise too small, and that some have fit through a vent as much as 5 mm smaller than their carapace width—the smallest dimension on the carapace. Field tests demonstrated that as many as 33 percent of the lobsters with carapace widths 1 mm larger than vent size, may have escaped through a vented pot.

We have developed a method to calculate theoretical catch size distributions for any size escape vent. If it can be determined that a known population sample is applicable to many fisheries on the New England coast, then substantial savings may be realized in the reduction of costly research programs to determine optimum vent sizes.

Table 11.—Legal retention and sublegal escapement for theoretical vents.

Vent or nonvented	Total no.	Legal lobsters	Legal retention	Sublegal lobsters	Sublegal escapement
Nonvented	1,304	150	—	1,154	—
44 mm (Theoretical)	593	150	100%	443	62%
45 mm (Theoretical)	458	150	100%	308	73%
46 mm (Theoretical)	339	148	97%	191	83%
47 mm (Theoretical)	257	145	97%	112	90%

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