TRAPPING OYSTER DRILLS IN VIRGINIA
II. THE TIME FACTOR IN RELATION TO THE CATCH PER TRAP*1

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In using traps to remove drills from oyster ground, assuming that trapping is an effective method of reducing the activities of these pests, it is important to keep costs at a minimum. One way of reducing the cost of trapping is to increase the time interval between lifts, but if the efficiency of traps varies with time, the nature of this relationship should be considered in choosing the optimum fishing interval.

The influence of time on the catch must also be known to determine the significance of the catch per trap in drill trapping experiments. Dr. Andrews, in the first paper of this series, used the catch per 100 traps per day as an index of availability. Are these indices comparable when the period between lifts of the traps varies, as it sometimes did on account of bad weather or for other reasons?

To test these pcints, 20 traps baited with seed oysters were set from the pier of the Virginia Fisheries Laboratory (Fig. 1). The traps were arranged in two series of 10 each, on opposite sides of the pier, each trap lying on the bottom about half-way between adjacent pairs of pilings, 11 feet apart. The water depth at mean low water ranged from 51 inches at the offshore end of the series to 14 inches at the inshore end. The mean tidal range at Gloucester Point is about 33 inches, therefore, the average depth over the traps varied from 67 to 30 inches.

Other traps were set at approximately the same distance apart, and in water of about the same depth, at two nearby piers located about 500 feet on each side of the laboratory pier (Fig. 1). These traps, five at each pier, were fished at irregular intervals.

The bait was not changed or augmented during these experiments. The traps were lifted individually, shaken vigorously over a screen of 16 meshes to the inch, and returned to the water. The accumulated debris was washed thoroughly by pouring salt water over the screen, and the drills were sorted out. The catches of the individual traps were segregated for later identification, counting, and measuring.

Two sets of experiments were conducted. In the first, the catches in daily lifts of the traps were compared against weekly lifts. In the second series, weekly and bi-weekly catches were compared. The frequency of fishing was alternated between the two series, to eliminate the effects of differential

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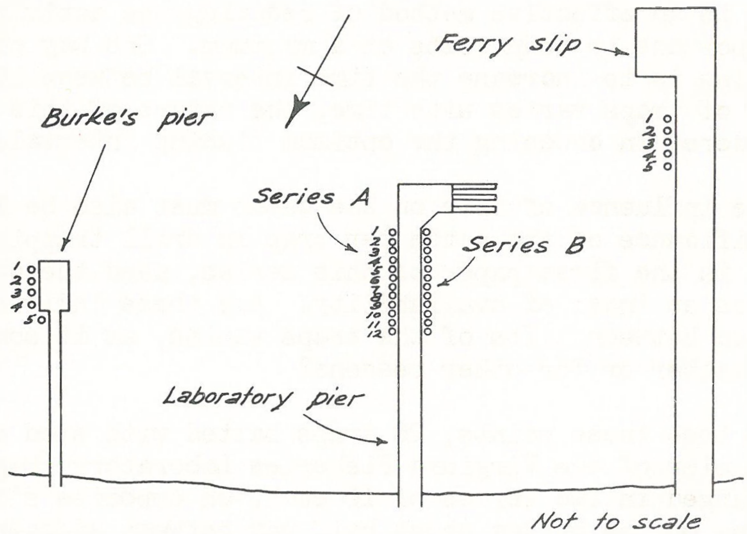

Fig. 1. Diagrammatic chart of the arrangement of experimental drill traps alongside the pier of the Virginia Fisheries Laboratory and adjacent piers. The traps are indicated by circles and serial numbers.

availability of drills on the two sides of the pier. Each series was lifted alternately daily and weekly for a total of six weeks. The same procedure was followed with the weekly and bi-weekly lifts, alternating the treatment between series each two-week period for a total of 12 weeks.

Urosalpinx cinerea was by far the most common species in the traps, although *Eupleura caudata* was taken rather regularly in small numbers. The total catch of *Urosalpinx* in all the experiments was 8,409, the total catch of *Eupleura* only 369. It is interesting to note that among hundreds of drills picked by hand off the pilings of various piers at Gloucester Point, not one *Eupleura* was found, yet the species was present in the area, as demonstrated by its capture in traps and in collections made by hand among the eel-grass beds in shallow water, and by the occurence of its characteristic egg cases on shells in shallow water. This is in sharp contrast to the species composition of the catch in traps on Wormley's Rock, about two miles below the Laboratory, where *Eupleura* appeared to be about twice as abundant as *Urosalpinx*.

EXPERIMENTAL RESULTS

The Catch in Series A and B

The 10 traps in series A rather consistently caught fewer drills than the 10 in series B. No serious attempt was made to discover the reason for this difference, although several possible explanations would merit investigation. Series A, on the east side of the pier, was shaded from the direct rays of the sun during the warmest part of the day; it was less protected from wave action than series B, which was sheltered behind the L-shaped extension at the outer end of the pier; on the average the traps in series A were in slightly deeper water. Since the experiments were divided equally between the two series, the effect of the position of the trap on the catch could be segregated, and it was possible to allow for the series effect in the statistical analysis.

In addition to the controlled experiments described above, the traps were fished at various time intervals to gather information for other purposes. In these experiments also, series B caught more drills than series A. The total numbers caught in each experiment at the Laboratory pier are listed in Table I.

Experiments with *Urosalpinx*

Comparison of daily and weekly fishing

Ten traps fished daily for six weeks caught 408 Urosalpinx or 9.8 drills per 10 traps per day. Ten traps fished weekly for the same period caught 361 *Urosalpinx*, or 8.6 drills per 10 traps per day. The weekly catches are summarized in Table II. The expected catches were computed by dividing the total in each week's experiment according to the ratio established by the total catch

Table I

Comparison of the catch of drills in traps in series A and B during equal time intervals at the Virginia Fisheries Laboratory Pier

Urosalpinx		*Eupleura*		
Series A	Series B	Series A	Series B	Source of information
333	436	56	41	Controlled experiment: daily vs. weekly lifts
760	780	17	30	Controlled experiment: weekly vs. bi-weekly lifts
1988	2357	64	104	Miscellaneous experiments
3081	3573	137	175	Totals

Table II

The catch of Urosalpinx per week in traps lifted daily and weekly, at the Virginia Fisheries Laboratory pier. Catches in series A and B are indicated by letters. The expected catches were computed by dividing the total catch in each week's experiment according to the ratio established by the total catch in the two series for the six experiments (333 A to 436 B).

	Daily		Weekly		
Date	Observed	Expected	Observed	Expected	X^2
15 July 1953	71 A	70	90 B	91	0.02
22 July 1953	41 B	39	28 A	30	0.23
29 July 1953	22 A	22	29 B	29	0.00
24 June 1954	124 B	117	83 A	90	0.96
1 July 1954	76 A	67	78 B	87	2.14
8 July 1954	74 B	72	53 A	55	0.13
Totals	408	387	361	382	3.48

Table III

The catch of Urosalpinx per two-week period in traps lifted weekly and bi-weekly at the Virginia Fisheries Laboratory pier. Catches in series A and B are indicated by letters. The expected catches were computed as for table 2, in the ratio 760 A to 780 B.

	Weekly		Bi-weekly		
Date	Observed	Expected	Observed	Expected	X^2
28 April 1954	189 A	168	151 B	172	5.18
12 May 1954	267 B	211	149 A	205	30.16
26 May 1954	176 A	152	133 B	157	7.56
9 June 1954	101 B	100	97 A	98	0.02
29 July 1954	57 A	52	49 B	54	0.94
12 August 1954	79 B	87	92 A	84	1.50
Totals	869	770	671	770	45.36

in the series of six experiments. None of the individual chi-square values was significant at even the five percent level of probability, nor were the summed or the pooled chi-square values highly significant statistically. It follows that, although somewhat fewer Urosalpinx were caught in the weekly lifts, this does not prove that drills are caught more efficiently by lifting the traps daily.

Comparison of weekly and bi-weekly fishing

Ten traps fished weekly for 12 weeks caught 869 Urosalpinx, or 10.3 drills per 10 traps per day. Ten traps fished every 14 days for the same period caught 671 Urosalpinx, or 8.0 drills per 10 traps per day. The biweekly catches are summarized in Table III. Two of the six individual chi-square values were significant at much better than the one percent level of probability, one at about the two percent level, and the remainder were not highly significant statistically. The summed chi-square values and the pooled chi-square values, however, were both highly significant statistically ($X^2 = 45.36$, P much less than 0.01; and $X^2 = 25.46$, P much less than 0.01, respectively). The odds are much less than one in one hundred that the observed difference in catch between weekly and bi-weekly lifts was due to chance.

The catch per unit time in miscellaneous experiments

The catch of many other trapping experiments, in which traps remained on the bottom for periodsof four to 15 days, were examined for information on the catch per unit time. There was no conscious effort in these experiments to vary the time between lifts according to the numbers of drills in the catch, except in winter, when the time intervals were increased because the catching rate was low. To avoid bias from this cause, catches made during November to March inclusive were not included in the analysis.

There appears to be a general tendency in all these data for the catch per unit of effort to vary inversely with the time interval between lifts of the traps. For example, when all catches from the laboratory pier, exclusive of the controlled experiments, were grouped according to fishing interval, they varied from 9.9 Urosalpinx per 10 traps per day when the mean time between lifts was 5.2 days, to 4.6 Urosalpinx per 10 traps per day when the mean time was 13.8 days. Similarly, the collections made from Burke's pier ranged from 13 drills per 10 traps per day when the mean time was 6.9 days, to 8 drills per 10 traps per day when the time was 13.8 days (Table IV). The catches in traps set from the ferry slip were too small to produce significant results.

Figure 2 illustrates, for all the experiments reported above, the relationship between fishing period and the catch per unit time. The lack of coincidence between the various curves is related principally to differences in the availability of Urosalpinx at the times or places in which the experiments were carried out. If these curves were adjusted for availability, they would correspond remarkably well.

Table IV

The relation between the duration of fishing and the catch of Urosalpinx per unit of effort in traps fished from piers at Gloucester Point, Virginia

Mean time interval between lifts in days	Number of Observations	Mean catch per 10 traps per day	Location
1	6	9.8	Laboratory pier
7	6	8.6	Controlled experiments
7	6	10.3	
14	6	8.0	
5.2	5	9.9	Laboratory pier
7.2	47	8.6	Miscellaneous
11.5	4	6.0	Collections
13.8	12	4.6	
6.9	23	13.0	Burke's pier
13.8	11	8.0	Miscellaneous Collections

Table V

The catch of Eupleura per week in traps lifted daily and weekly at the Virginia Fisheries Laboratory pier. The catches in series A and B are indicated by letters. The expected catches were computed as for table 2, in the ratio 56 A to 41 B.

Date	Daily		Weekly		X^2
	Observed	Expected	Observed	Expected	
15 July 1953	29 A	22	9 B	16	5.29
22 July 1953	7 B	3.5	1 A	4.5	6.22
29 July 1953	5 A	4.5	3 B	3.5	0.13
24 June 1953	12 B	6.5	3 A	8.5	8.21
1 July 1954	8 A	7	4 B	5	0.34
8 July 1954	6 B	7	10 A	9	0.25
Totals	67	50.5	30	46.5	20.44

TABLE VI

The catch of Eupleura per two-week period in traps lifted weekly and bi-weekly at the Virginia Fisheries Laboratory pier. The catches in series A and B are indicated by letters. The expected catches were computed as for table 2, in the ratio 17 A to 30 B.

Date	Weekly		Bi-weekly		
	Observed	Expected	Observed	Expected	X^2
28 April 1954	5 B	3.8	1 A	2.2	1.03
12 May 1954	2 A	2.5	5 B	4.5	0.16
26 May 1954	4 B	4.5	3 A	2.5	0.16
9 June 1954	6 A	2.9	2 B	5.1	5.19
29 July 1954	2 A	1.8	3 B	3.2	0.03
12 August 1954	11 B	8.9	3 A	5.1	1.37
Totals	30	24.4	17	22.6	7.94

Table VII

The relation between the duration of fishing and the catch of Eupleura per unit of effort in traps fished from piers at Gloucester Point, Virginia

Mean time interval between lifts in days	Number of observations	Mean catch per 10 traps per day	Location
1	6	1.60	Laboratory pier
7	6	0.71	Controlled
7	6	0.71	experiments
14	6	0.40	
5.3	6	0.44	Laboratory pier
7.3	47	0.38	Miscellaneous
11.5	4	0.17	Collections
13.9	15	0.08	
6.9	23	0.46	Burke's pier
13.8	11	0.16	Miscellaneous
			Collections

Experiments with Eupleura

Comparison of daily and weekly fishing

Ten traps fished daily for six weeks caught 67 Eupleura, or 1.6 drills per 10 traps per day. Ten traps fished weekly for the same period caught 30 Eupleura, or 0.7 drills per 10 traps per day. The weekly catches are summarized and compared with the expected catches, computed as for Urosalpinx, in Table V. The summed chi-square value was highly significant statistically ($X^2 = 20.44$, P less than 0.01), and the pooled chi-square also was highly significant ($X^2 = 14.12$, P much less than 0.01). Fewer Eupleura were caught in the weekly lifts, and the odds are less than one in 100 that this difference could have occurred by chance.

Comparison of weekly and bi-weekly fishing

Ten traps fished weekly for 12 weeks caught 30 Eupleura, or 0.35 drills per ten traps per day. Ten traps fished every 14 days for the same period caught 17 Eupleura, or 0.2 drills per 10 traps per day. The catches are summarized in Table VI. The summed chi-square value was not highly significant statistically ($X^2 = 7.94$, P about 0.25), and the pooled chi-square gave similarly inconclusive results ($X^2 = 3.59$, P somewhat greater than 0.05). Although fewer Eupleura were caught in the bi-weekly lifts, the difference is not highly significant. This lack of significance may have been related to the small catches.

The catch per unit time in miscellaneous experiments

Catches in the miscellaneous trapping experiments, when analysed in the same way as for Urosalpinx, appeared to show a decline in the catch of Eupleura per unit of effort as the time between lifts increased. The miscellaneous catches from the laboratory pier varied from 0.44 Eupleura per 10 traps per day when the mean fishing period was 5.3 days, to 0.08 drills per 10 traps per day for a mean period of 13.9 days. Similarly the catch per unit of effort in the collections from Burke's pier decreased as the fishing period increased (Table VII).

Figure 3 illustrates the apparent decline in the catch of Eupleura per unit time as the time between lifts increased. As for Urosalpinx, the lack of coincidence between individual curves appears to be caused by differences in the availability of drills in space and time.

SUMMARY AND CONCLUSIONS

To interpret the results of experiments in trapping oyster drills, it is usually necessary to reduce the catches to some standard form, based on the catch per unit number of traps per unit time. The question immediately arises: does the trap continue to catch efficiently, irrespective of the length of time that it fishes, and if not, what is the relation between catch per unit of effort and time?

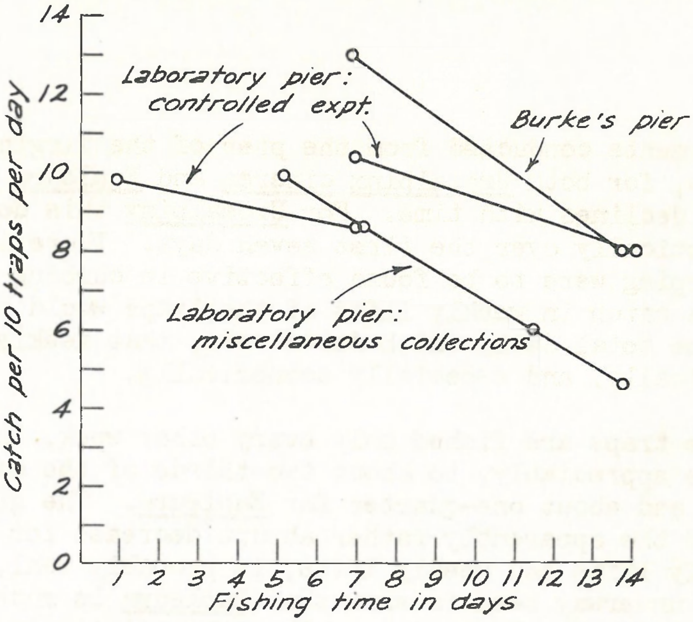

Fig. 2. The catch of Urosalpinx per 10 traps per day in relation to the time interval between lifts of the traps.

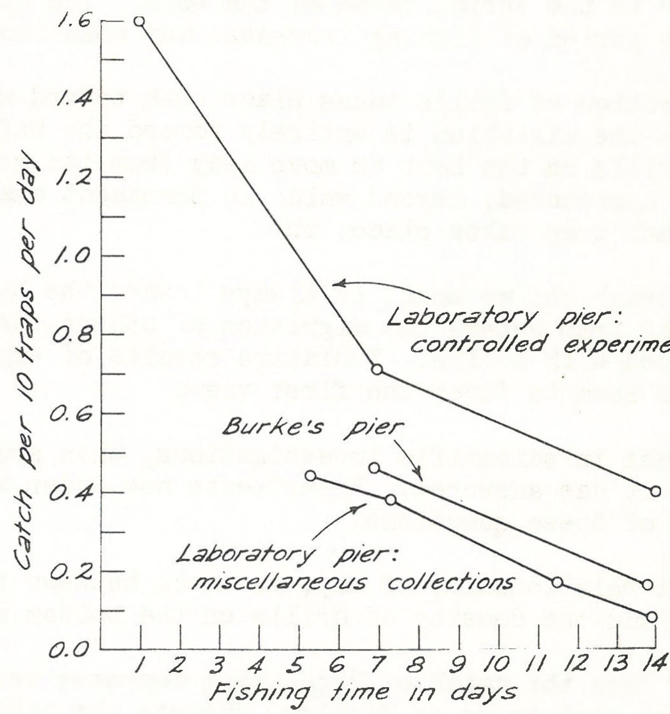

Fig. 3. The catch of Eupleura per 10 traps per day in relation to the time interval between lifts of the traps.

Experiments conducted from the pier of the Virginia Fisheries Laboratory seem to show, for both Urosalpinx cinerea and Eupleura caudata, that the rate of catching declines with time. For Urosalpinx this decline is not significant statistically over the first seven days. There is very little doubt that if trapping were to be found effective in curbing predation by this species, the catch in weekly lifts of the traps would be so little, if at all, less than the total daily catch for a week, that weekly fishing could be justified biologically, and especially economically.

If the traps are fished only every other week, the catch per unit of effort drops appreciably, to about two-thirds of the daily catch for Urosalpinx and about one-quarter for Eupleura. The greater decline for Eupleura and the apparently rather abrupt decrease for this same species between daily lifts and weekly lifts, is probably real, for recent experiments still underway seem to show that Eupleura is much more destructive of small oysters than Urosalpinx. Thus the relatively greater decline in the catch per unit of effort with time is probably caused by destruction of the smaller, and presumably more attractive, oysters.

Perhaps the most important conclusion arising from these experiments is that drill traps constructed of wire mesh and baited with seed oysters are not "traps" in the strict sense of the word. The reduced efficiency of traps as the period of fishing increases may come about in one of two ways:

(1) Migration of drills takes place both toward and away from the traps; at first the migration is entirely toward the bait simply because there are no drills on the bait to move away from it; gradually a dynamic equilibrium is approached, beyond which no permanent changes in the numbers of drills on each trap takes place; or

(2) Although the movement is always toward the bait, the presence of drills in the trap deters the migration of others, until the bait becomes saturated with drills. Tentative results of experiments now being conducted seem to favor the first view.

As is usual in scientific investigations, this study has raised more questions than it has answered. Experiments now under way were designed to answer some of these questions:

(1) What relationship, if any, is there between the equilibrium catch of drill traps and the density of drills on the bottom being trapped?

(2) Why does the catch of Urosalpinx decrease very little, if at all, during the first week or so of fishing, whereas the catch of Eupleura drops precipitately in the first seven days?

(3) What effect on the catch is produced by the gradual mortality of the seed oysters used as bait?

(4) Do drills enter the traps because they are attracted to the bait, or simply because the bait offers an additional area on which to crawl and feed?