WILLAPA OYSTER STUDIES--USE OF THE PASTURE HARROW FOR THE CULTIVATION OF OYSTERS

By Clyde S. Sayce* and Charles C. Larson**

The English pasture harrow is used in oyster cultivation to break apart and scatter clusters of oysters. It is also used to prepare oysters for harvest by loosening them from the substrate and removing fouling growth. An area of the Long Island Oyster Reserve, Willapa Bay, Wash., was divided into a control and three lanes to test the effect of the harrow upon Pacific oysters (Crassostrea gigas). The control was undragged, lane 1 was dragged once, lane 2 ten times, and lane 3 three times. Condition of samples of oysters was determined for each lane every week during dragging and once each month for 6 months after completion of the experiment. The experiment showed that Pacific oysters spawned shortly after being dragged while undragged oysters spawned later. Total mortality of oysters dragged 10 times was no higher than that of oysters dragged once only. Dragging oysters once and 3 times increased Pacific oyster spatfall 3 and 5 times, respectively, but dragging more than 3 times did not increase spatfall further.

INTRODUCTION

Farm harrows, both disc and tooth, modified plows, and oyster and clam dredges have been used in Long Island Sound, New York, to aid the cultivation of oysters by burying oyster drills. In the gradual mechanization of the oyster industry of Willapa Bay, Wash., straight-tooth drags, spring-tooth harrows, and tractor harrows were tried and discarded while the pasture harrow has been used most successfully in cultivation of Pacific oysters (Crassostrea gigas).

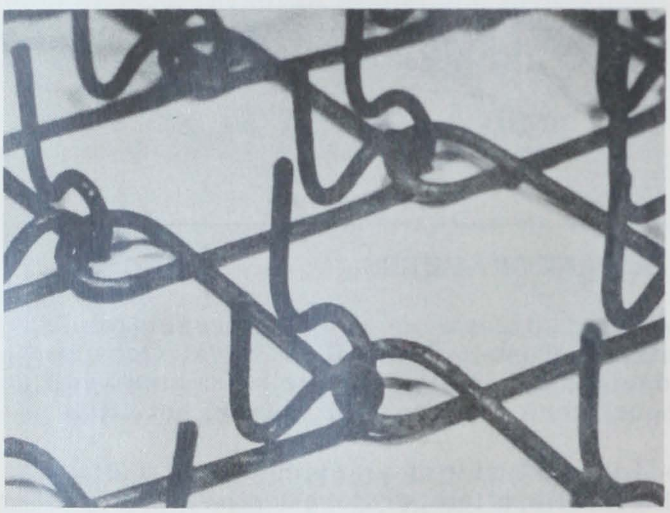

Fig. 1 - Detail of the linkage of teeth of the English pasture harrow. (Photo by C. S. Sayce)

The commercially available English pasture harrow is used by farmers to break up dirt clods in pasture leveling. This harrow is formed of triangular-shaped linkages with a 4-inch long tooth at the base of each leg. The legs are about 8 inches long and adjacent links are held together by a loop at the apex of the triangle and rings at each leg. This arrangement gives a loose linkage of triangles made of $\frac{7}{16}$-inch diameter rod with 4-inch teeth spaced 4 to 6 inches apart; rows are 6 to 7 inches apart (fig. 1). The toothed harrow section is 10 feet wide and 6 feet long, has a total length of 10 feet, including weights and towing bar, and has a total weight of about 250 pounds (Fig. 2).

The first use of this harrow in Willapa Bay was to break apart clusters of growing

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oysters and scatter them more evenly over the ground. The cultivation was during the second summer after planting of seed, and during the following year if oyster growth and thickness of the planting appeared to warrant it. This procedure has virtually eliminated breaking and scattering by hand during low tide and has saved the grower considerable expense. The harrow is dragged from an "A" frame mounted on either an oyster scow or a tow boat and raised and lowered by winch, powered or unpowered. Only one person, the boat operator, is usually needed for either arrangement, since the harrow may be dragged continuously except when beds are heavily covered with eel grass or moss. At such times, an additional man is needed to raise the harrow frequently for cleaning (fig. 3).

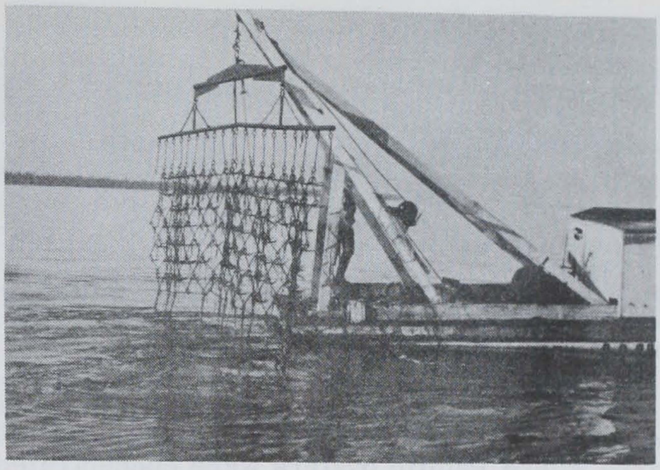

Fig. 2 - A two-section English pasture harrow hanging from an "A" frame on a 10- by 30-foot oyster barge. (Photo by C. S. Sayce)

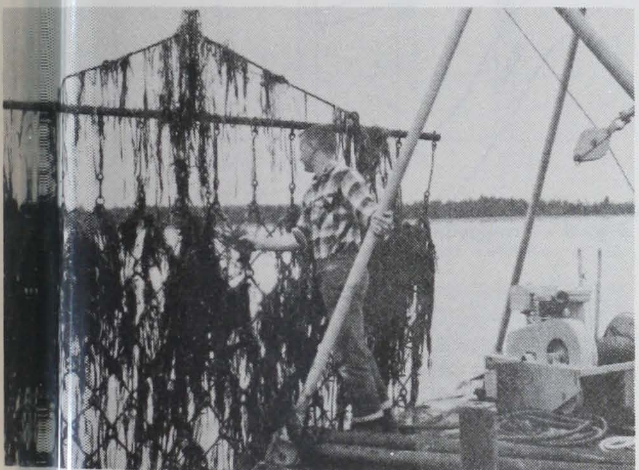

Fig. 3 - A single-section English pasture harrow suspended from a davit boom showing eel grass dragged from an oyster bed. (Photo by C. S. Sayce)

Two methods of dragging permit complete coverage of an oyster bed without excessive dragging over some parts and none over others. One method is to circle the bed continuously, reducing the radius one width of the harrow at each circuit. The other is to begin at one corner and drag forth and back along the oyster bed moving over one harrow width each time. This system of dragging requires a small, tight turning circle at the end of the oyster bed or off the end (if space is available) or lifting the harrow at the end of each crossing. This disadvantage, as compared with continuously circling the oyster bed, is compensated by the advantage of more precise control of the amount of harrowing any given portion receives; additionally, it is easy to harrow on a line perpendicular to the first one. The ground type, its position in reference to prevailing winds and tides, and amount of harrowing needed should be considered when a decision is made about the procedure.

Oysters that are partially buried may be pulled out of the ground to the surface without excessive damage to them. This action is desirable to raise buried oysters following storms or just prior to harvest to loosen them in preparation for pickup by an oyster dredge. In action the harrow digs out and tumbles oysters cleaning them of mud and fouling organisms. It is used, therefore, to clean shell cultch just before an impending spatfall.

OBJECTIVE

Use of the harrow in oyster farming has increased during the past few years, but its effect upon oysters has not been investigated. This paper describes an experiment in Willapa, Bay, Wash., conducted between July 8, 1964 and March 13, 1965, by the staff of the Washington Department of Fisheries, Willapa Bay Shellfish Laboratory, to evaluate the use of the pasture harrow upon Pacific oysters.

METHODS

A natural bed on Long Island State Oyster Reserve in southern Willapa Bay was chosen for this experiment (fig. 4). The ground, composed of a mixture of soft mud and old, native

Fig. 4 - A view looking north at the Cultivation Experiment 1 tract on Long Island State Oyster Reserve in southern Willapa Bay, Wash. (Photo by C. S. Sayce)

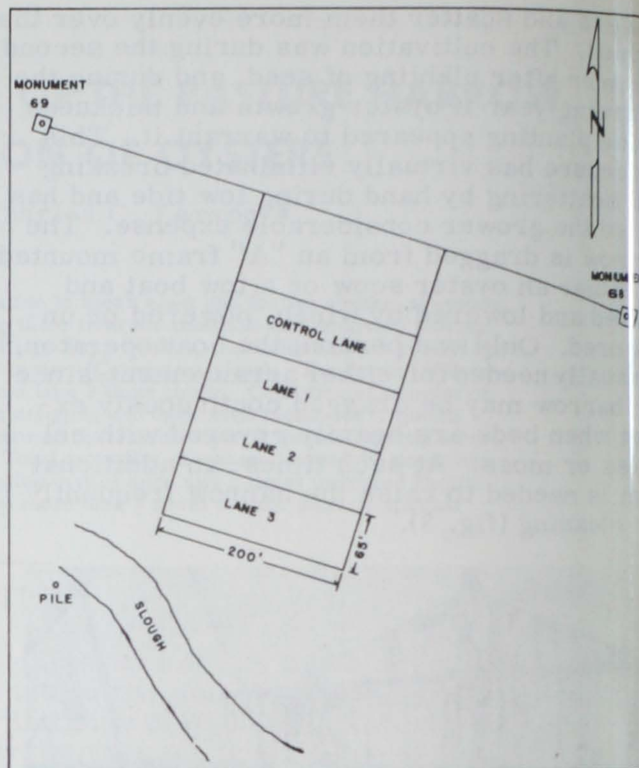

Fig. 5 - Arrangement of lanes for Cultivation Experiment 1.

oyster shell, appeared to be more firm in the area where Pacific oysters were concentrated. The oysters were old (5+ years), clustered, and partially buried. The tract was laid out in four rectangular lanes 65 by 200 feet with the length running parallel to the reserve line from monument 68 to 69 in a northwest-southeast direction. The plots were designated control lane, lane 1, lane 2, and lane 3 (fig. 5), and surveys of each lane were made before, during, and after dragging. About 25 percent of the area had an eel grass cover; the growth was heaviest in the control lane and lane 3.

Table 1 - Mean Number of Live Oysters, Loose Shells, and Clusters Per Square Yard for All Lanes of Cultivation Experiment 1

Date	Lane	Square Yard Sampled	Mean Live Oysters Per Yard^2	Mean Number of Shells Per Yard^2	Mean Number of Clusters Per Yard^2
1964					
July 23	1	22	19.3	15.4	3.0
	2	22	12.8	9.3	3.9
	3	19	8.2	12.2	1.0
Ausust 7	Control	21	14.9	24.8	2.5
August 6	2	24	18.2	19.0	3.0
October 3	1	4	21.5	12.2	4.2
	2	6	12.3	13.0	0.8
	3	3	51.0	43.0	8.7
1965					
March 13	1	10	9.1	34.3	2.5
	2	10	17.6	24.2	1.2
	3	10	7.8	13.0	0.2
	Control	10	8.4	22.2	2.4

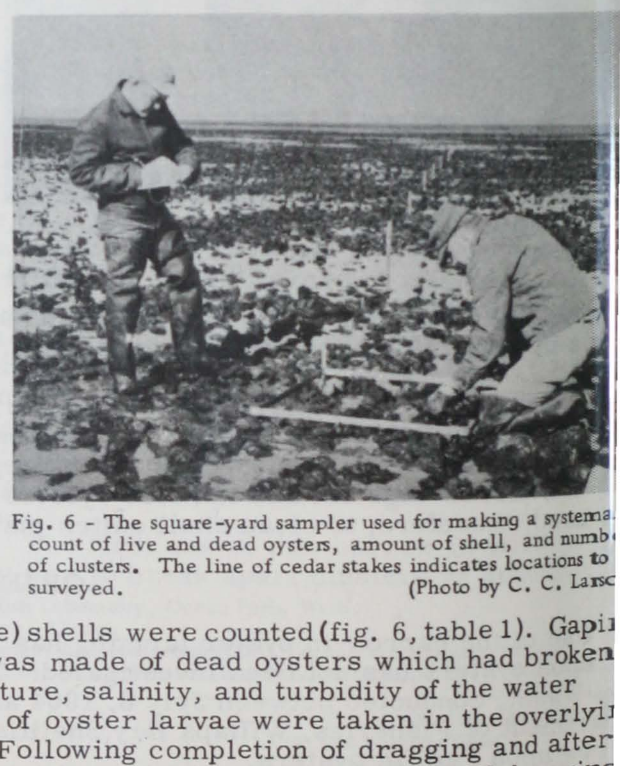

Fig. 6 - The square-yard sampler used for making a systema count of live and dead oysters, amount of shell, and numb of clusters. The line of cedar stakes indicates locations to surveyed. (Photo by C. C. Larsc

A square-yard frame was used to sample areas at regular intervals along a diagonal line bisecting each lane. Within the square-yard sample area, all live and dead oysters, number of clusters, oysters per cluster, and loose (single) shells were counted (fig. 6, table 1). Gapi oysters were counted as dead, and special note was made of dead oysters which had broken or punctured shells (fig. 7). Records of temperature, salinity, and turbidity of the water were tabulated during the experiment and counts of oyster larvae were taken in the overlyi waters during the spawning and setting season. Following completion of dragging and after the spatfall, shell samples from each lane were checked to determine the effect of dragging upon the setting of Pacific oysters. The experiment began with a predragging survey of all lanes.

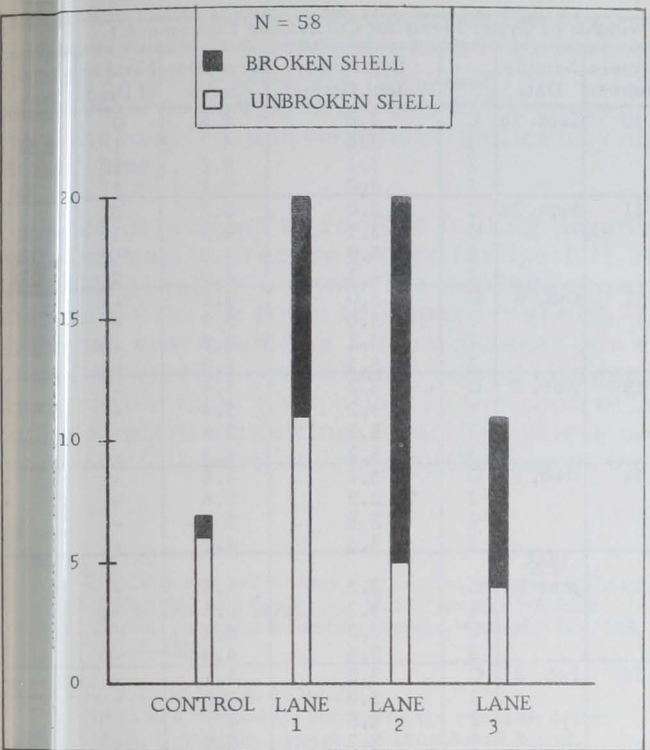

Fig. · Pacific oyster mortalities from all lanes of Cultivation Experiment 1 separated into broken-shell and unbroken-shell categories.

The first survey and collection of samples for determination of oyster condition was on July 8, 1964. Experimental harrowing began July 23 when each of the lanes 1, 2, and 3 was dragged once. The control lane was never dragged, lane 1 was dragged only once, lane 2 was dragged once each week for 10 weeks, and lane 3 was dragged during the beginning, middle and last week (total of 3 times). A sample of 20 oysters was taken weekly from each lane immediately before the dragging and, after completion of experimental dragging, monthly for 6 months until March 1, 1965 (table 2). Dragging produced some changes in the condition of oysters.

Condition of oysters1/ in all lanes was similar before dragging, ranging from 7.2 in lane 3 to 8.0 in the control lane. The condition of control-lane oysters (9.4) on August 6 indicated ripe, ready to spawn oysters; condition then immediately dropped to a very low value (3.8) on August 11 after spawning. Recovery was rapid but erratic and at the end of the sampling period (March 1, 1965), control-lane oysters had the lowest condition (3.9) while all dragged lanes had an identical but higher value (5.1).

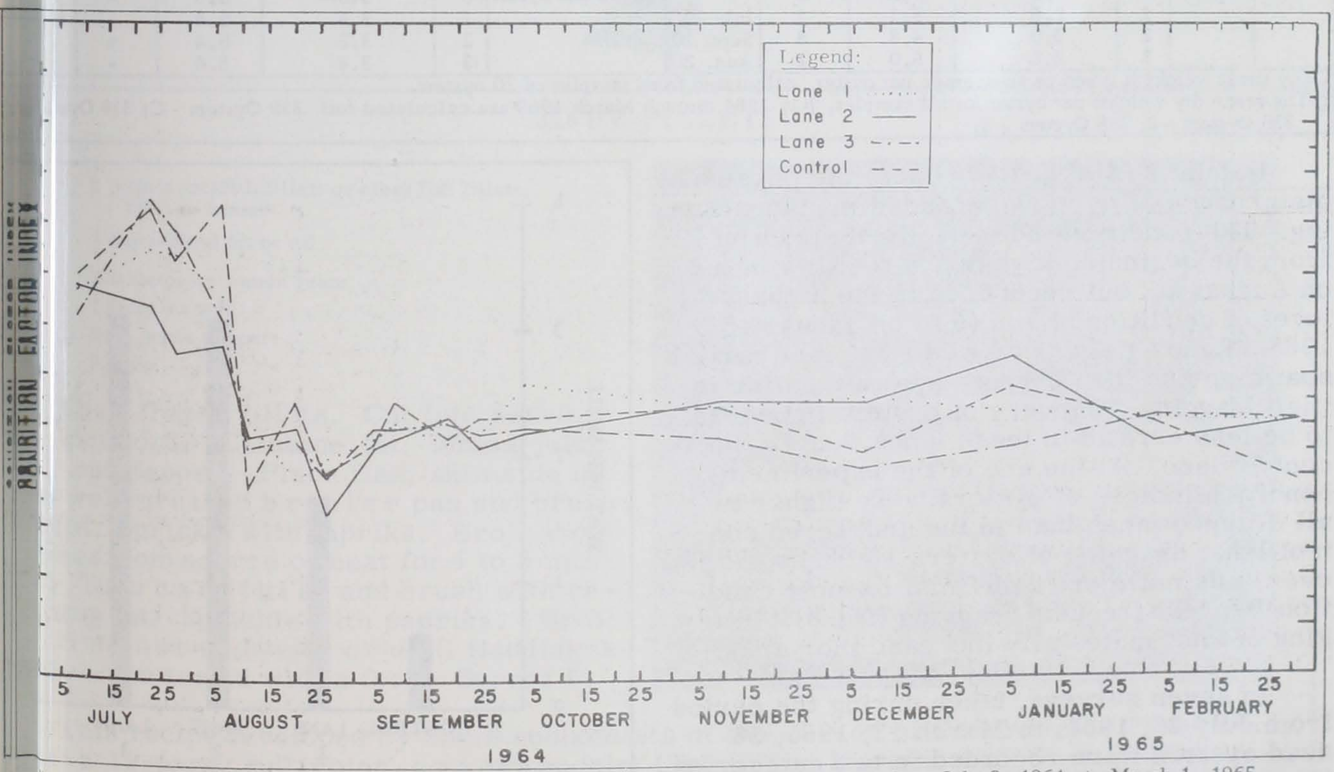

Fig. 8 - Condition indices of Pacific oysters for all lanes of Cultivation Experiment 1 from July 8, 1964, to March 1, 1965.

1/Classification of Pacific oysters in Willapa Bay according to condition index is as follows: Below 4.0, extremely poor quality; 4.0 to [illegible], poor quality; 8.0 to 12.0, good quality; above 12.0, excellent quality.

Table 2 - Dragging Schedule, Condition Indices, and Dry Weights of Oyster Meats for Cultivation Experiment 1.

Sample Number	Sample Date	Lane	Dry Meat Weight Grams[1]	Condition Index	Number of Drags	Drag Date
	1964					
1	July 8	C	4.4	8.0	0	-
		1	4.2	7.7	0	-
		2	4.4	7.8	0	-
		3	4.5	7.2	0	-
2	July 23	C	5.2	9.3	0	
		1	5.5	8.5	1	July 23
		2	4.1	7.4	1	July 23
		3	4.9	9.5	1	July 23
3	July 28	C	5.4	8.3	0	
		1	5.2	8.4	1	July 23
		2	4.4	6.5	2	July 30
		3	5.3	8.9	1	July 23
4	Aug. 6	C	6.3	9.4	0	
		1	4.4	7.6	1	July 23
		2	3.9	6.6	3	Aug. 6
		3	4.5	7.1	1	July 23
5	Aug. 11	C	2.5	3.8	0	
		1	2.8	5.2	1	July 23
		2	2.9	4.8	4	Aug. 13
		3	2.7	4.6	1	July 23
6	Aug. 20	C	3.2	5.5	0	
		1	2.2	4.0	1	July 23
		2	2.8	5.0	5	Aug. 20
		3	3.3	4.8	2	Aug. 20
7	Aug. 26	C	2.6	4.1	0	
		1	2.7	4.4	1	July 23
		2	2.7	3.3	6	Aug. 27
		3	2.6	4.0	2	Aug. 20
8	Sept. 4	C	2.9	4.7	0	
		1	2.9	4.8	1	July 23
		2	2.7	4.6	7	Sept. 3
		3	3.0	5.0	2	Aug. 20
9	Sept. 8	C	2.7	5.5	0	
		1	2.6	5.1	1	July 23
		2	3.0	4.8	8	Sept. 10
		3	2.8	5.0	2	Aug. 20
10	Sept. 18	C	3.0	4.8	0	
		1	2.6	4.7	1	July
		2	3.1	5.2	9	Sept.
		3	3.0	5.1	2	Aug.
11	Sept. 24	C	3.0	5.2	0	
		1	3.1	4.9	1	July
		2	3.0	4.6	10	Sept.
		3	3.1	4.9	3	Sept.
12	Oct. 4	C	3.0	5.2	-	
		1	3.6	5.9	-	-
		2	3.1	4.9	-	-
		3	3.1	5.0	-	-
13	Nov. 9	C	3.2	5.4	-	
		1	3.2	5.4	-	-
		2	3.3	5.5	-	-
		3	3.2	4.8	-	-
14	Dec. 7	C	3.1	4.5	-	
		1	2.9	5.6	-	-
		2	2.8	5.5	-	-
		3	3.3	4.2	-	-
	1965					
15	Jan. 5	C	3.2	5.8	-	-
		1	3.2	5.3	-	-
		2	3.2	6.4	-	-
		3	2.6	4.6	-	-
16	Feb. 2	C	3.0	5.1	-	
		1	3.2	5.2	-	-
		2	2.5	4.7	-	-
		3	3.2	5.2	-	-
17	March 1	C	2.3	3.9	-	
		1	3.3	5.1	-	-
		2	2.9	5.1	-	-
		3	3.1	5.1	-	-
Mean per oyster		C	3.5[2]	5.8	-	
		1	3.4	5.8	-	-
		2	3.2	5.4	-	-
		3	3.4	5.6	-	-

1/Dry meat weight is given as an average per oyster calculated from samples of 20 oysters.
2/The mean dry weights per oyster for all samples, July 1964 through March 1965 are calculated for: 339 Oysters - C; 339 Oysters - 335 Oysters - 2; 338 Oysters - 3.

In lane 2 (dragged 10 times) the physical disturbance of oysters produced mass spawning. The condition index declined steadily from the beginning high of 7.8 to a low of 3.3 on August 26, but recovered to the highest level of condition shown (6.4) on January 5, 1965. Lanes 1 and 3 showed effects of partial spawning and then of more spawning after initial dragging; recovery of oysters appeared to be less erratic in these lanes than in the control lane. At the end of the experiment, condition indices of oysters were higher in all dragged lanes than in the undragged control lane; dragging of oysters 10 times, however, was not more beneficial to their condition than less frequent dragging (fig. 8). Dragging did not materially increase mortality.

In seven surveys, taken during the period from July 23, 1964, to March 13, 1965, 58 dead oysters were recorded in two categories, broken shell and other. In the control lane 7 (12 percent) were dead, one of which had a broken shell; in lane 2, dragged 10 times, 19

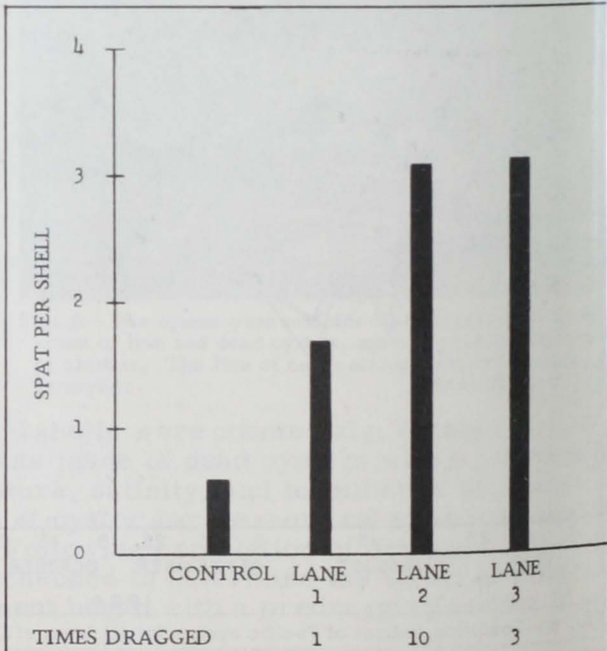

Fig. 9 - Counts of Pacific oyster spat per shell from the 1964 s[...] fall in all lanes of Cultivation Experiment 1.

(33 rcent) were dead, of which 15 (26 percent) were broken; and in lane 3, dragged 3 times, 11 ercent) were dead, of which 7 (12 percent) were broken. It can be concluded that limited dra ng caused negligible mortality, but a threefold increase in dragging caused nearly a five-fol rease in mortality. Deaths (31) caused by dragging, however, represented only 53 per-cen he total (58) and were not significantly high (fig. 7). The 1964 spatfall was improved in the dra d lanes.

ce harrowing to remove fouling organisms from old oysters and shell would be an in-exp ive way to prepare ground for spatfall, shell samples were taken from each lane after the 196 tting season to determine setting according to the amount of dragging. The control-lane she d the lowest count (0.6 spat per shell). Lane 2 (dragged 10 times) and lane 3 (dragged 3 tim had spat counts of 3.1 and 3.2 spat per shell, respectively, about 5 times greater than the spa on control-lane shell. Lane 1 (dragged only once) had 1.7 spat per shell--nearly 3 tim greater than the spatfall in the control lane (fig. 9). These records indicate that dragging onl e improved setting of Pacific oysters on old shell and dragging them 3 times greatly im-pr spatfall, but that dragging them more than 3 times did not further improve spatfall.

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JIFFY FILLETS

- 2 pounds rockfish fillets or other fish fillets, fresh or frozen
- $\frac{1}{4}$ cup melted fat or oil
- 2 tablespoons lemon juice
- 1 teaspoon salt
- Dash white pepper
- Paprika

Thaw frozen fillets. Cut into serving- portions. Combine fat, lemon juice, and pepper. Place fish, skin side up, well-greased broiler pan and brush fat. Sprinkle with paprika. Broil about hes from source of heat for 4 to 5 min- . Turn carefully and brush with re- ing fat. Sprinkle with paprika. Broil 5 minutes longer or until fish flakes ly when tested with a fork. Serves 6.

This recipe developed by home economists of the Bureau of Commercial Fisheries is a 19-page, full-color, cookery booklet (Top O' the Mornin' with Fish and Shellfish, Kitchen Series No. 15) recently released by the Bureau of Commercial Fisheries, . Department of the Interior. For 25 cents you can buy a copy from the Superintendent ocuments, U. S. Government Printing Office, Washington, D. C. 20402.