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Job Report

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Survey of Oyster Diseases in the Galveston Bay Area

Abstract: Mortalities among tray-held oysters (Crassostrea virginica) were studied during a two year period at stations located on Switchover Reef and Hanna Reef. In 1963 mortalities at both stations showed similar patterns, increasing during the summer months (with peaks in August-September) and declining during the fall and winter. The summer mortalities were associated with high infections of Dermocystidium marinum. From March through December, 1963 oysters at the Switchover station suffered a mortality of 52.6 per cent. From April through December, 1963 a mortality of 42.2 per cent occurred among the Hanna oysters.

In April, 1964 a sudden, high (22 per cent) mortality rate was found among Switchover oysters, followed by decreasing rates in May and June. Mortalities at both stations showed a summer peak (in September) but the mortality rate at the Switchover station in September was less (11 per cent) than that in April. The summer mortalities were again associated with high incidences of D. marinum but the April mortality at Switchover occurred when the incidence of infection (as determined by thioglycollate cultures) was light to moderate.

Although the number of market oysters which died during a twelve-month period (March, 1963 - March, 1964 at Switchover and May, 1963 - May, 1964 at Hanna) was 75 to 80 per cent of the number originally stocked, surviving market-size oysters exceeded the original number by 35 per cent (at Switchover) and 60 per cent (at Hanna). Thus, growth of seed oysters to market size (recruitment) exceeded mortality. In the second year recruitment was negligible (since 95 per cent of the oysters were market size in March, 1964) and a 60 per cent reduction in number occurred.

At stocking, the average length of the Switchover oysters was 66.8 mm; that of the Hanna oysters was 62.9 mm. By December, 1964 the average length of Switchover oysters had increased to 113.0 mm. and the average length of the Hanna oysters was 104.2 mm. During March - August, 1964 little or no growth was observed among Hanna oysters and the majority appeared to be receding in length. The average length decreased from 98.1 in March to 95.4 mm. in August. Thereafter, new growth was evident and the average length began to increase again.

A full report of the study, including an analysis of disease organisms present in oyster tissue sections, will be presented by Dr. J. G. Mackin of Texas A & M University.

Objectives: To study the mortality rate among groups of oysters held in trays and to determine the cause, or causes, of mortality.

Procedures: Two tray stations were constructed, one on Switchover Reef adjoining the tripod reef marker, the other on Hanna Reef at Moody's Pass. Each station consisted of a wooden platform approximately ten feet wide and twenty feet long supported by creosote piling. The platforms contained two bays, approximately seven feet long and six feet wide, surrounded by walkways. Two angle-iron racks, constructed to slide through vertical pipe supports, were placed in each bay. The racks were fastened by cable to cranks so that they could be easily lifted for observation. Each rack contained four plastic-coated metal trays 18 inches wide, 32 inches long and 4 inches deep. Tops, constructed of one-half inch hardware cloth attached to a metal frame, were hinged to the trays. An inverted tray was also used as a top in some instances. The tops were wired to the trays to prevent movement while in the water.

Trays were stocked with culled oysters placed bill-up to facilitate observation. Oysters were examined at intervals, generally once a month in winter and spring, more often during summer and fall. All dead oysters including boxes (shells only, with valves intact) and gapers (recently dead, or dying oysters without complete deterioration of the tissues) were removed at each station visit. Portions of gaper tissues were cultured in fluid thioglycollate medium containing Mycostatin and Chloromycetin. The gapers were then fixed in Zenker's fixative for 12-18 hours, washed in tap water and preserved in 70 per cent isopropyl alcohol. Live oyster samples were also collected at some (but not all) station visits and treated in the same manner as the gapers. Preserved oysters were delivered to Dr. J. G. Mackin at Texas A & M University for sectioning and disease analysis.

Oysters were measured (to the nearest millimeter along the right valve from hinge to bill) at the time of stocking (or shortly thereafter). The live oysters remaining in the trays were re-measured at intervals throughout the study. Dead oysters and live oysters removed from the trays during the station visits were also measured. Oysters were counted at more frequent intervals to determine whether any were missing.

The trays and tops were cleaned at intervals and replaced when necessary. The oysters were cleaned and culled to remove oyster spat and fouling organisms.

Bottom water samples were collected at each station visit for determination of salinity and temperature. Observations of organisms associated with the oysters were made.

Findings and Discussion: The Switchover (A) station was located on the artificial Switchover Reef in the vicinity of the Southwest Pass area of Todd's Dump. The Hanna (B) station was located at Moody's Pass, approximately in the center of Hanna Reef. Both station platforms were oriented at right angles to the water currents and the water depth at each station was approximately seven feet. Station locations are shown in Figure 1.

The Switchover station was stocked with culled oysters dredged from Southwest Pass (Todd's Dump) on February 13-14, 1963. The study was begun on February 25, 1963 with 2101 oysters in twelve trays. The Hanna station was stocked with culled oysters dredged from Hanna Reef on March 7, 12, and 19, 1963. The study was begun on April 5, 1963 with 2800 oysters in twelve trays. Because several of the trays were overcrowded, oysters were re-grouped in fifteen trays during May.

Probably all mortalities due to handling and culling occurred during the two to four week period between stocking and the beginning of the mortality records. Since oysters which died during these intervals were discarded, the initial mortality records do not include losses due to handling.

The number of dead oysters recovered, the number of live oysters remaining, and the calculated number of deaths per day for each station visit are given in Tables 1 - 1A (Switchover) and Tables 2 -2A (Hanna). Mortality data have beem converted to deaths per month and the monthly mortality rates (percentage of oysters alive at the beginning of the month which died during that month) have been calculated (Table 3, Figure 2). Cumulative mortalities during the two year period at each station are shown in Table 4, Figure 3.

During 1963, mortality cycles were similar; increasing in the summer, reaching a peak mortality rate in August or September, and declining in the fall and winter. The peak monthly mortality rate of the Switchover station (15.6 per cent) occurred in August; at the Hanna station the peak monthly mortality rate (11.5 per cent) occurred in September. In general, mortality rates at the Hanna station followed one month behind those at the Switchover station and the summer mortality rates were not as high.

By the end of December, 1963 mortality among oysters at the Switchover station was 52.6 per cent; mortality among Hanna oysters was 42.2 per cent (the mortality occurred during a 10 month period at Switchover and a 9 month period at Hanna). During the high mortality period (May - October), 48.8 per cent of the Switchover oysters died compared to 38.8 per cent of the Hanna oysters.

In 1964 the mortality pattern at the Hanna station was similar to that in 1963. Mortalities began to increase in April and reached a peak (monthly death rate of 16.4 per cent) in September. During the period May - October, 43.3 per cent of the oysters died, somewhat higher than in 1963.

The mortality pattern among Switchover oysters in 1964 differed from that in 1963. A high (22 per cent) mortality rate occurred in April followed by a sharp decline in May and June. The summer mortality pattern reached a peak death rate of 11.0 per cent in September. During the period May - October, 27.0 per cent of the oysters died, only a slightly higher than the death rate in April.

At the end of the two year period (22 months at Switchover and 21 months at Hanna), 73.4 per cent of the Switchover oysters had died as compared to 69.9 per cent of the Hanna oysters. During 1964 (January - December) 47.7 per cent of the Switchover oysters and 52.2 per cent of the Hanna oysters died.

During a twelve-month period (March, 1963 through February, 1964) approximately 44 per cent of the dead oysters recovered from Switchover station were market size (over 75 mm. in length). The original number of market oysters at stocking was 618; the number of market oysters which died during the twelve-month period was 494. If no growth of seed oysters had taken place and the 494 market oysters which died during the year were members of the original market stock, the annual market oyster mortality would have been approximately 80 per cent.

Of the 1266 dead oysters recovered from the Hanna station from May, 1963 through April, 1964, 622 (approximately 49 per cent) were market size. If these oysters had been members of the original 834 market oysters stocked in 1963, the annual market oyster mortality would have been approximately 75 per cent.

However, growth occurred at both stations and the market oysters, at the end of the twelve-month period, numbered 838 (calculated) at Switchover and 1336 (calculated) at Hanna. Market oyster stocks increased 35 per cent at Switchover and 60 per cent at Hanna.

Therefore, growth (recruitment) exceeded mortality resulting in an increase in market oyster stocks. During the second year recruitment was negligible (since 95 per cent of the oysters were market size) and the number of market oysters declined by approximately 60 per cent at both stations (during a ten month period from March through December).

The weighted incidence of Dermocystidium marinum infection among live and dead (gaper) oysters is given in Table 5 and in Figures 4 and 5. The incidence ratings were based upon numerical values from 0 to 5; negative infections were given a value of 0; very light infections a value of 0.5; light infections 1.0; light to moderate 2.0; moderate infections 3.0; moderate to heavy infections 4.0; and heavy infections were given a value of 5.0. Infection incidences determined for samples from each station visit were converted to monthly infection incidences.

At Switchover station, the initial D. marinum infection incidence (in March, 1963) was negative among the gapers collected. The infection of gapers was high in April, declined in May, increased to moderate to heavy infections in June and continued at high levels during the remainder of the year. The incidence of infection among Hanna gapers during 1963 was similar to that at Switchover. The initial infection incidence (May 6, 1963) was negative but the monthly incidence was 3.0 (moderate). Monthly infection incidence continued at high levels throughout the year.

During 1964 infections among the Hanna gapers continued at high levels. Infection incidences among live oysters generally followed the mortality cycle, increasing in the summer months. The highest monthly incidence of infection (among live oysters) occurred in August, one month before the peak death rate. Infections among live oysters remained above epidemic level (2.0) in the fall and winter.

Although obscured in the monthly infection incidences, a decrease of infection among gapers was found in mid-June among Hanna oysters both in 1963 and 1964. A similar decrease in infection was noted among live oyster samples in mid-June, 1964, one week after the infection incidence of gapers decreased (Figure 5-B).

During the April, 1964 mortality at the Switchover station, gaper infection incidence was light to moderate (2.5). In May, infection was negative but only one gaper out of 29 dead oysters was recovered. From late May throughout the remainder of the year, the incidence of infection among gapers was high.

Among the live oysters at Switchover station in 1964, infection incidence was at epidemic level in April, increased to a peak (3.6) in October and remained high thereafter. Infection incidences among live oysters collected at each station visit in April-June showed considerable fluctuation. From August through December, however, fluctuations were slight. (Figure 4-B).

The high incidence of D. marinum infection found among gapers from both stations during the summer months (1963 and 1964) indicates a positive relationship between D. marinum infection and summer mortality. However, the high mortality at Switchover during April, 1964 was not associated with a high D. marinum infection (as determined by thioglycollate cultures) and other factors may have been responsible. A study of tissue sections (to be reported by Dr. Mackin) should provide more information.

Live oysters were measured at the time of stocking (or shortly thereafter) and at irregular intervals throughout the two year period. Since all dead oysters recovered from the stations were also measured, the average length of dead oysters (in monthly intervals) was calculated. These data are given in Table 6 and Figure 6.

Switchover oysters at stocking averaged 66.8 mm. in length. The size range was 20 to 170 mm. and the modal size was 73 mm. Hanna oysters averaged 66.6 mm. in length at stocking. The size range was 25 to 150 mm. and the modal size was 65 mm.

In March, 1964 the surviving Switchover oysters had increased 32 mm. in length to an average size of 98.9 mm. Hanna oysters increased 35.2 mm. to an average size of 98.1 mm. From March through December, 1964 Switchover oysters increased by 14.2 mm. to an average length of 113.0 mm. while the Hanna oysters increased 6.1 mm. to an average length of 104.2 mm.

During March - August, 1964 the average length of the Hanna oysters decreased from 98.1 mm. to 95.4 mm. Observations during station visits indicated that little or no growth (increase in length) occurred during April, May and June and the majority of the oysters had receded in length (growth checks were common as the new lip was formed within the original lip). New shell growth was noted in July and recovery of lost growth (length) was common in September.

The average size of dead oysters collected at both stations was consistently smaller than the average size of the live oysters. Measurement error was partially responsible since the bills of the dead oysters were frequently worn, probably as a result of mud crabs and stone crabs attacking the gaping oysters to obtain the meats. However, new shell growth among the boxes and gapers not damaged by crabs was almost always negligible.

Salinities at both stations (Table 7, Figure 7) followed a similar pattern, rising from spring lows to a high in summer (August - September). In 1963, salinities remained high during the fall and winter but, in 1964, dropped slightly in December. Both the mortality cycle (Figure 2) and the cycle of *D. marinum* incidence (Figures 4 and 5) followed the seasonal salinity pattern (with the exception of the 1964 spring mortality at Switchover). Salinities at the Hanna station were generally lower than those recorded at Switchover during the summer peaks but were higher during the spring lows. Salinities at both stations ranged higher in 1963 than in 1964.

Temperatures were usually taken at mid-morning or mid-afternoon during the station visits. When both stations were visited on the same day, temperature differences reflect the time difference. In 1963, the Hanna station was usually visited first and temperature recordings were generally lower than those at Switchover. However, temperatures were very similar at both stations. From May through September, temperatures were above 25°C. According to Ray (1964), the greatest development of *D. marinum* infection occurs at temperatures ranging from 25°C to the maximum summer temperatures.

"Mud mats" formed by nereid worms and tube-building amphipods were very common on Switchover oysters throughout both years. These mats were not found on Hanna oysters although individual mud tubes were present.

The conch (*Thais haemastoma*) was common at the Hanna station during spring and early summer both in 1963 and 1964. It appeared to be more abundant during 1964. The conch was not found at the Switchover station in 1963 but was present in small numbers in 1964. Small conchs were common at both stations during fall, 1964 but were not found at either station in 1963.

The boring clam (*Diplothyra sp.*)was common at the Hanna station and rare at the Switchover station. During 1964 shells of the Hanna oysters were riddled with boring clam holes and become badly eroded. The boring sponge (*Cliona sp.*) also increased at the Hanna station in 1964 causing further erosion of the shells. This may have been a contributing factor in the poor growth of the Hanna oysters during spring and summer.

The Gulf oyster (*Ostrea equestris*) appeared in small numbers at both platforms but was more common at Hanna.

Mud crabs (Panopeus herbstii and Eurypanopeus depressus) and the stone crab (Menippe mercenaria) were common at both stations. The anomuran, Petrolisthes armatus, was very common at both stations in 1964 but was less abundant in 1963. The dove shells (Anachis avara and A. obesa) appeared in large numbers in 1964 but were not found in 1963. The mussel (Brachidontes recurvus) decreased in numbers from 1963 to 1964.

Barnacles (Balanus sp.), slipper shells (Crepidula sp.) and unidentified hydroids, anemones, bryozoans and tunicates were common at both platforms.

Comments:

The mortality pattern among Hanna oysters in 1963 and 1964 and among Switchover oysters in 1963 was similar to the cycle found in Louisiana (Mackin, 1961) with highest death rates occurring in September and the lowest death rates in January and February. The 1964 spring mortality was similar to that found in Barataria Bay, Louisiana during May, 1957 (Mackin, op cit.). A 20 per cent loss of oysters in 30 days occurred in May when culture records showed that the mortality was not caused by D. marinum. Approximately 75 per cent of the gapers recovered during the May mortality in Barataria Bay were infected with "mycelial disease". However, in Barataria Bay, the seasonal summer mortality peak was greater than the mortality peak associated with mycelial disease whereas the spring peak in Galveston Bay exceeded the summer peak. The mycelial organism has been reported in Texas waters (Mackin, 1962) from Aransas Bay, Copano Bay, Corpus Christi Bay and Tres Palacios Bay but was not reported from Galveston Bay.

Literature Cited

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Mackin, J. G. 1961. Oyster diseases caused by Dermocystidium marinum and other organisms in Louisiana. Publ. Inst. Mr. Sci., Vol. 7

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Table 1: Number of dead oysters collected, the calculated deaths per day and the bumber of live oysters remaining at the Switchover tray station during 1963.

Station Visit Date	Days Between Visits	Number of Oysters Dead	Number of Oysters Live*	Deaths/Day (Number)
1963				
2-25	0	0	2101 (Stock)	0
3-23	26	21	2073	0.81
4-23	31	57	2006	1.84
5-22	29	108	1898	3.72
6-5	14	67	1822	4.79
14	9	69	1753	7.64
20	6	42	1711	7.00
26	6	39	1671	6.50
7-3	7	48	1623	6.86
11	8	34	1589	4.25
16	5	30	1558	6.00
24	8	53	1504	6.62
8-9	16	117	1386	7.31
14	5	42	1344	8.40
20	6	46	1289	7.67
28	8	53	1236	6.62
9-5 **	8	70	1159	8.75
11 **	6	51	1096	8.50
20	9	41	1052	4.56
25	5	14	1038	2.80
10-14	19	33	1005	1.74
31	17	31	974	1.82
11-29	29	27	939	0.93
12-27	28	11	917	0.39

(*) Number of live oysters is the number remaining after dead oysters removed, live oysters removed for culture and missing oysters were subtracted.

(**) Trays were examined on September 3, 4 and 5 and on September 10, 11 in an attempt to collect more gapers. Data in 9-3, 4, 5 have been combined under 9-5; data for 9-10, 11 have been grouped under 9-11.

45 live oysters were removed and 35 oysters were missing during 1963.

Table 1A: Number of dead oysters collected, the calculated deaths per day and the number of live oysters remaining at the Switchover tray station during 1964

Station Visit Date	Days Between Visits	Number of Oysters Dead	Number of Oysters Live*	Deaths/Day (Number)
1964				
1-26	26	4	905	0.15
3-31	69	19	889 **	0.28
4-25	25	186	693	7.44
5-9	14	29	656	2.07
20	11	11	640	1.00
6-2	13	14	621	1.07
18	16	7	609	0.44
7-2	14	5	596	0.36
7	5	5	582	1.00
27	20	19	554	0.95
8-6	10	9	537	0.90
11	5	7	524	1.40
26	15	22	494	1.47
9-3	8	16	473	2.00
10	7	18	450	2.57
15	5	9	436	1.80
10-8	23	31	397	1.35
22	14	7	382	0.50
11-6	15	9	367	0.60
27	21	6	351	0.29
12-8	11	1	340	0.09
1-7-65	31	5	325	0.16

(*) Live oysters = the number remaining after dead oysters and live oysters for culture were removed and any missing oysters were subtracted.

(**) Two oysters were added to the stock on March 31, 1964. Both were oysters which had grown in the trays during the previous year.

Table 2: Number of dead oysters collected, the calculated deaths per day and the number of live oysters remaining at the Hanna tray station during 1963

Station Visit Date	Days Between Visits	Number of Oysters		Deaths/Day (Number)
		Dead	Live*	
1963				
4-5	0	0	2800 (Stock)	
5-6	32	48	2743	1.50
15	9	39	2704	4.33
22	7	26	2678	3.71
6-5	14	52	2618	3.71
14	9	36	2582	4.00
21	7	39	2476	5.57
27	6	18	2445	3.00
7-2	5	32	2408	6.40
11	9	42	2366	4.67
16	5	30	2336	6.00
25	9	73	2263	8.11
8-9	15	148	2115	9.87
14	5	38	2076	7.60
22	8	43	2033	5.38
28	6	39	1993	6.50
9-6	9	68	1918	7.56
13	7	69	1844	9.86
20	7	40	1804	5.71
26	6	50	1751	8.33
10-16	20	112	1639	5.60
13	15	66	1573	4.40
11-8	8	23	1550	2.88
12-5	27	47	1487	1.73

(*) Live oysters are those remaining after subtracting the number of dead oysters collected, the number of live oysters removed for culture and the number of missing oysters, if any.

26 live oysters were removed and 109 were missing during 1963.

Table 2A: Number of dead oysters collected, the calculated deaths per day and the number of live oysters remaining at the Hanna tray station during 1964.

Station Visit Date	Days Between Visits	Number of Oysters		Deaths/Day (Number)
		Dead	Live*	
1964				
1-30	56	11	1468	0.20
3-18	48	13	1445	0.27
4-27	40	64	1375	1.60
5-20	23	72	1297	3.13
6-2	13	12	1279	0.92
18	16	48	1222	3.00
24	6	21	1196	3.50
7-1	7	40	1148	5.71
7	6	31	1109	5.17
24	117	73	1029	4.29
8-6	13	44	976	3.38
11	5	22	946	4.40
26	15	75	863	5.00
9-3	8	43	815	5.38
9	6	37	771	6.17
15	6	25	741	4.17
10-8	23	90	643	3.91
22	14	17	618	1.21
11-6	15	20	593	1.33
10	4	6	588	1.50
27	17	12	565	0.71
12-7	10	1	554	0.10
1-6-65	30	3	541	0.10

(*) Live oysters are those remaining after subtracting the number of dead oysters collected, the number of live oysters removed for culture and the number of missing oysters, if any. 162 live oysters were removed and 4 were missing during 1964.

Table 3: Monthly mortality rate (%) at Switchover and Hanna tray stations during 1963 and 1964

Month	Switchover		Hanna	
	Deaths/Month	% Mortality per Month	Deaths/Month	% Mortality per Month
1963				
1				
2	2.4	0.1		
3	33.3	1.6		
4	68.1	3.3	39.0	1.4
5	124.9	6.3	107.4	3.9
6	201.3	10.8	130.6	4.9
7	188.8	11.5	217.0	8.9
8	227.3	15.6	231.5	10.5
9	164.2	13.5	226.7	11.5
10	55.3	5.4	155.6	9.0
11	27.4	2.8	61.3	3.9
12	11.2	1.2	13.9	0.9
1964				
1	5.9	0.6	6.3	0.4
2	8.1	0.9	7.8	0.5
3	8.7	1.0	25.7	1.8
4	196.4	22.1	52.6	3.7
5	41.4	6.1	72.7	5.3
6	13.5	2.2	105.2	8.2
7	28.3	4.7	133.4	11.5
8	44.4	8.1	144.2	14.4
9	53.2	11.0	136.8	16.4
10	23.2	5.6	60.3	8.8
11	9.9	2.6	26.3	4.3
12	4.4	1.3	3.1	0.6

Figure 2: Monthly mortality rate (% mortality) at Switchover and Hanna platforms during 1963 and 1964.

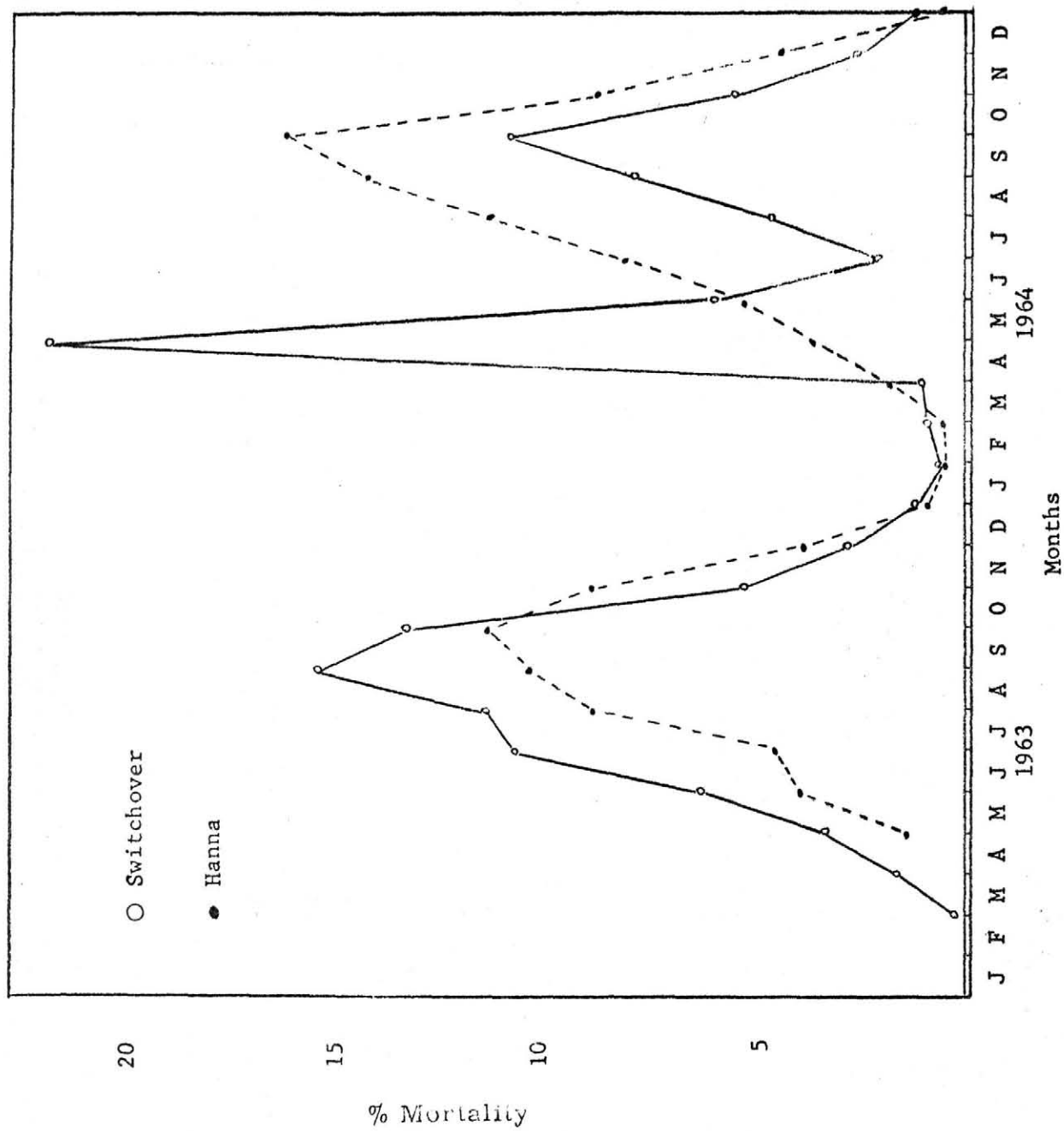

Table 4: Cumulative deaths and cumulative mortality (%) among oysters at Switchover and Hanna tray stations during 1963 and 1964

Month	Switchover		Hanna	
	Cumulative Deaths	Cumulative Mortailty (%)	Cumulative Deaths	Cumulative Mortality (%)
1963				
1				
2	2.4	0.1		
3	35.7	1.7		
4	103.8	4.9	39.0	1.4
5	228.7	10.9	146.4	5.2
6	430.0	20.5	277.0	9.9
7	618.8	29.4	494.0	17.6
8	846.1	40.3	725.5	25.9
9	1010.3	48.1	952.2	34.0
10	1065.6	50.7	1107.8	39.6
11	1093.0	52.0	1169.1	41.2
12	1104.2	52.6	1183.0	42.2
1964				
1	1110.1	52.8	1189.3	42.5
2	1118.2	53.2	1197.1	42.8
3	1126.9	53.6	1222.8	43.7
4	1323.3	63.0	1275.4	45.6
5	1364.7	65.0	1348.1	48.2
6	1378.2	65.6	1453.3	51.9
7	1406.5	66.9	1586.7	56.7
8	1450.9	69.1	1730.9	61.8
9	1504.1	71.6	1867.7	66.7
10	1527.3	72.7	1928.0	68.9
11	1537.2	73.2	1954.3	69.8
12	1541.6	73.4	1957.4	69.9

(During the period January - December, 1964 mortality at Switchover was 47.7% and mortality at Hanna was 52.2%).

Figure 3: Cumulative Mortality (%) at Switchover and Hanna platforms - 1963-64

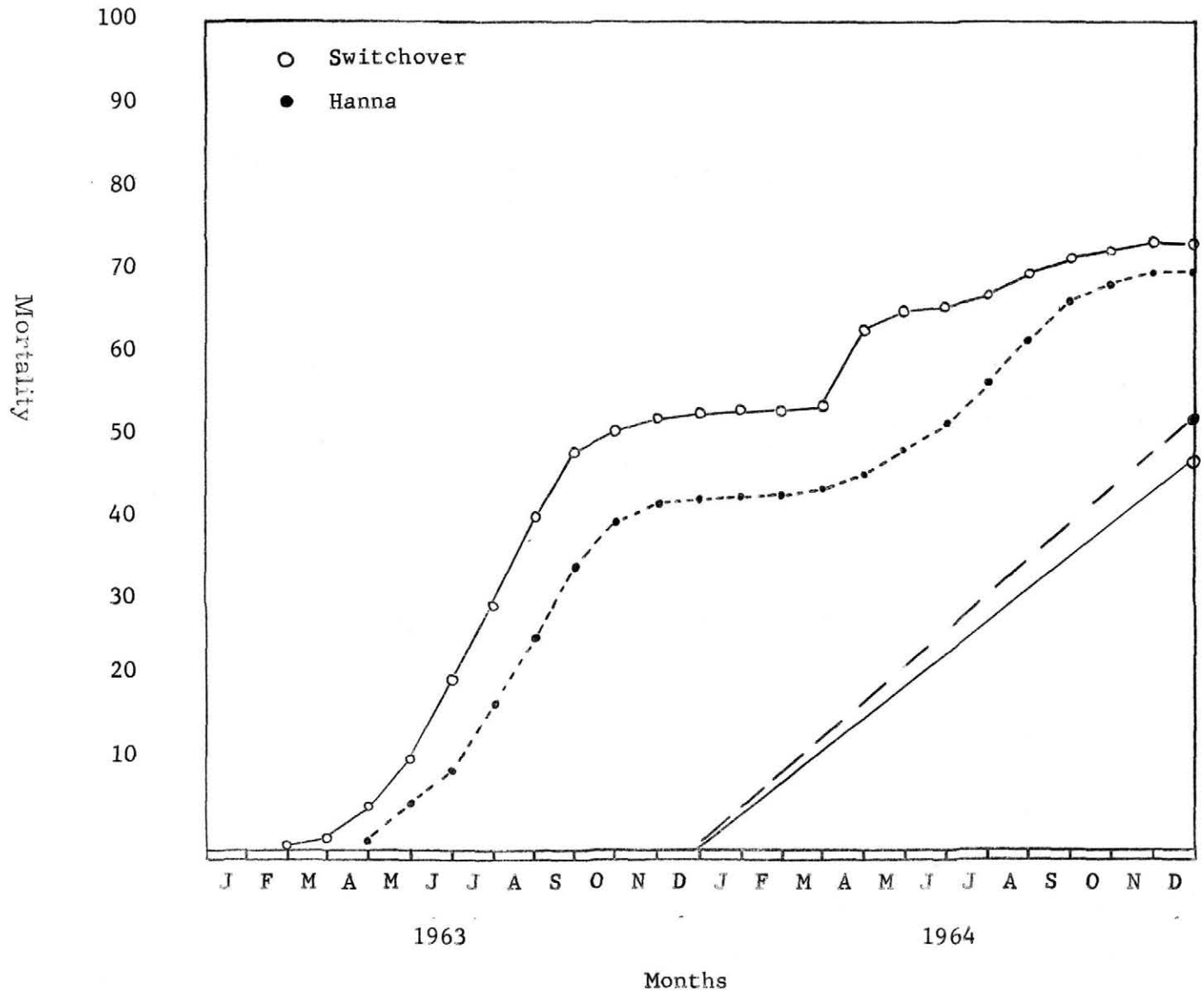

Table 5: Weighted incidence of Dermocystidium marinum infection among dead (gaper) and live oysters collected from Switchover and Hanna tray stations during 1963 and 1964

SWITCHOVER STATION

Month	No. Gapers 1963	No. Gapers 1964	Gaper Infection 1963	Gaper Infection 1964	No. Live 1963	No. Live 1964	Live Infection 1963	Live Infection 1964
1	-	1	-	5.0	-	8		1.4
2	-	-	-	-	-	-		-
3	5	3	0.1	-	7	0	0.1	-
4	5	7	3.9	2.5	10	10	2.2	2.0
5	2	2	2.2	2.5	0	13	-	2.1
6	20	0	4.3	-	10	10	2.1	2.0
7	33	4	4.1	4.8	0	25	-	2.4
8	19	1	4.2	5.0	0	22	-	2.5
9	21	2	4.7	4.5	2	15	-	3.3
10	4	1	5.0	5.0	0	16	-	3.6
11	4	0	5.0	-	8	16	2.6	3.3
12	3	0	3.3	-	8	10	1.4	3.6

HANNA STATION

Month	No. Gapers 1963	No. Gapers 1964	Gaper Infection 1963	Gaper Infection 1964	No. Live 1963	No. Live 1964	Live Infection 1963	Live Infection 1964
1	-	4	-	3.8	-	8	-	0.9
2	-	-	-	-	-	-	-	-
3	-	2	-	5.0	-	8	-	0.4
4	-	0	-	-	-	6	-	2.0
5	11	5	3.0	3.8	9	6	1.3	1.2
6	16	7	3.5	3.5	8	20	1.7	2.2
7	35	23	4.8	4.7	-	24	-	2.6
8	43	18	4.4	4.6	-	24	-	3.4
9	41	47	4.4	4.9	-	15	-	2.9
10	16	13	4.8	4.8	-	16	-	2.9
11	4	4	-	5.0	-	15	-	2.4
12	4	1	5.0	5.0	9	10	2.6	2.8

Figure 4: Monthly weighted incidence of D. marinum infection among dead (gaper) and live oysters on Switchover Platform during 1963-64

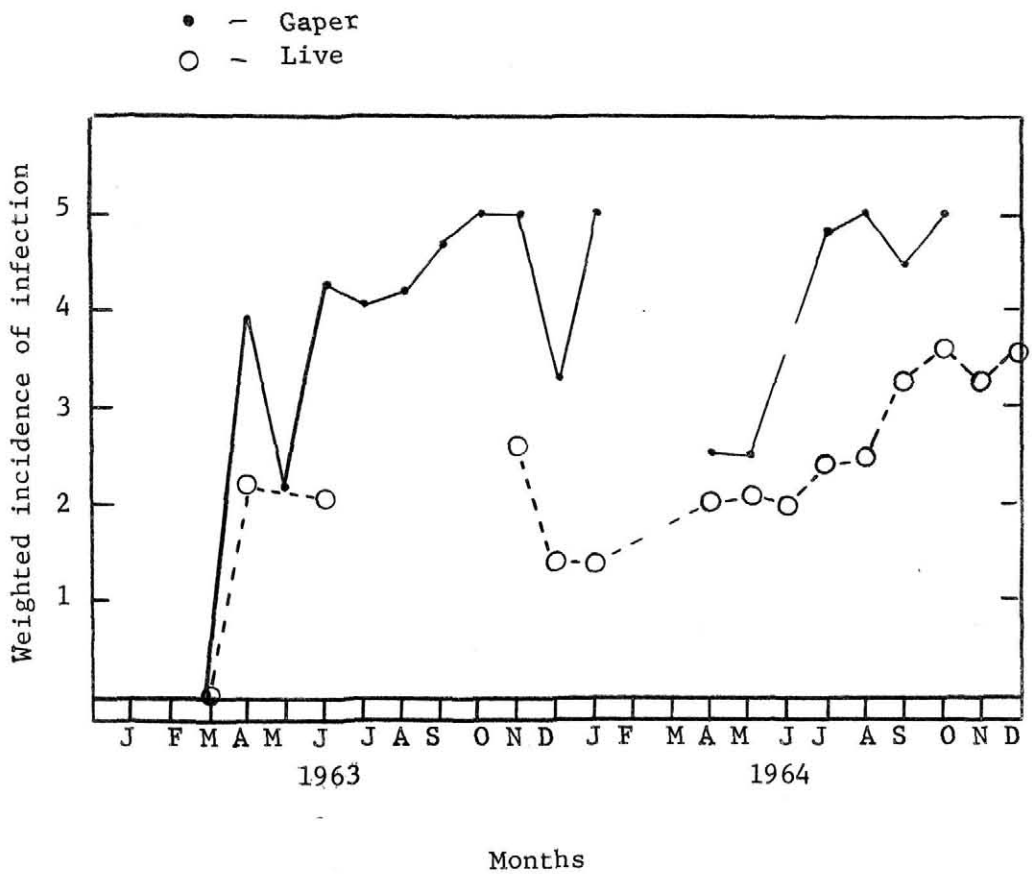

Figure 5: Monthly weighted incidence of D. marinum infection among dead (gaper) and live oysters on Hanna Platform during 1963-64

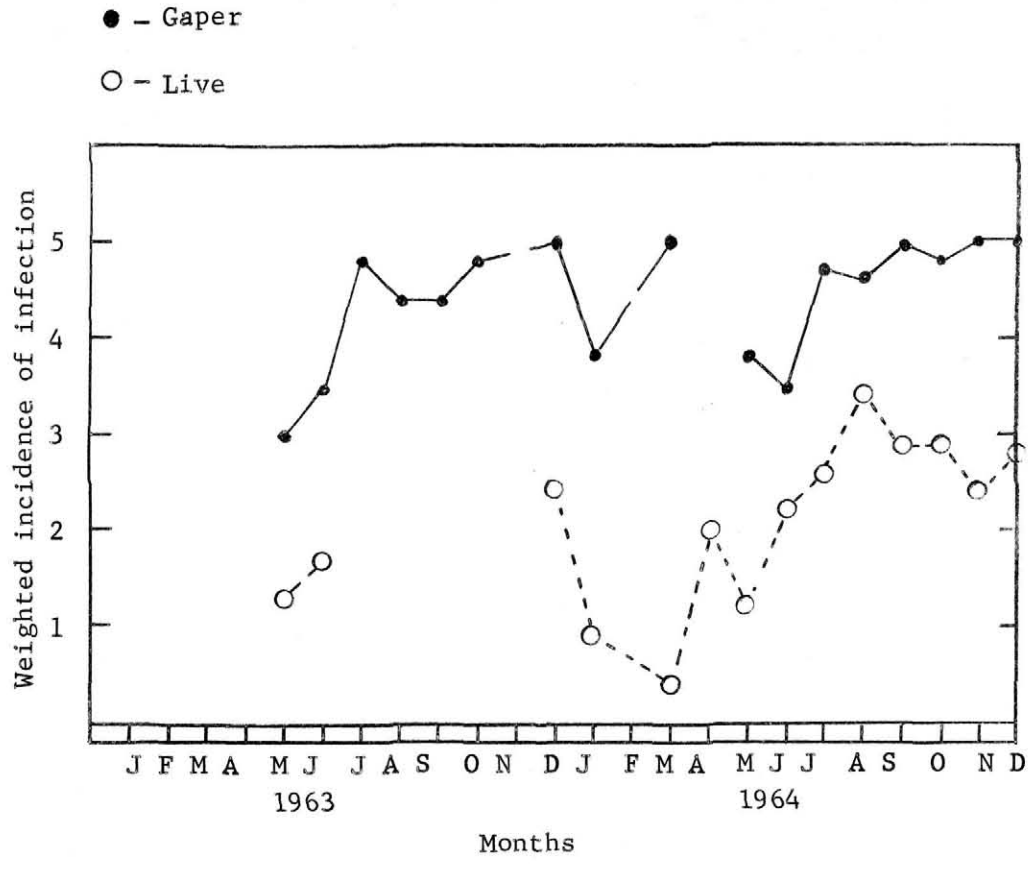

Table 6: Average length of live oysters at stocking and at intervals throughout 1963 and 1964 at tray stations Switchover and Hanna compared with the average length of dead oysters recovered from each platform

Month	AVERAGE LENGTH (mm) Live Oysters Switchover	Live Oysters Hanna	Dead Oysters Switchover	Dead Oysters Hanna
1963				
1	-	-	-	
2	-	-	-	-
3	66.8 (Stock)	-	62.3	-
4	-	-	58.5	-
5	-	66.6 (Stock)	62.5	67.2
6	-	-	71.5	71.4
7	-	70.5*	73.3	72.0
8	-	-	79.7	73.5
9	82.9	-	81.3	78.4
10	-	-	81.7	80.1
11	-	-	80.3	81.6
12	-	-	80.0	80.0
1964				
1	-	-	85.0	82.0
2	-	-	-	-
3	98.8	98.1	91.7	82.8
4	-	-	90.5	86.3
5	-	-	94.6	88.6
6	-	-	88.4	86.6
7	105.8	-	91.5	89.0
8	-	95.4	91.7	91.0
9	106.8	96.5	101.3	93.1
10	-	-	95.7	90.8
11	112.3	100.6	102.2	95.0
12	112.6	101.7	101.5	91.5

* Average length of Hanna oysters in July, 1963 based upon 1393 oysters in 9 of the 15 trays (approx. 57% of the population).

Figure 6: Switchover Platform

Comparison of average length of live and dead oysters during 1963-64

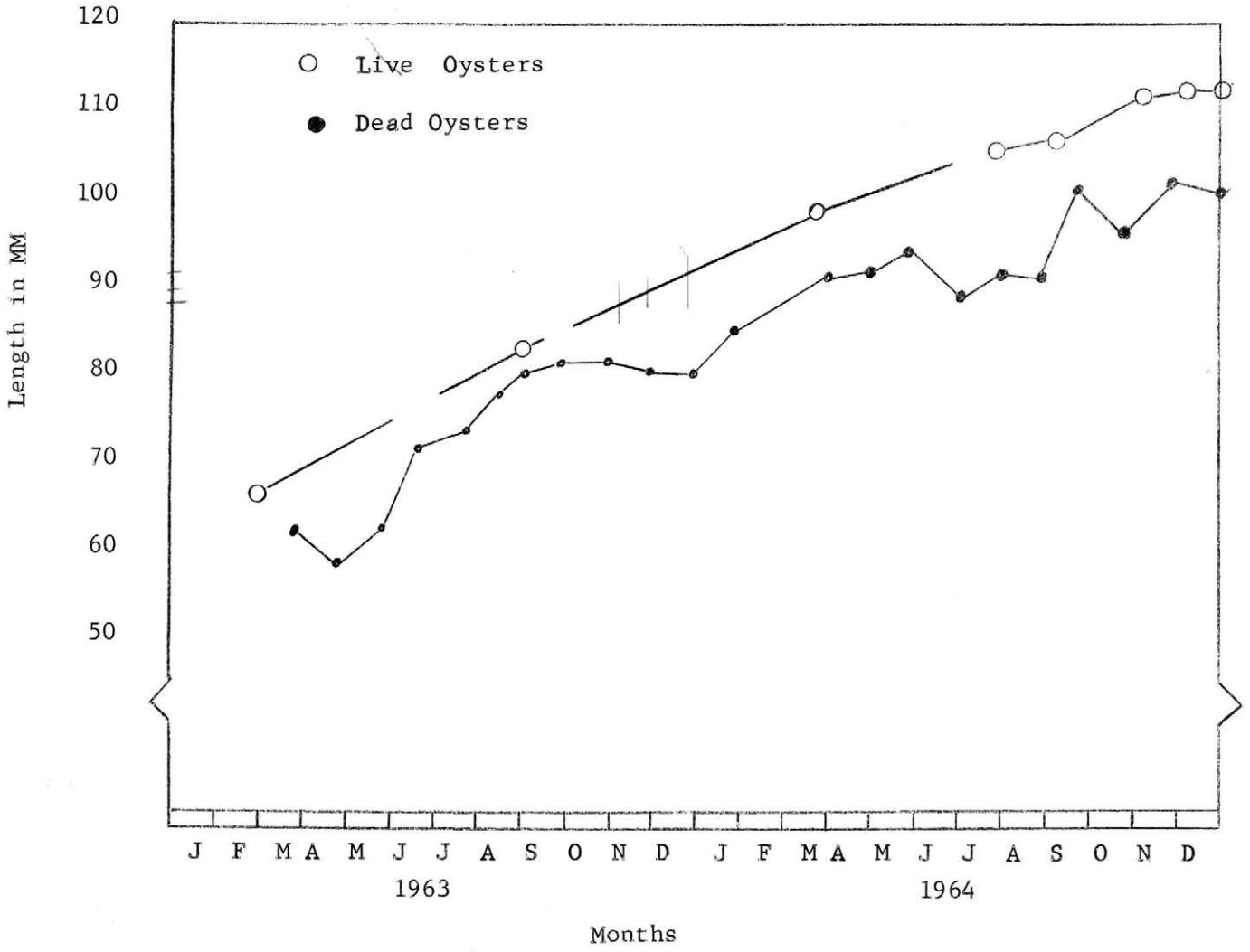

Figure 6: Hanna Platform

Comparison of average length of live and dead oysters during 1963-64

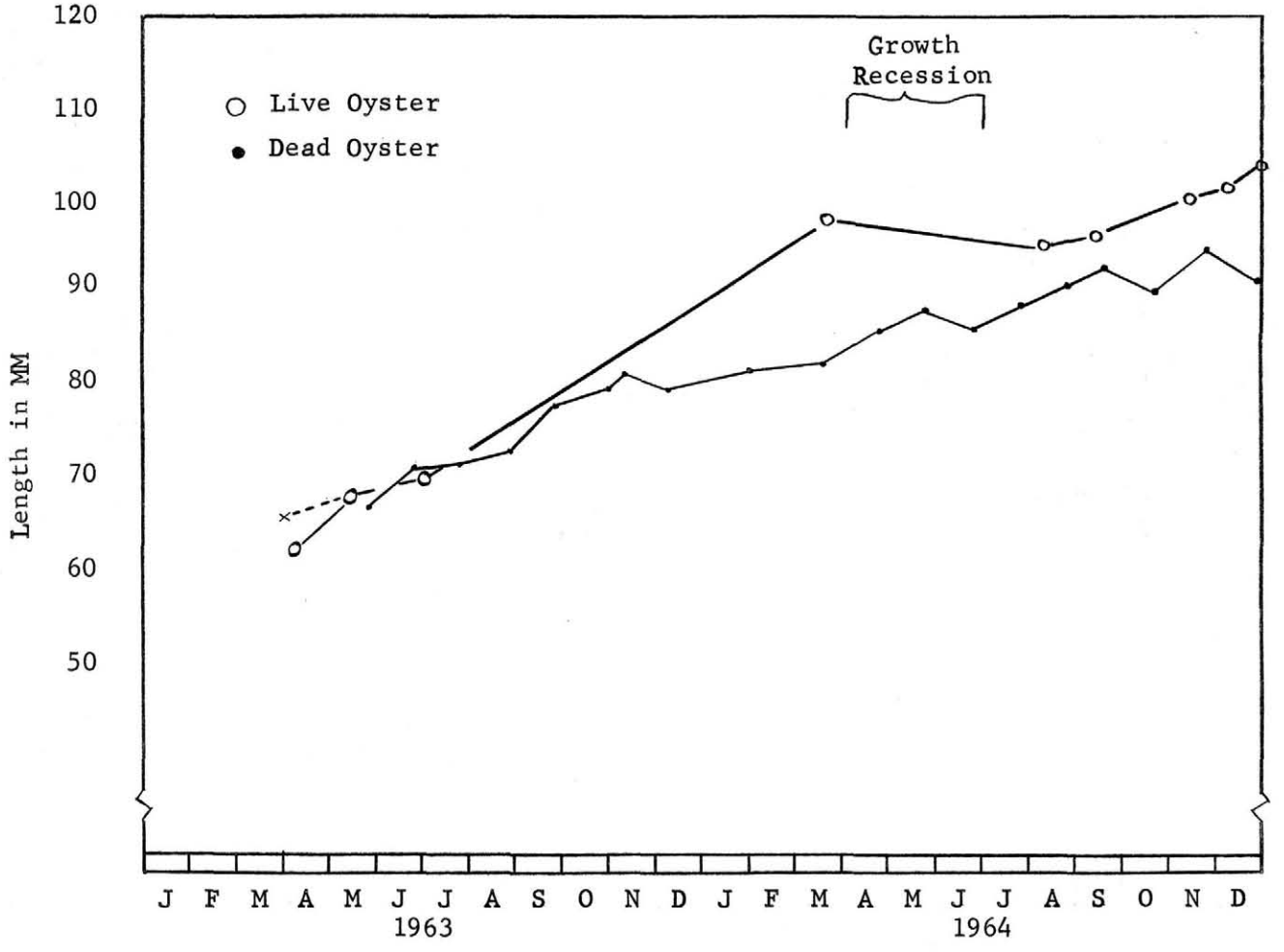

Table 7: Monthly salinity and temperature at Switchover and Hanna tray stations during 1963 and 1964

	SALINITY (‰)				TEMPERATURE (°C)			
	Switchover		Hanna		Switchover		Hanna	
	1963	1964	1963	1964	1963	1964	1963	1964
Jan.		26.9		25.5		9.8		11.0
Feb.								
March		20.4		22.5		17.4		16.5
April		19.0		20.0		23.4		24.2
May	19.0	17.6	22.7	19.7	27.9	24.6	26.6	27.0
June	20.8	19.5	21.4	20.4	29.4	26.4	28.5	27.6
July	20.7	20.1	21.1	20.8	30.5	29.6	29.9	29.1
Aug.	25.2	22.6	24.2	20.9	31.3	30.0	29.8	29.7
Sept.	26.3	24.4	23.8	24.0	27.6	29.2	26.9	28.8
Oct.	25.5	23.6	21.2	21.4	23.4	20.0	21.3	20.8
Nov.	24.0	22.2	24.9	23.2	12.6	18.6	21.7	19.1
Dec.	23.5	21.0	21.5	19.6	6.8	10.9	12.8	9.6

Figure 7: Comparison of monthly average temperature and salinity at Switchover and Hanna Platforms - 1963-64