TABLE 46 : SEASONAL STRINGS, 1949* SPAT PER SHELL

DATE PUT OUT	OYSTER BAY	MUD BAY	NORTH BAY
June 20	241	251	1061
23	314	178	790
26	380	307	1026
30	351	586	495
July 5	590	449	1069
8	398	374	804
11	436	554	823
18	477	215	290
21	372	192	336
27	292	95	537
Aug. 2	100	55	299

* Taken into the Laboratory Aug. 9, 1949

TABLE 48: PLANKTON LARVAE SURVEY OF OYSTER BAY

STATION 9, Aug. 8, 1944

STANDARD TIME	HEIGHT OF TIDE IN FEET	NUMBER OF LARVAE PER 20 GAL. SAMPLE
9:00 AM	12.4	8
9:30	11.3	48
10:00	10.2	40
10:30	8.6	612
11:00	6.9	32
11:30	5.6	140
12:00 N	4.3	224
12:30 PM	2.9	100
1:00	1.7	48
1:30	0.9	84
2:00	0.45	12
2:30	0.4	64
3:00	0.8	8
3:30	1.5	8
4:00	2.8	4
4:30	4.3	36
5:00	5.9	212
5:34	7.4	772
6:00	9.4	720
6:30	11.2	444
7:00	12.6	148
7:30	14.0	120
8:00	15.0	84
8:30	15.6	56
9:00	15.8	76
9:30	15.5	76
10:00	14.5	420

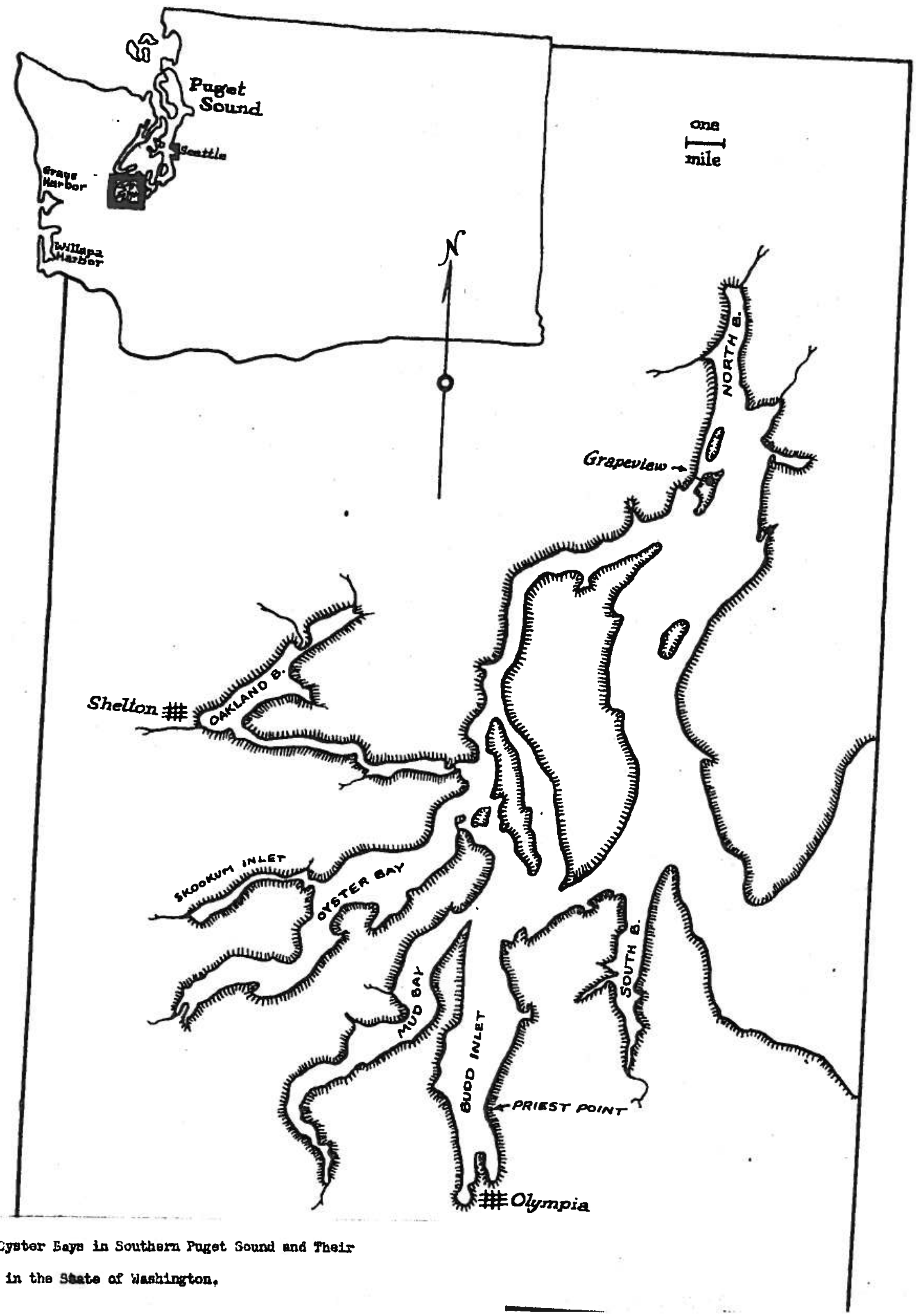


Figure 1 Olympia Oyster Bays in Southern Puget Sound and Their Location in the State of Washington.

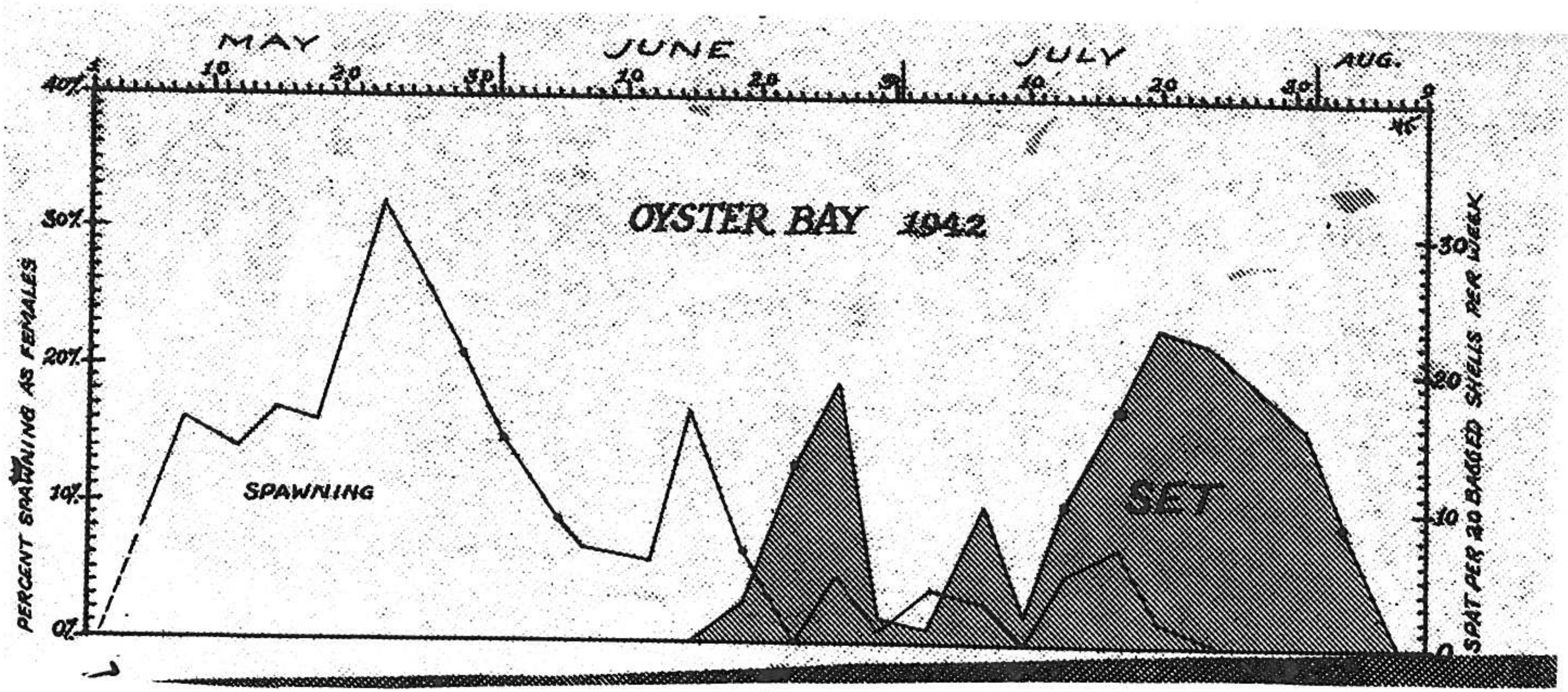


Figure 2 Oyster Bay Reproductive Season, 1942

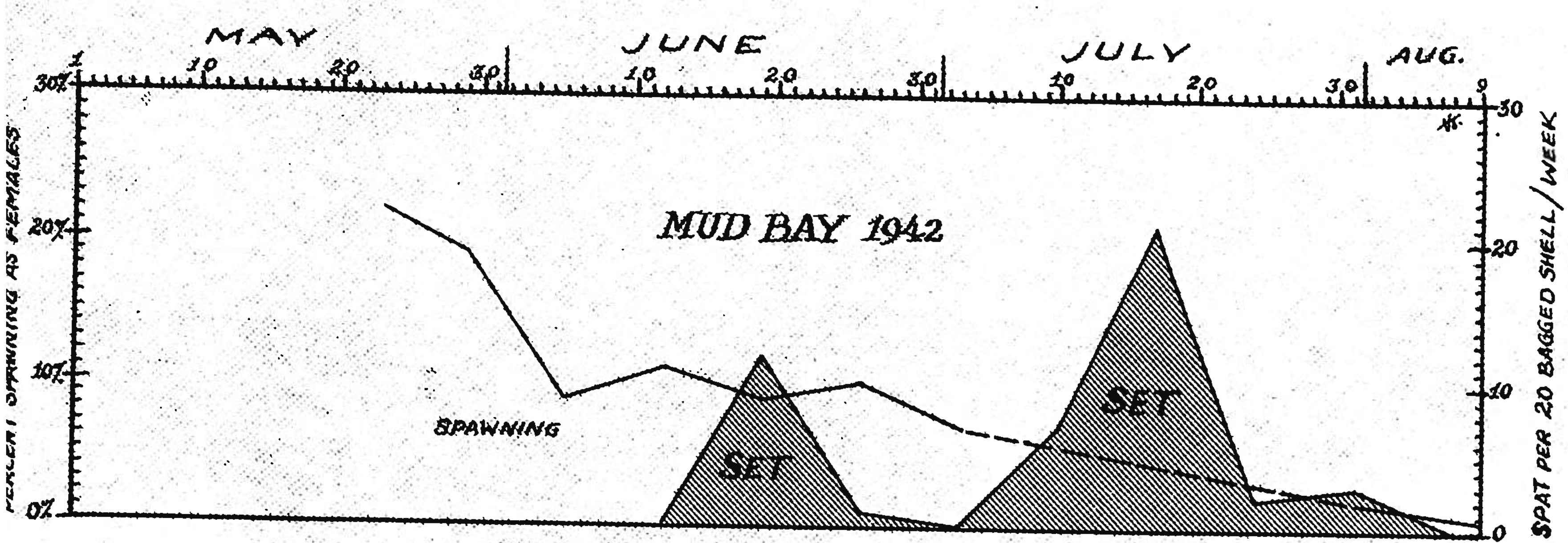
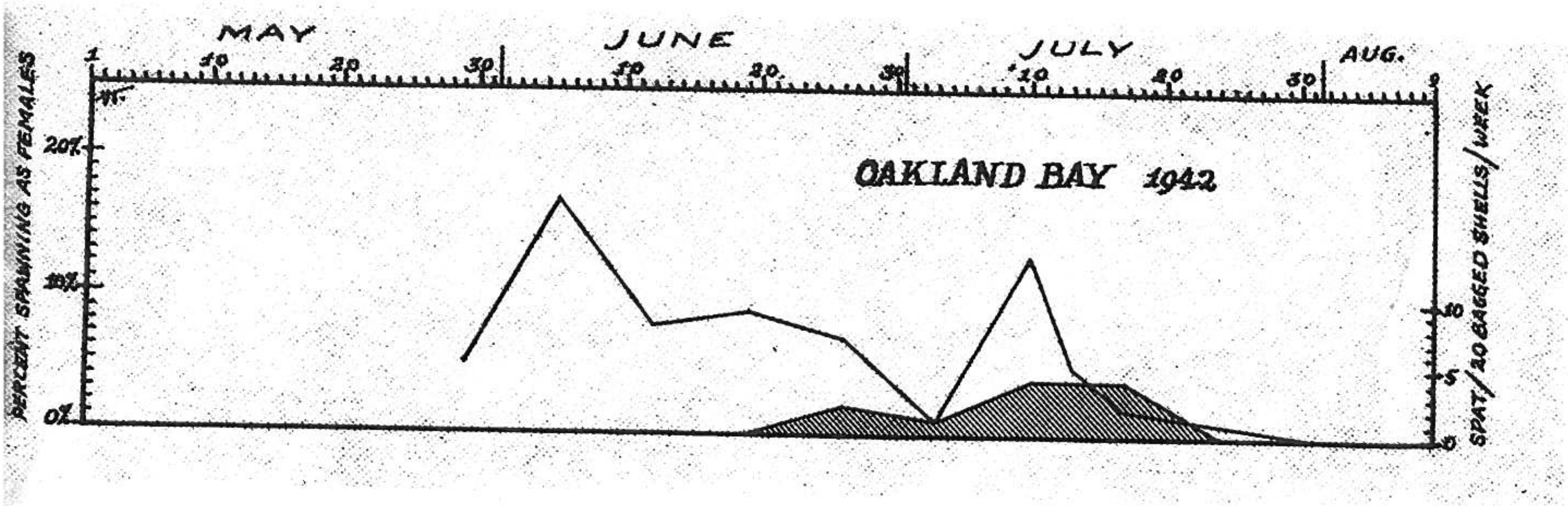
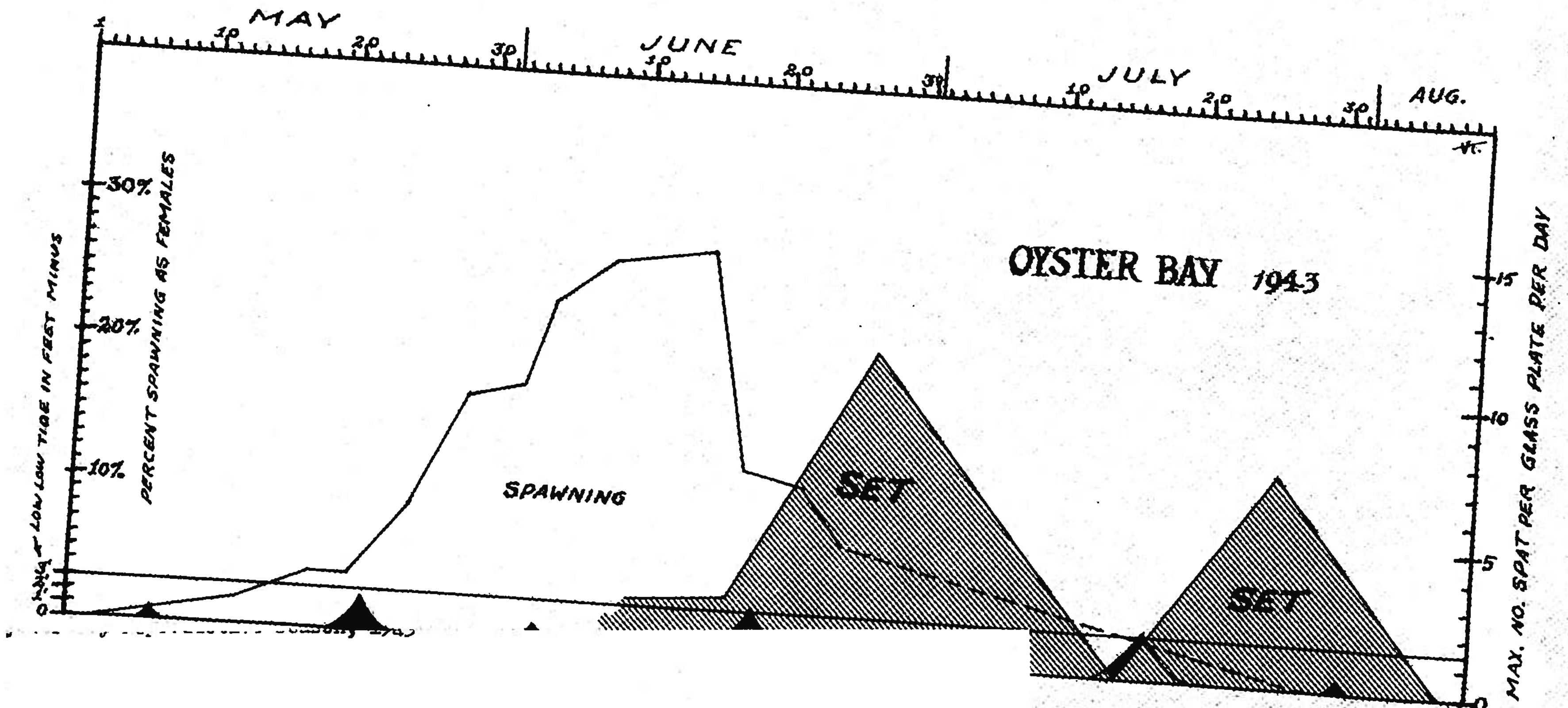


Figure 3 Mud Bay Reproductive Season, 1942.



Mud Bay

Figure 4 Oakland Bay, Reproductive Season, 1942.



igure 5 Oyster Bay Reproductive Season, 1943

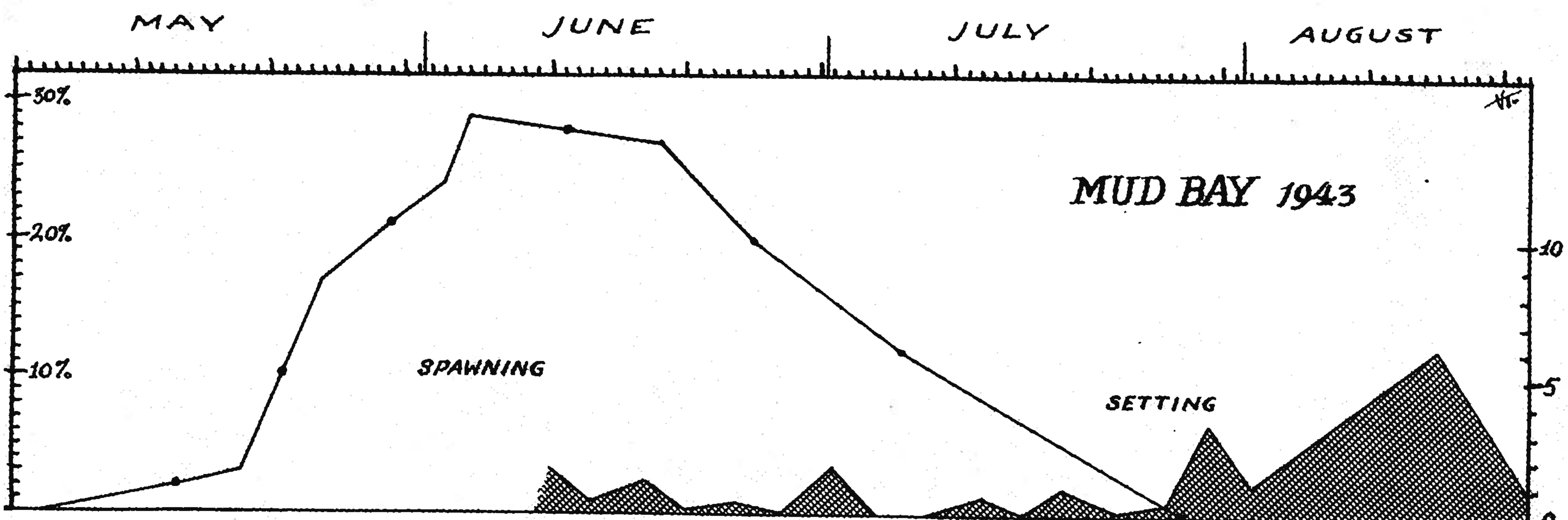


Figure 6 Mud Bay Reproductive Season, 1943.

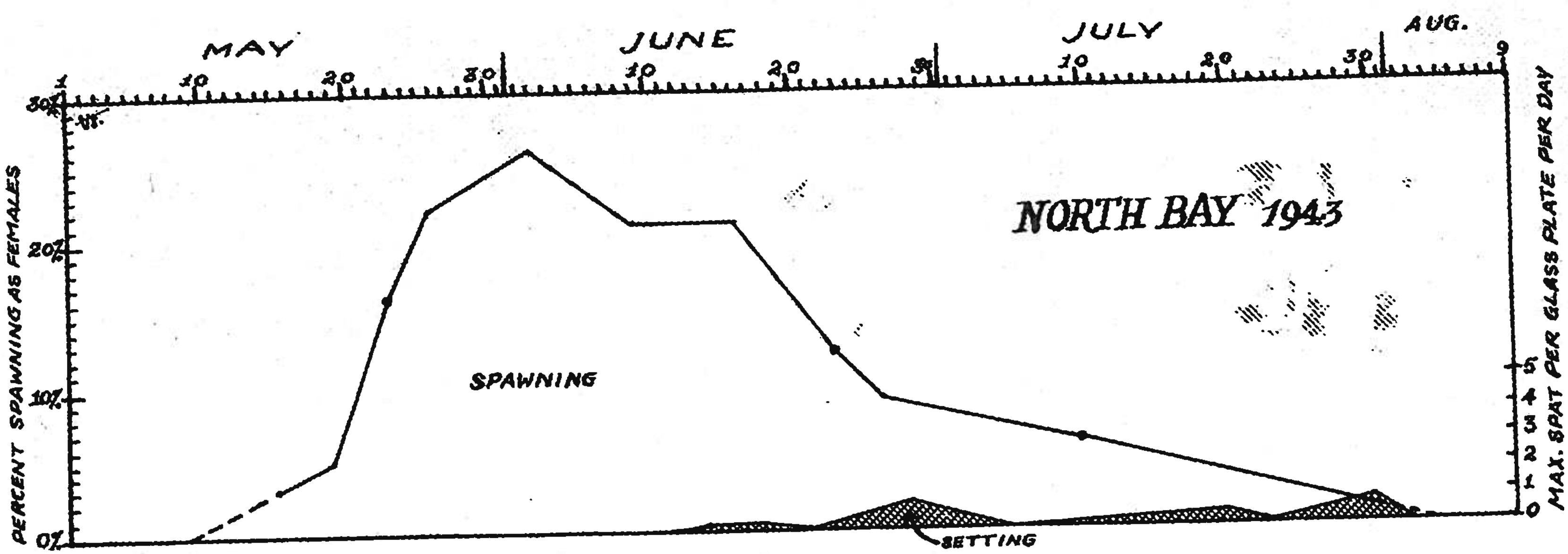
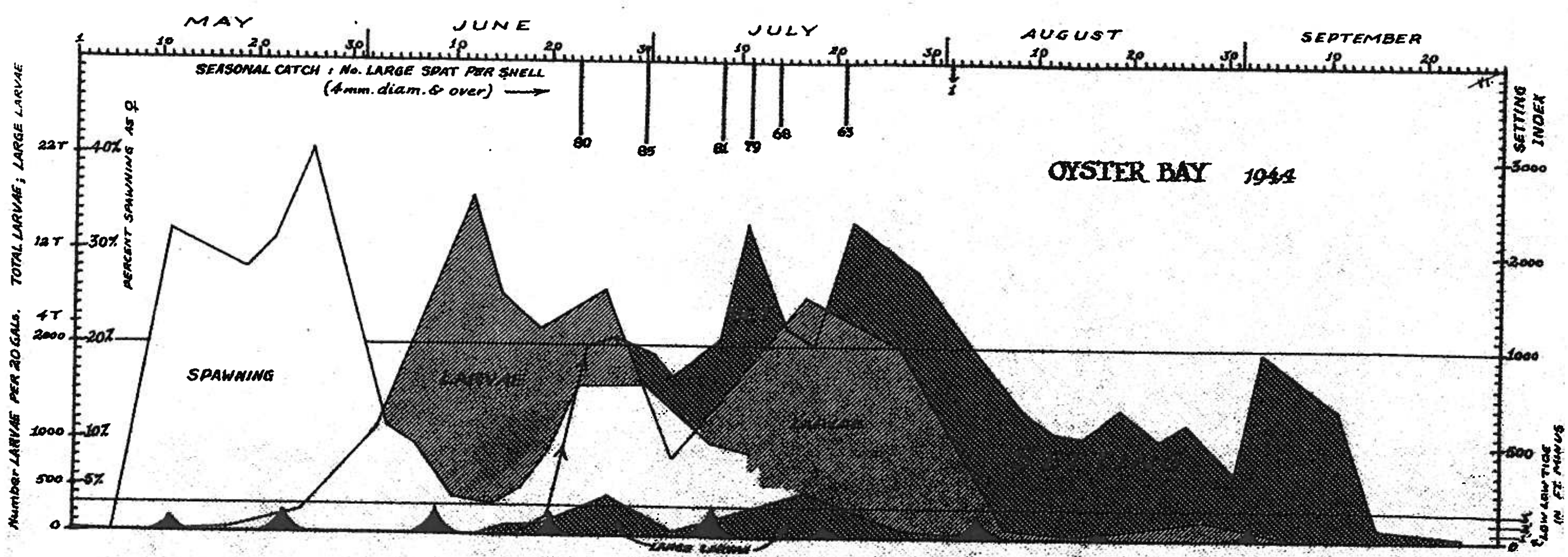


Figure 7 North Bay Reproductive Season, 1943.


MAY
JUNE
JULY
AUGUST
SEPTEMBER
SEASONAL CATCH : No. LARGE SPAT PER SHELL
(4mm. diam. & over)
80
85
81
79
68
63
1
OYSTER BAY 1944
SPAWNING
LARVAE
LARGE LARVAE
Number LARVAE PER 20 GALS. TOTAL LARVAE; LARGE LARVAE
PERCENT SPAWNING AS ♀
22T
12T
4T
2000
1000
500
0
40%
30%
20%
10%
5%
SETTING INDEX
3000
2000
1000
500
0
LOW LOW TIDE IN FT. MINUS

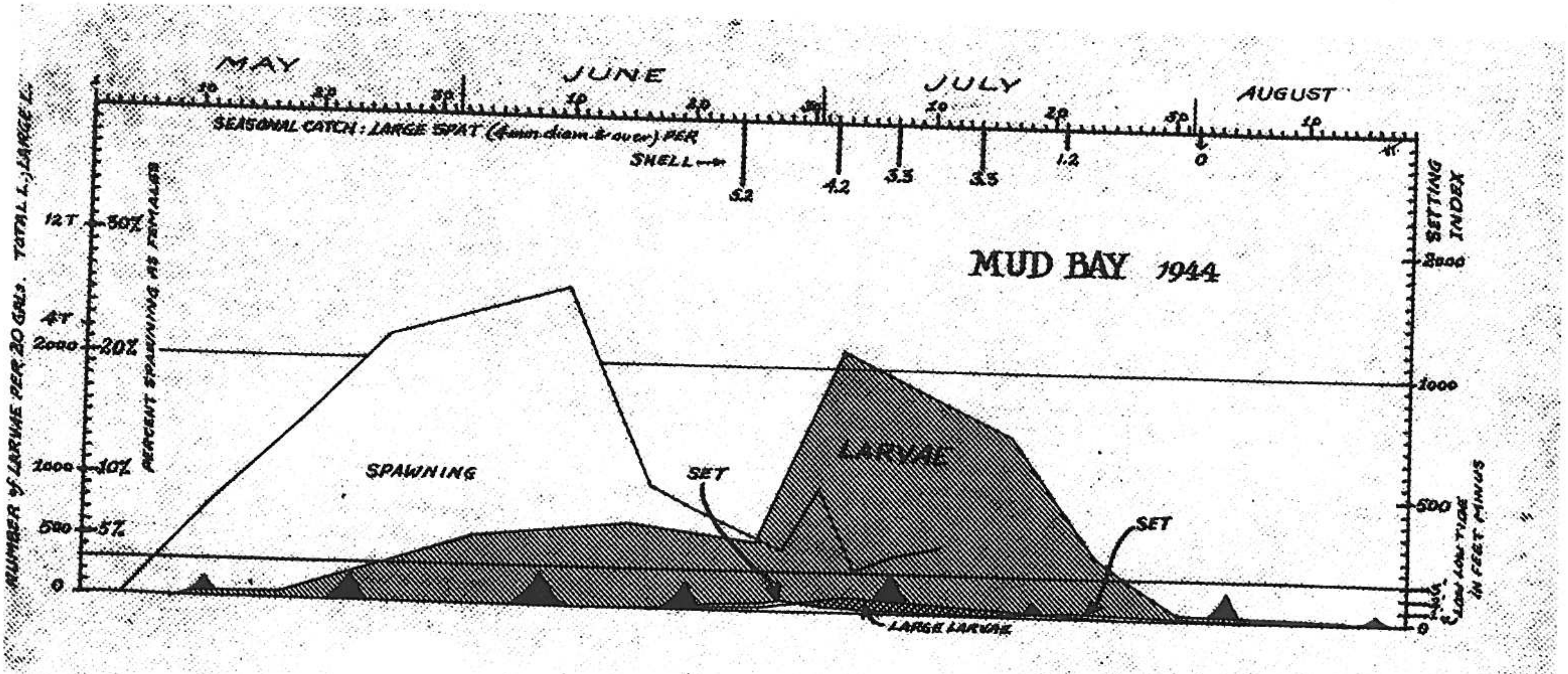


Figure 10 Mud Bay Reproductive Season, 1944.

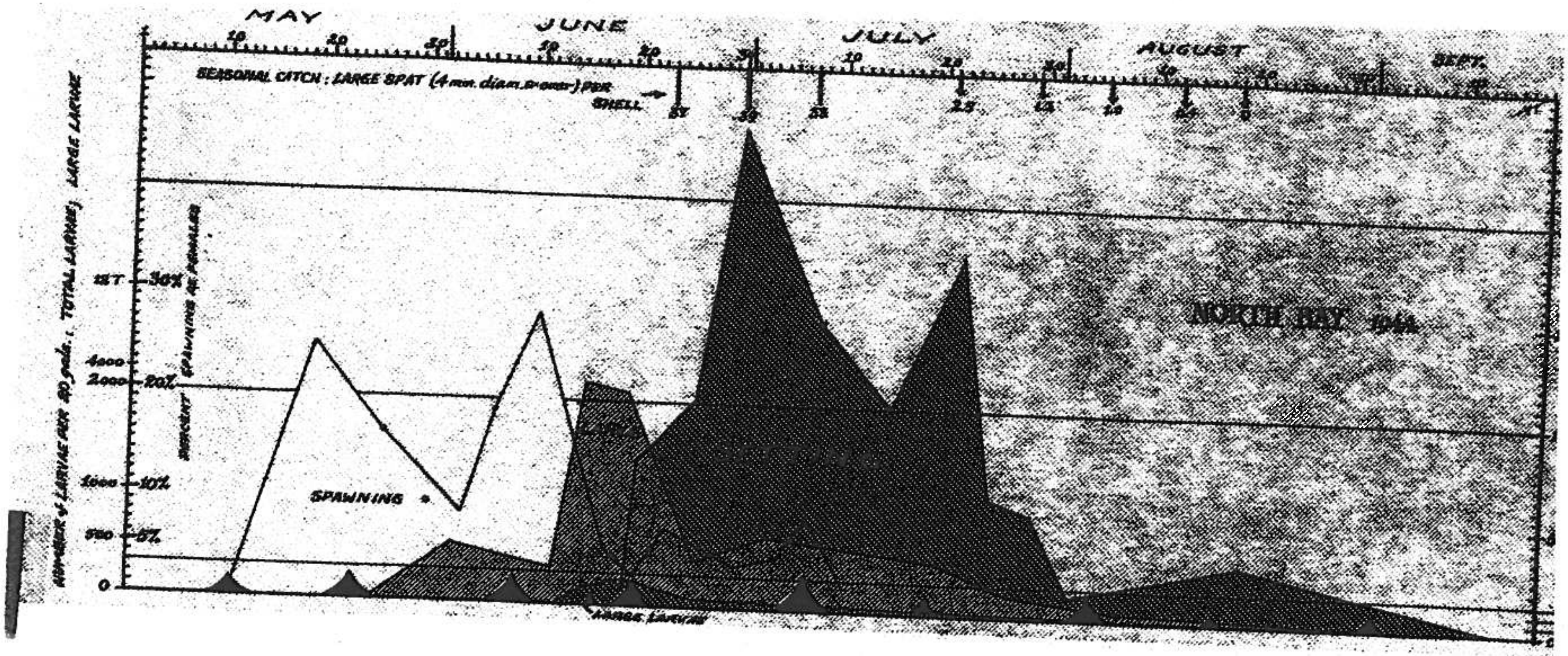


Figure 11 North Bay Reproductive Season, 1944

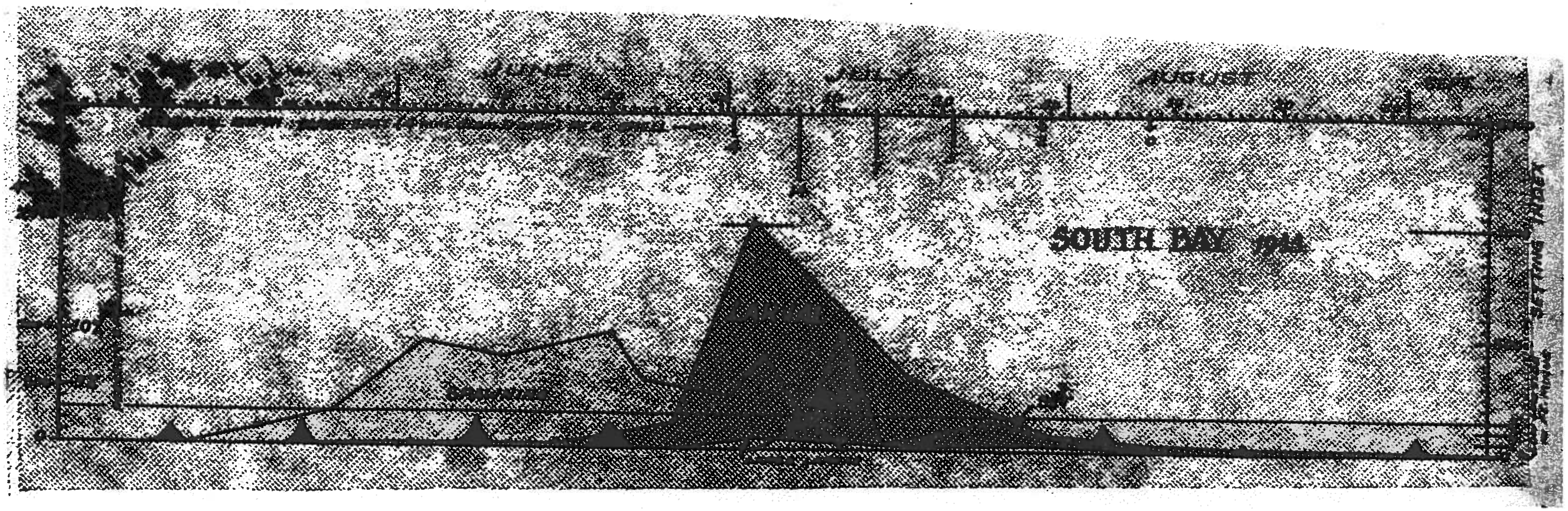


Figure 12 South Bay Reproductive Season, 1944

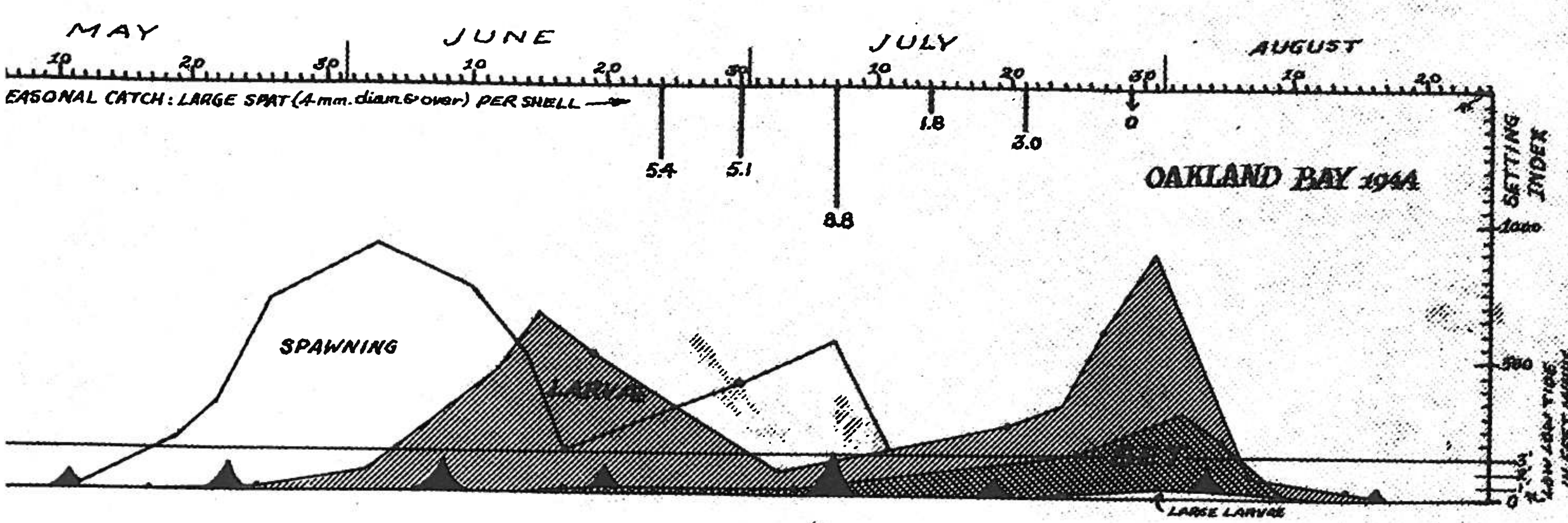
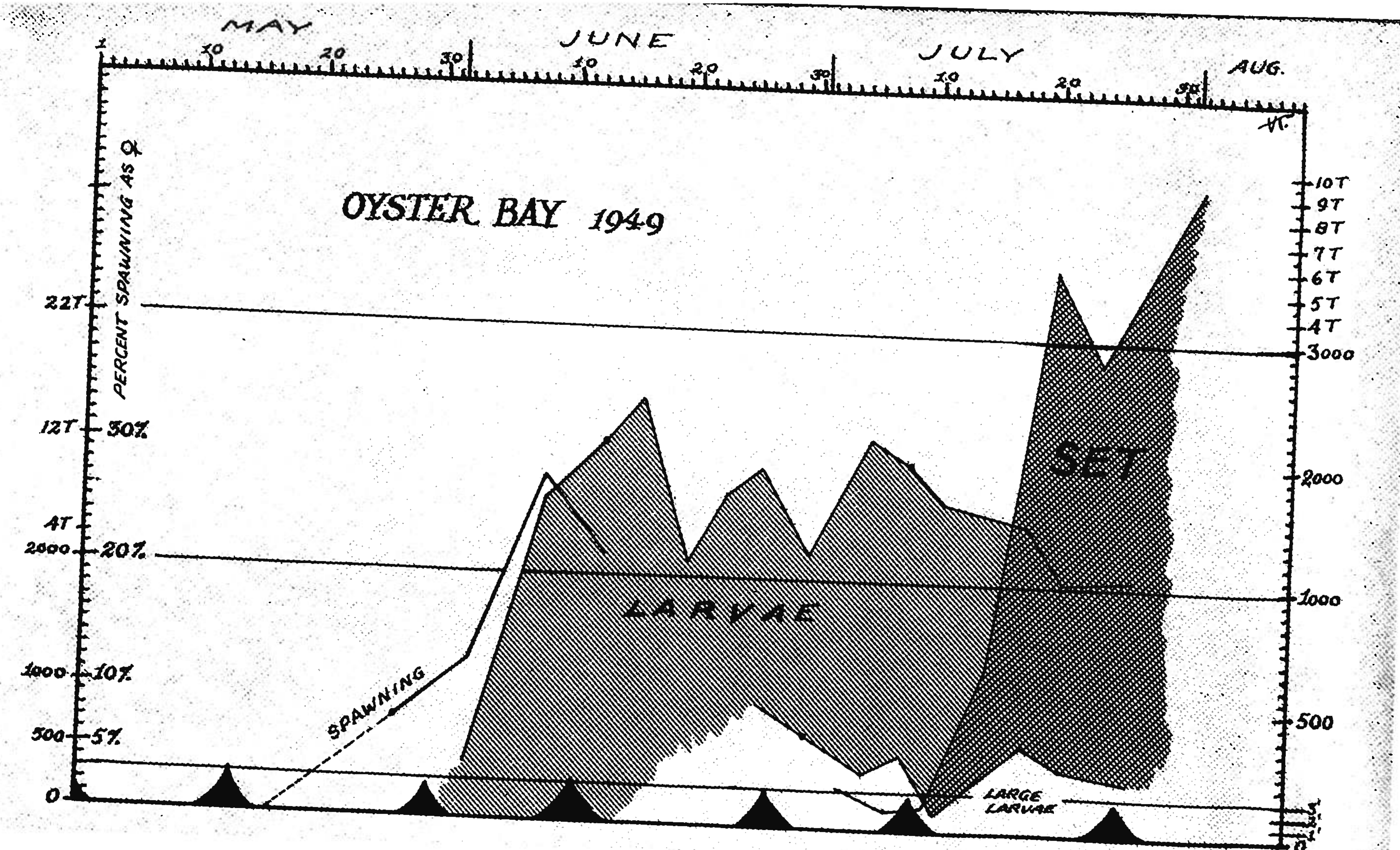


Figure 13 Oakland Bay Reproductive Season, 1944



Oyster Bay Reproductive Season, 1949.

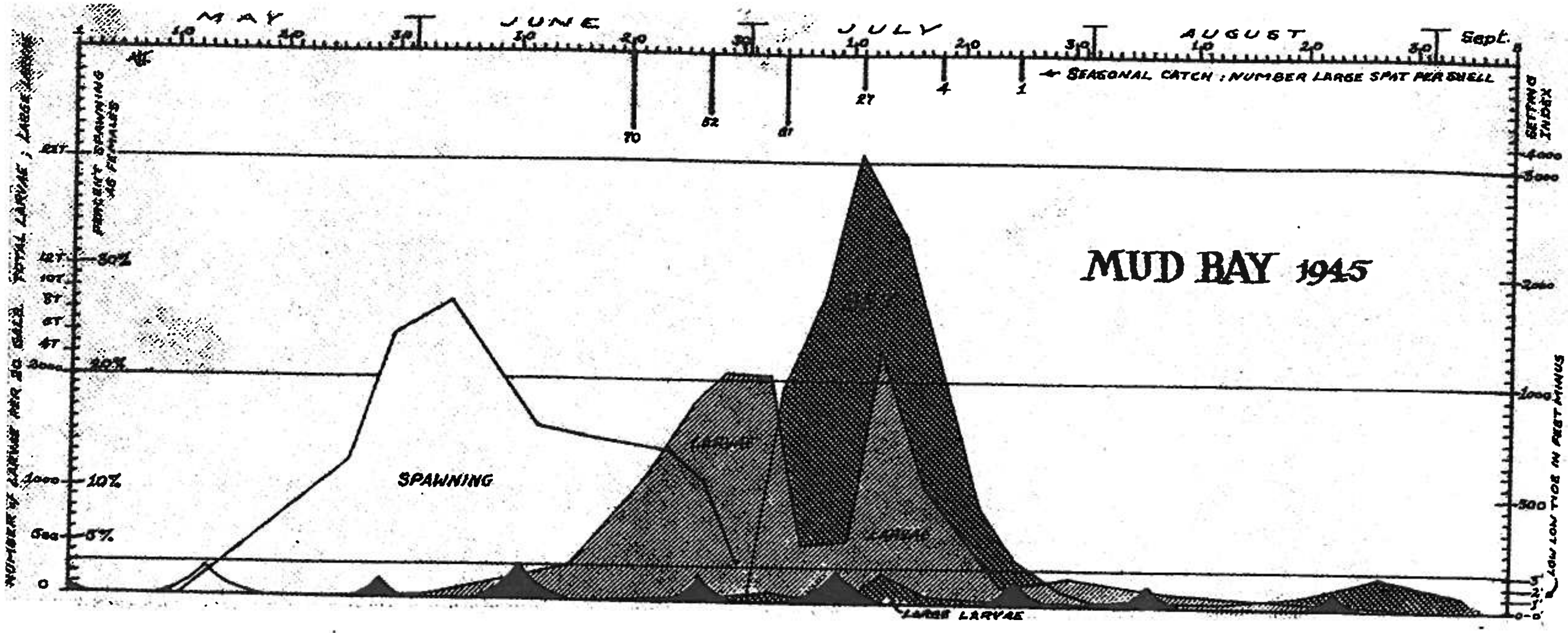


Figure 15 Mud Bay Reproductive Season, 1945

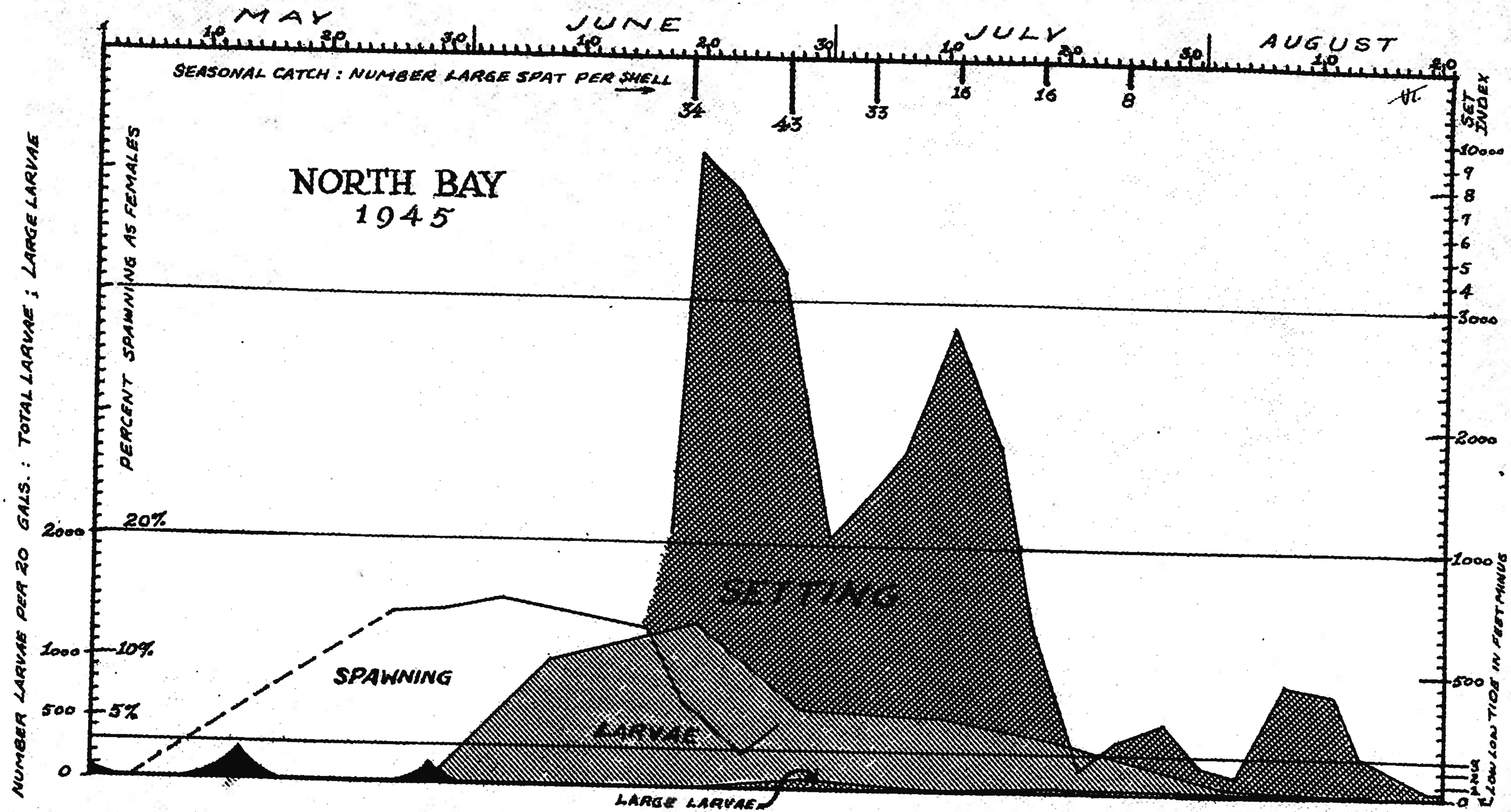


Figure 16 North Bay Reproductive Season, 1945.

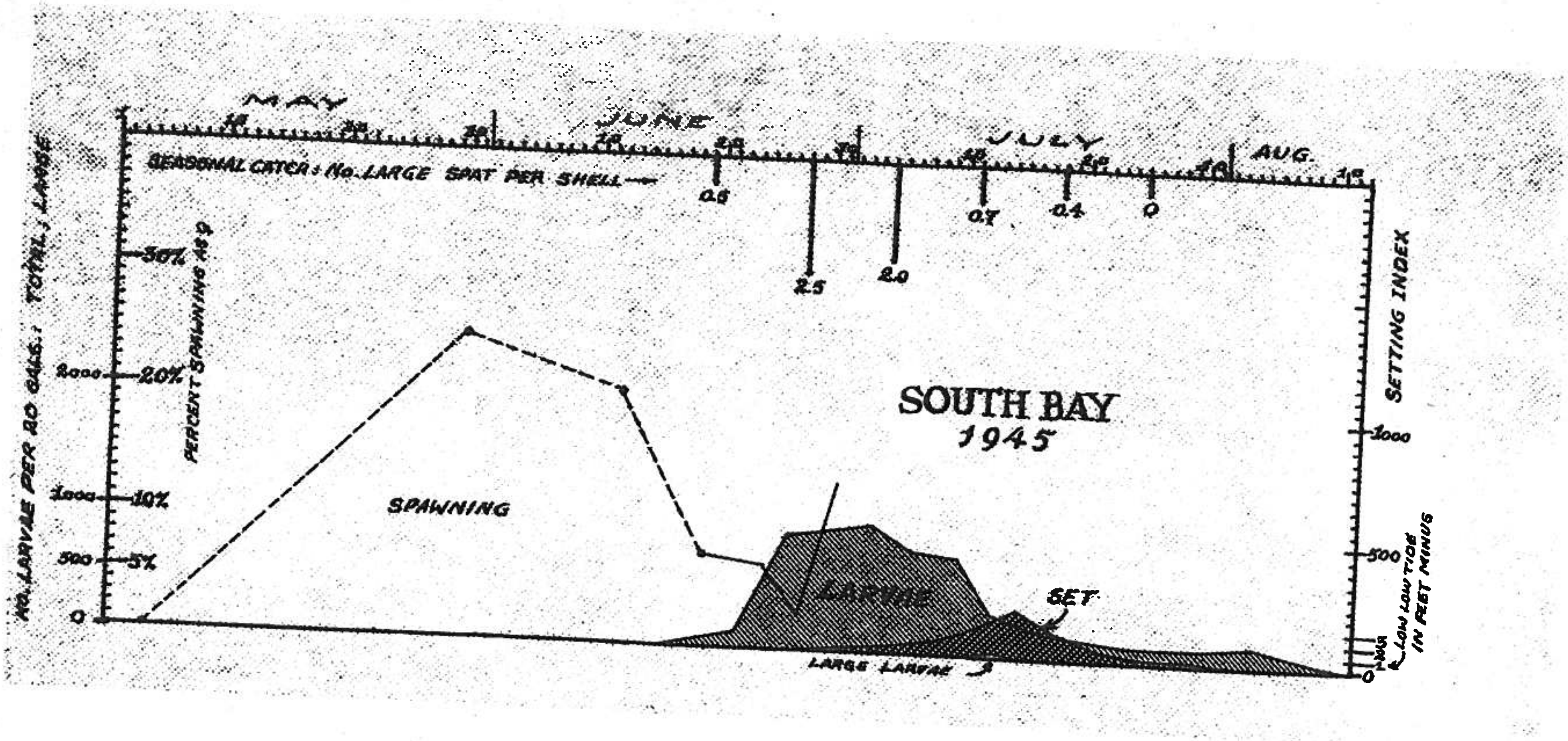


Figure 17 South Bay Reproductive Season, 1945.

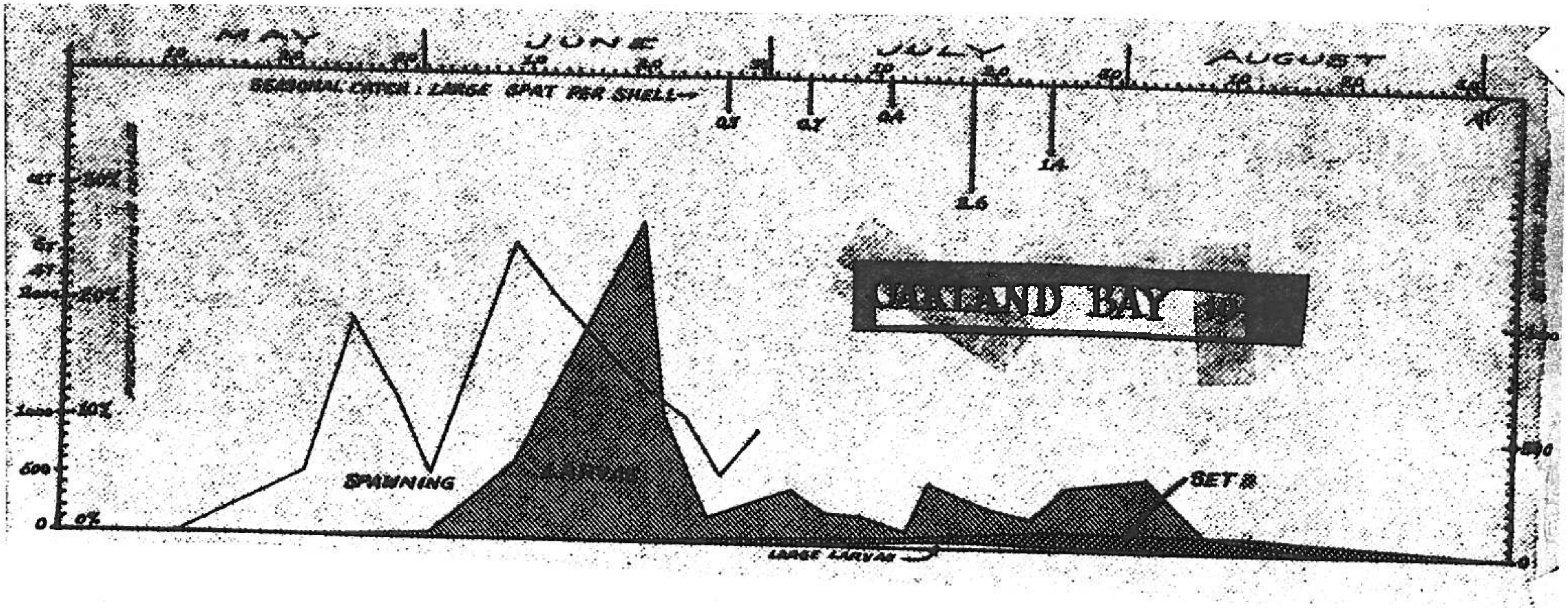


Figure 18   Oakland Bay Reproductive Season, 1945

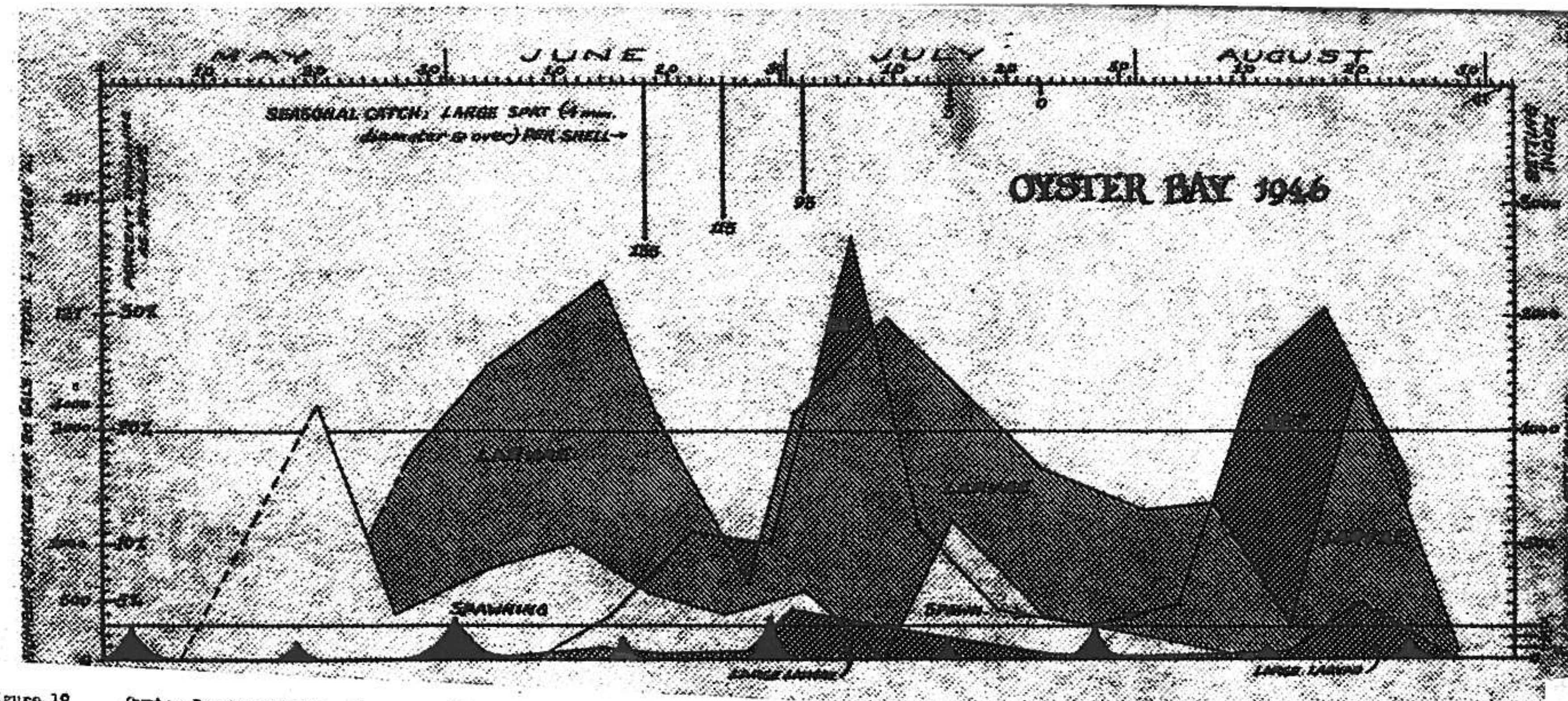


figure 19 Oyster Bay Reproductive Season, 1946

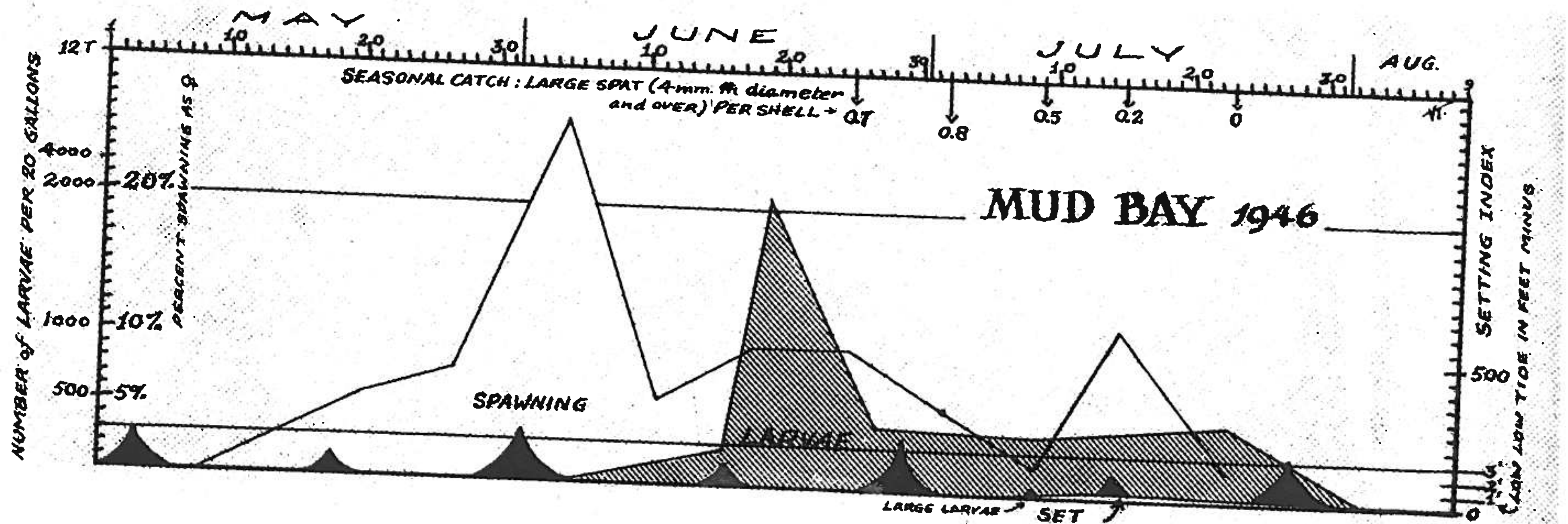


Figure 20 Mud Bay Reproductive Season, 1946.

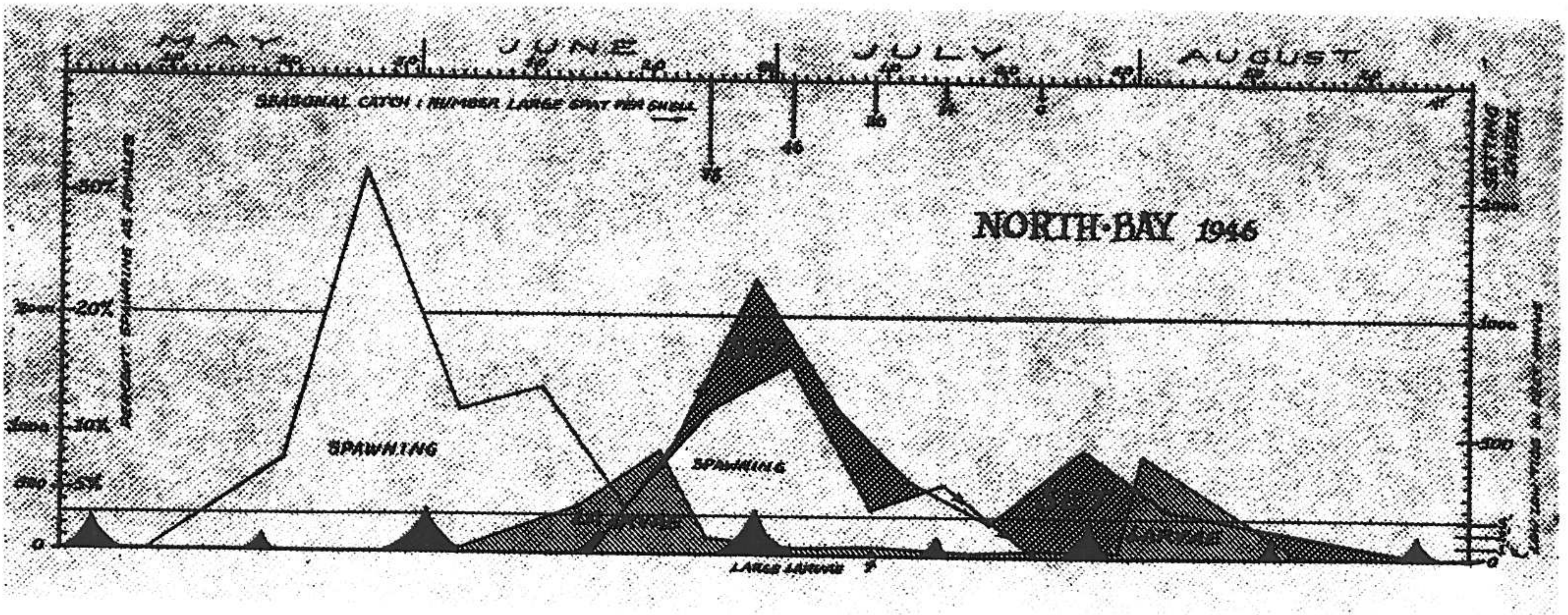


Figure 21 North Bay Reproductive Season, 1946

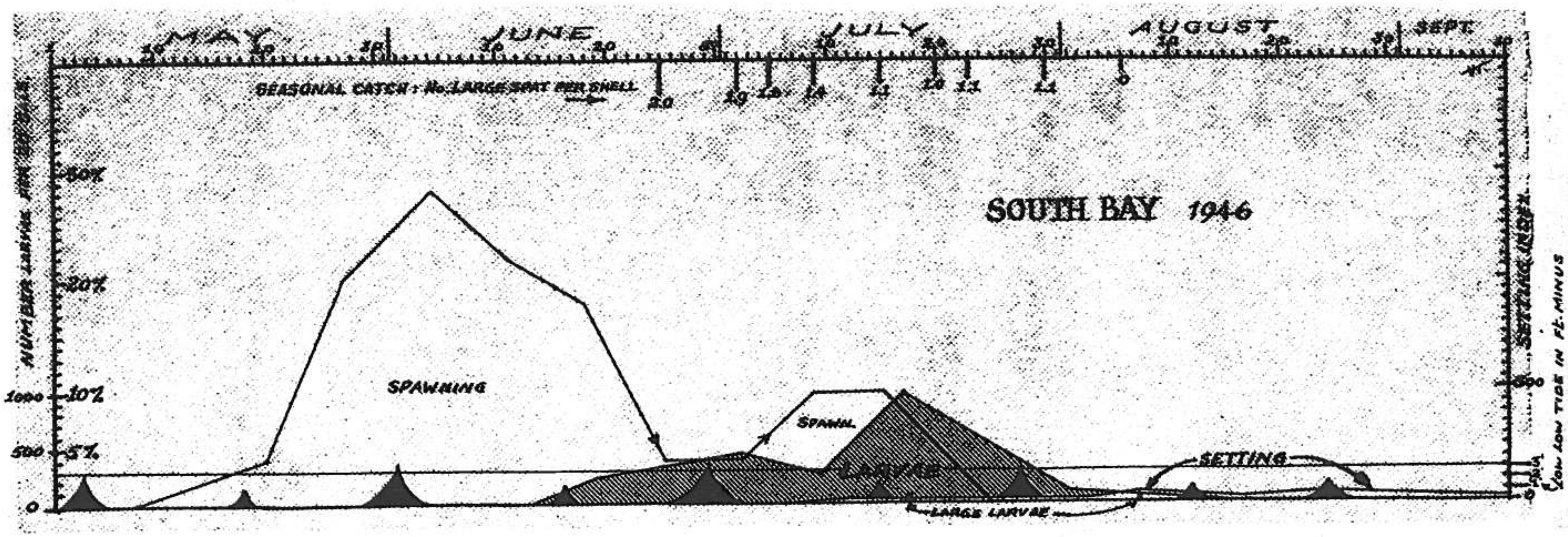
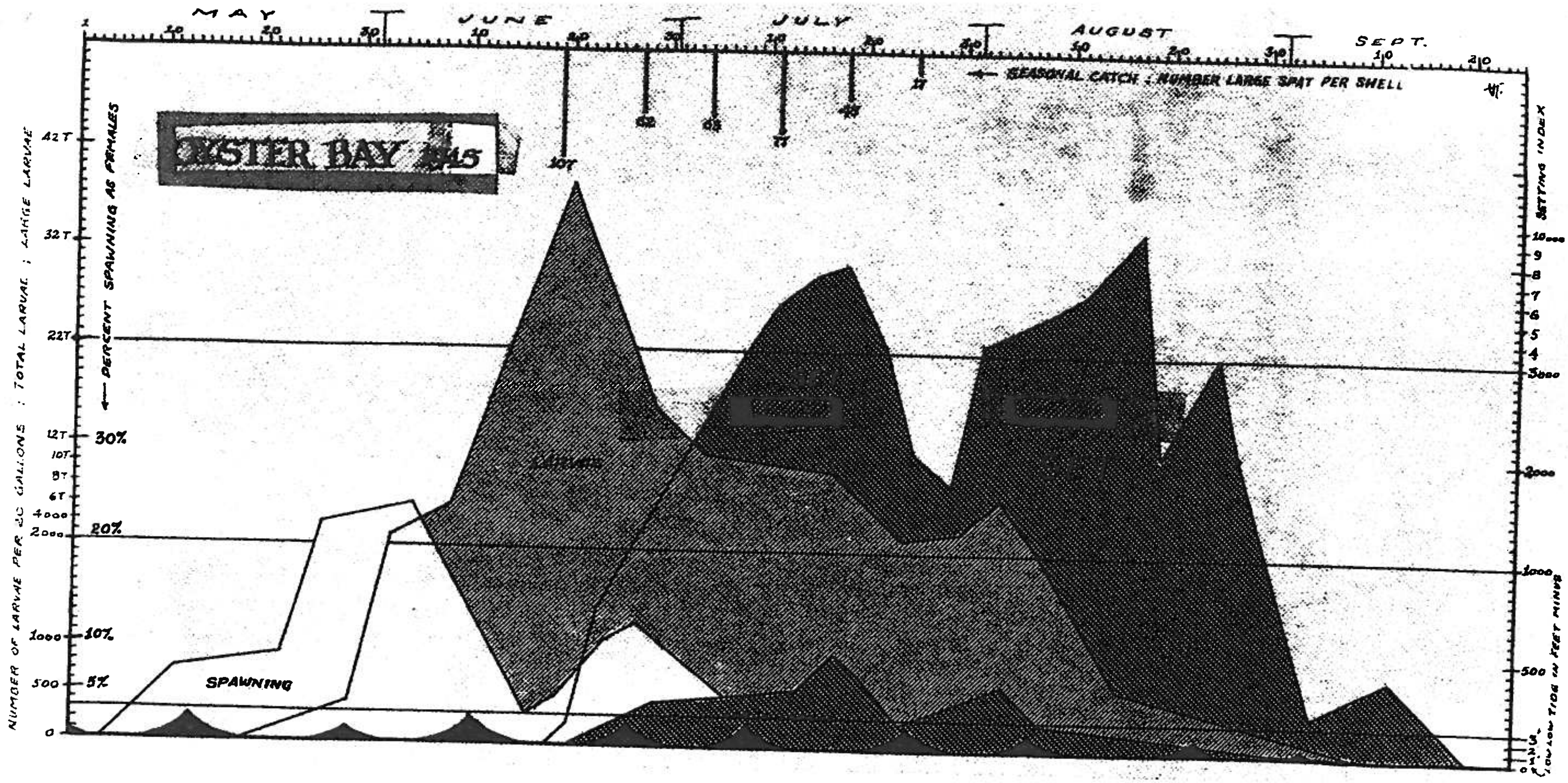


Figure 22 South Bay Reproductive Season, 1946


OYSTER BAY 1945
MAY
JUNE
JULY
AUGUST
SEPT.
← SEASONAL CATCH ; NUMBER LARGE SPAT PER SHELL
← PERCENT SPAWNING AS FEMALES
SPAWNING
NUMBER OF LARVAE PER 50 GALLONS : TOTAL LARVAE ; LARGE LARVAE
SETTING INDEX
LOW TIDE IN FEET MINUS

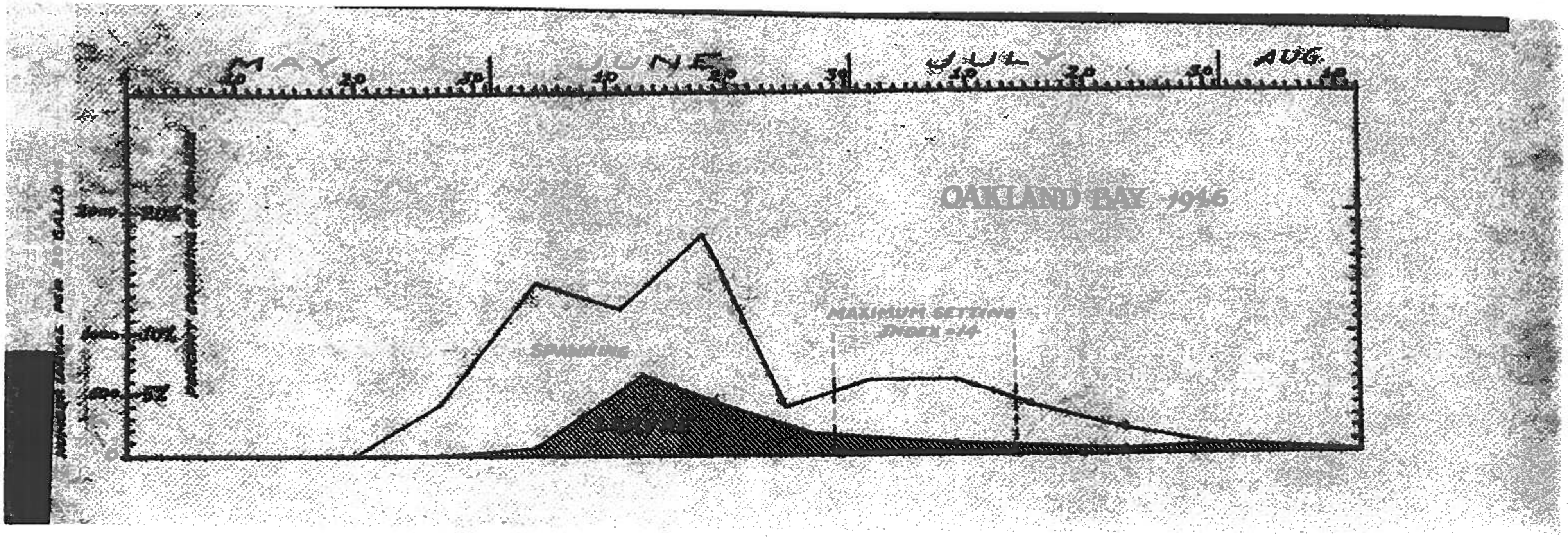


Figure 23 Oakland Bay Reproductive Season, 1946.

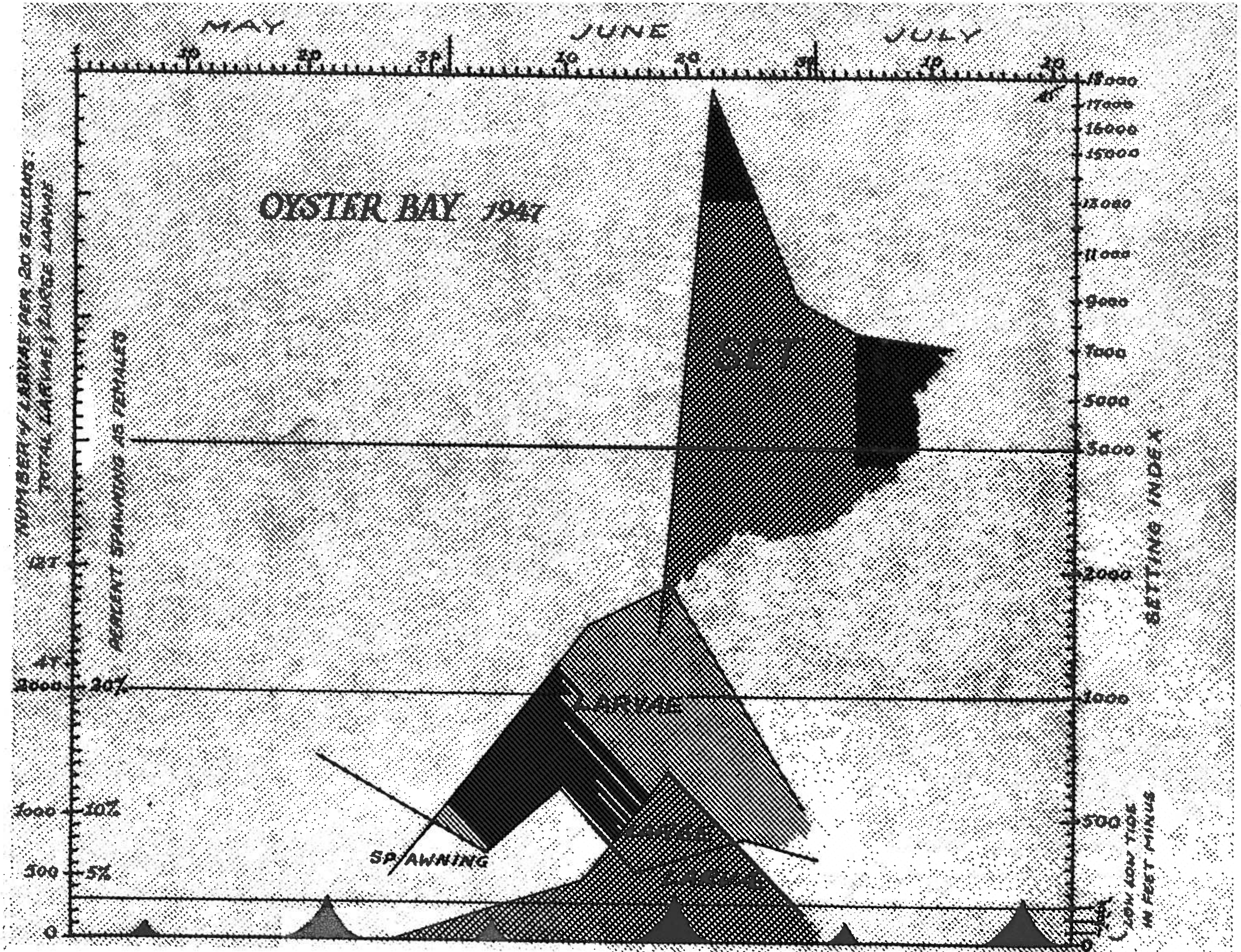


Figure 24 Oyster Bay Reproductive Season, 1947

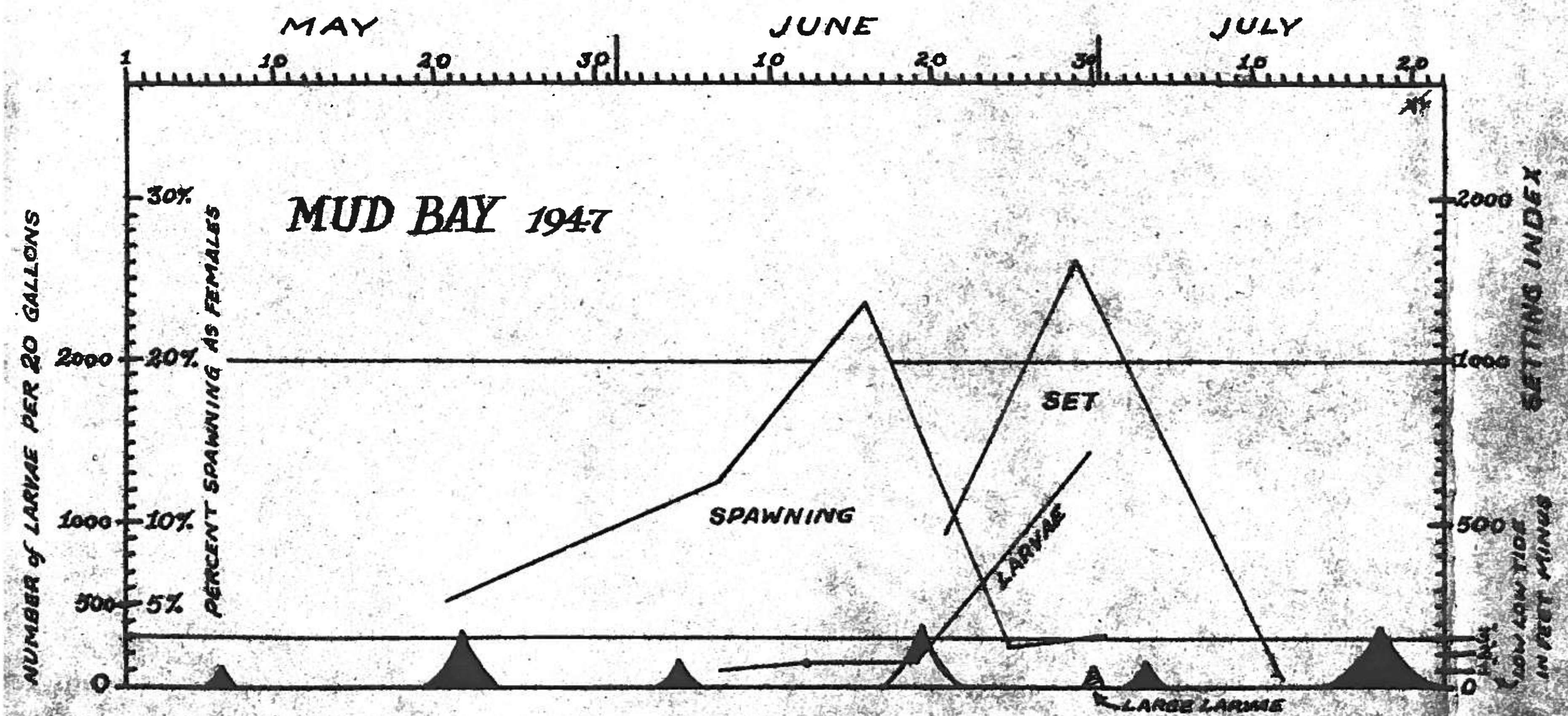
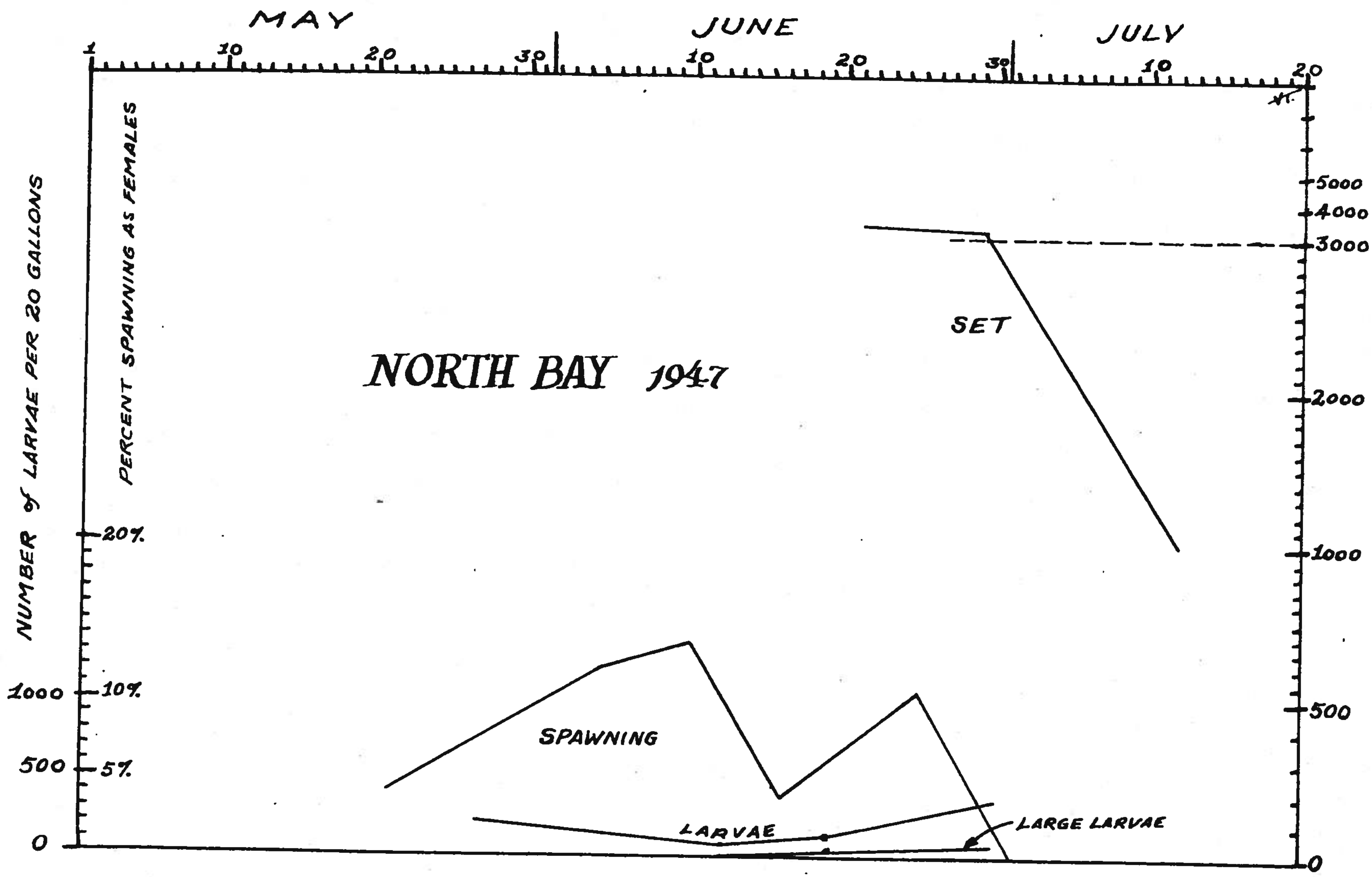


Figure 25 Mud Bay Reproductive Season, 1947.



igure 26 North Bay Reproductive Season, 1947.

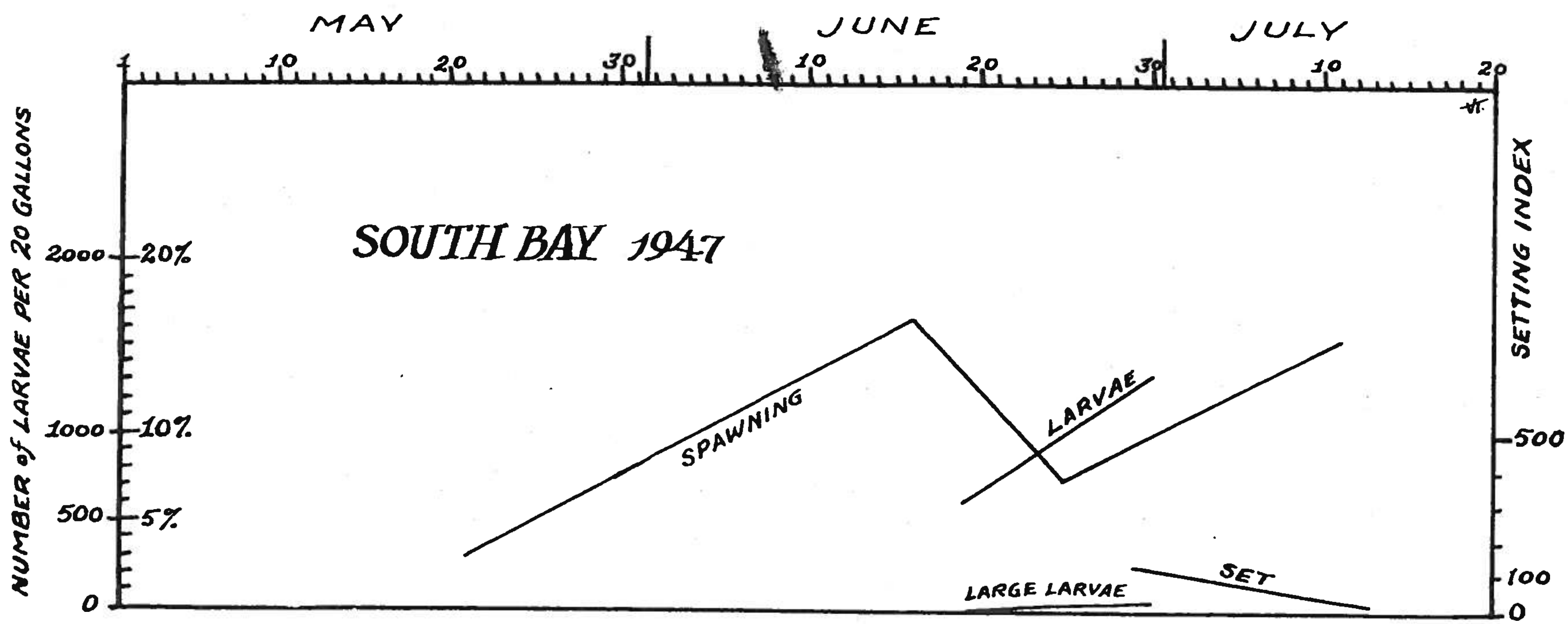
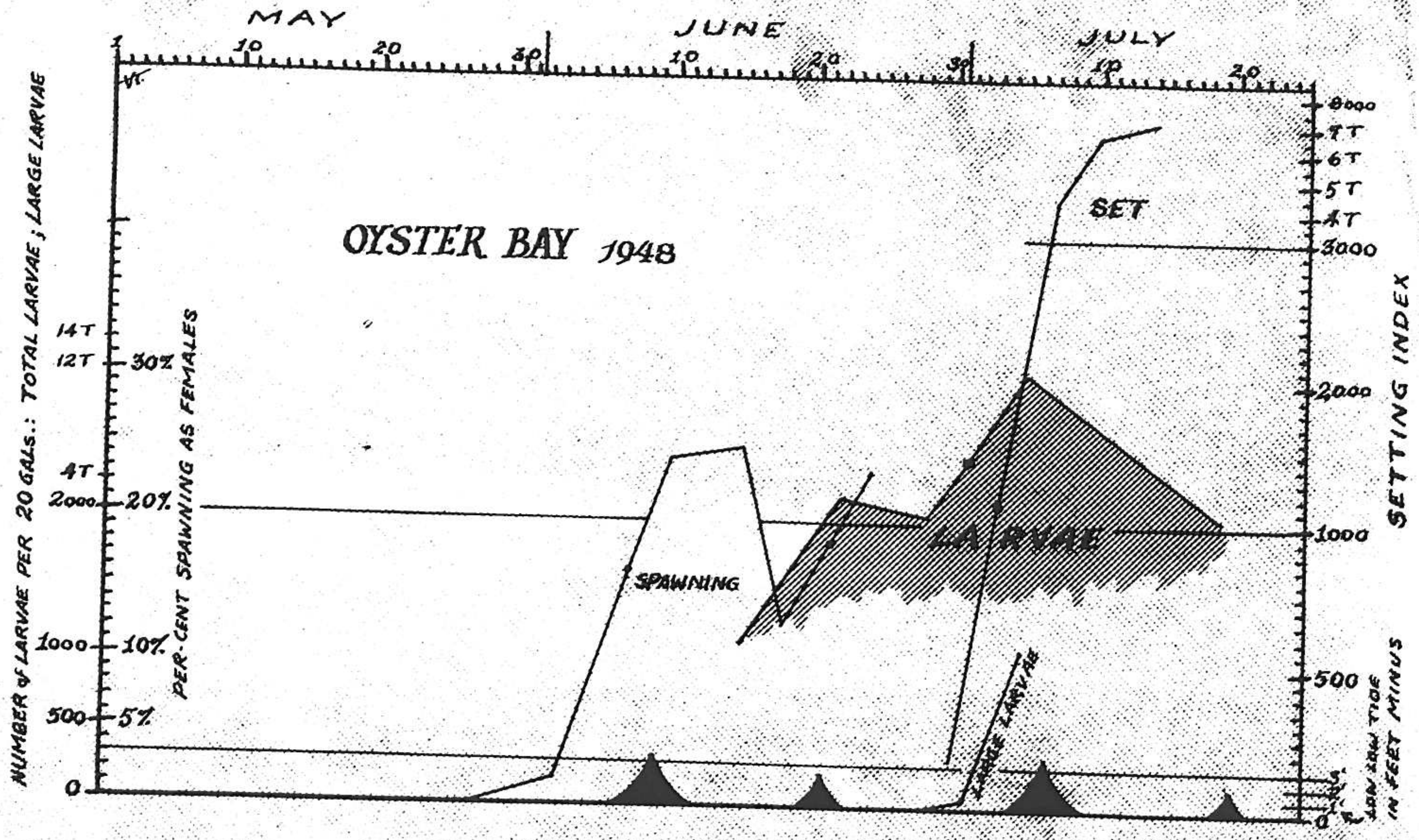


Figure 27 South Bay Reproductive Season, 1947.



grue 28 Oyster Bay Reproductive Season, 1948.

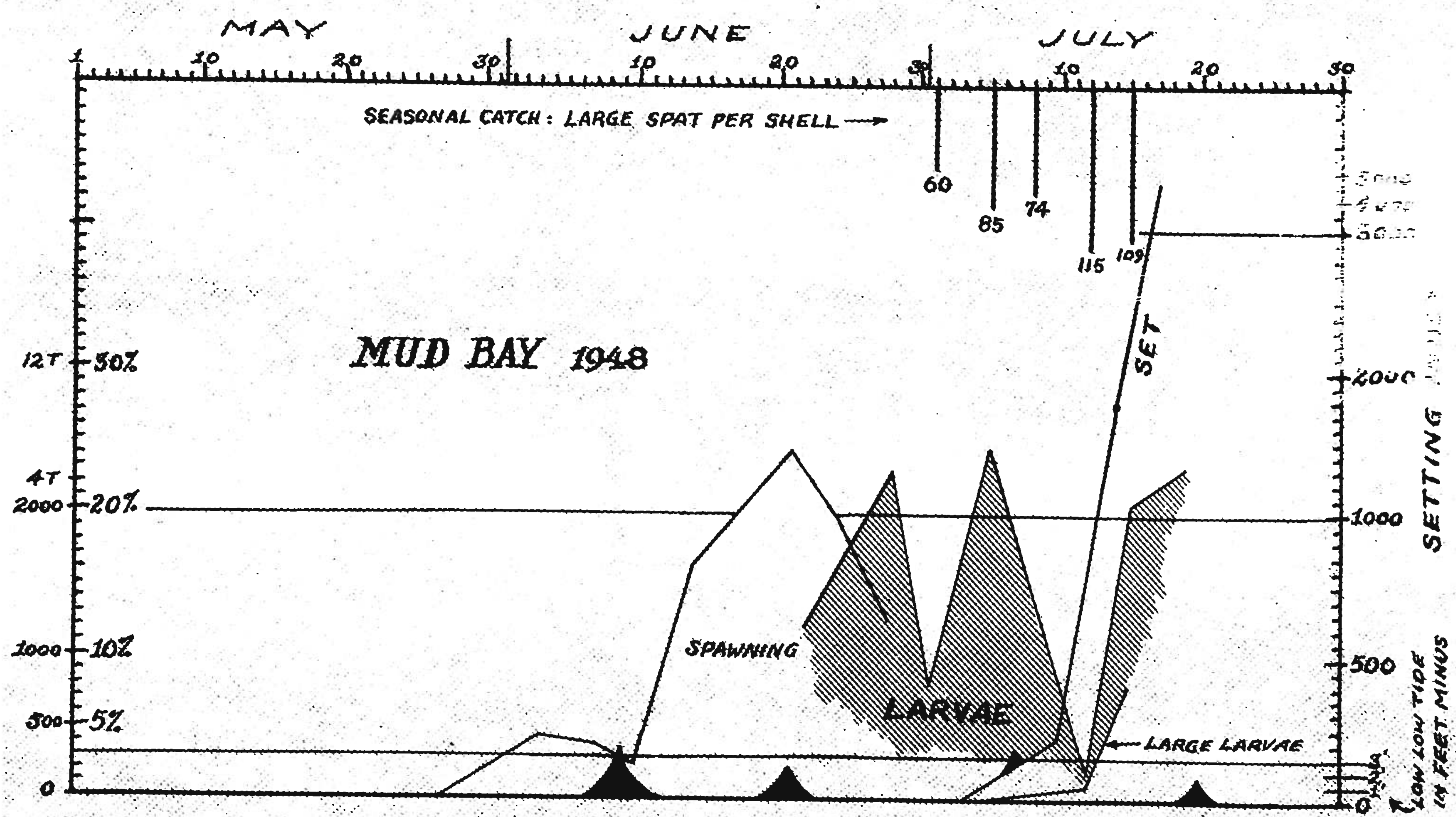
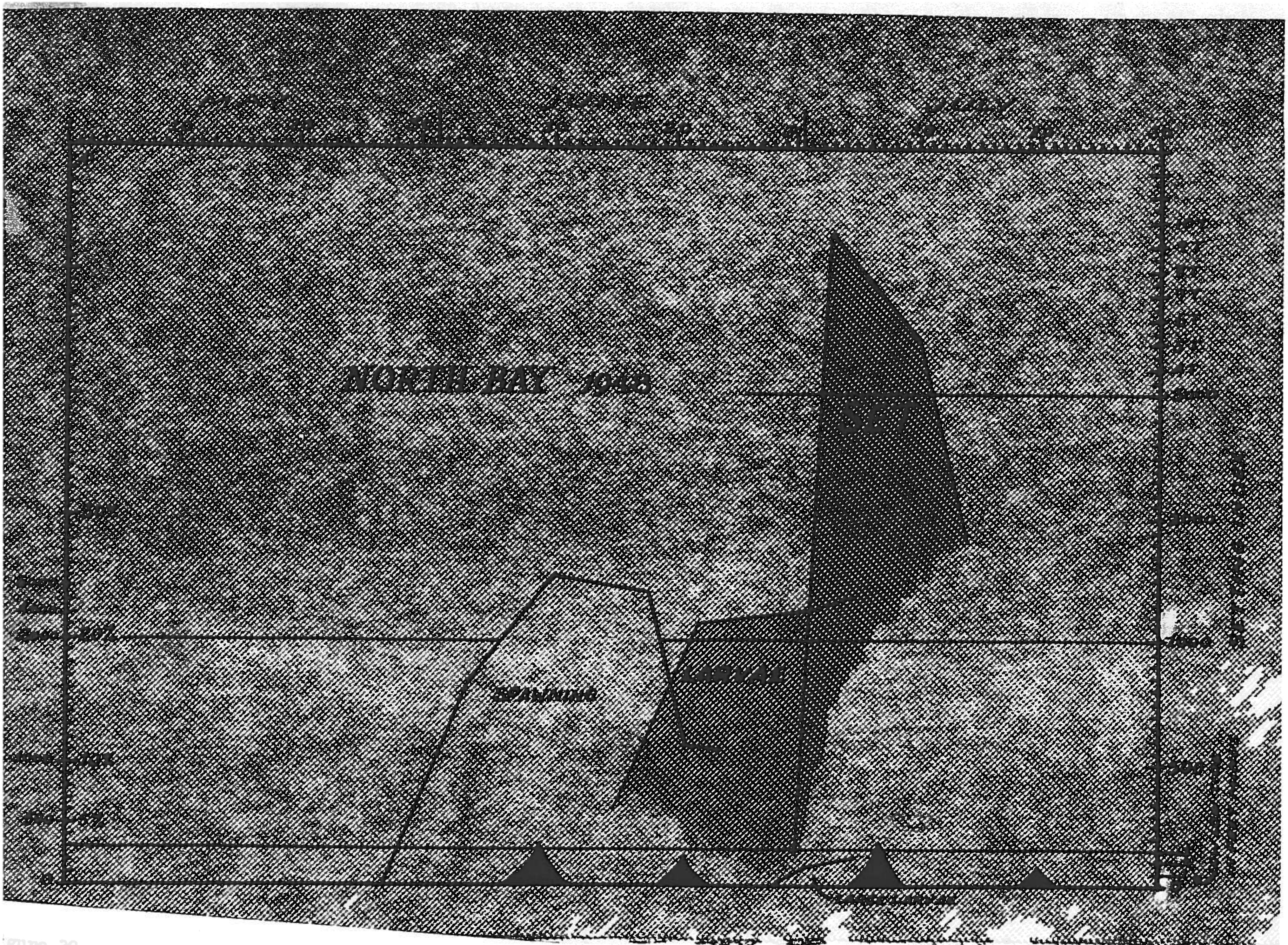


Figure 29 Mud Bay Reproductive Season, 1948.



gure 30 North Bay Reproductive Season, 1948.

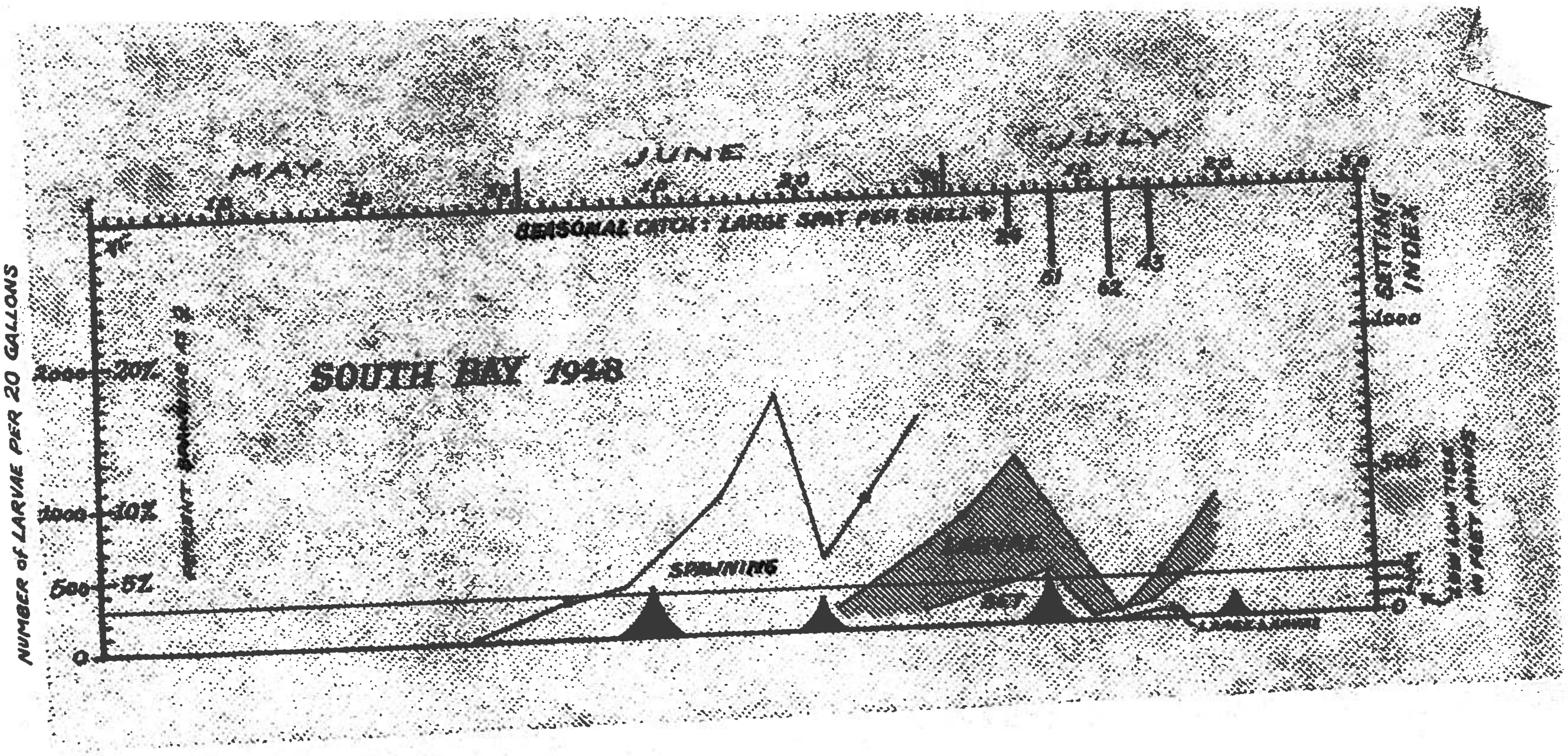


Figure 31 South Bay Reproductive Season, 1948

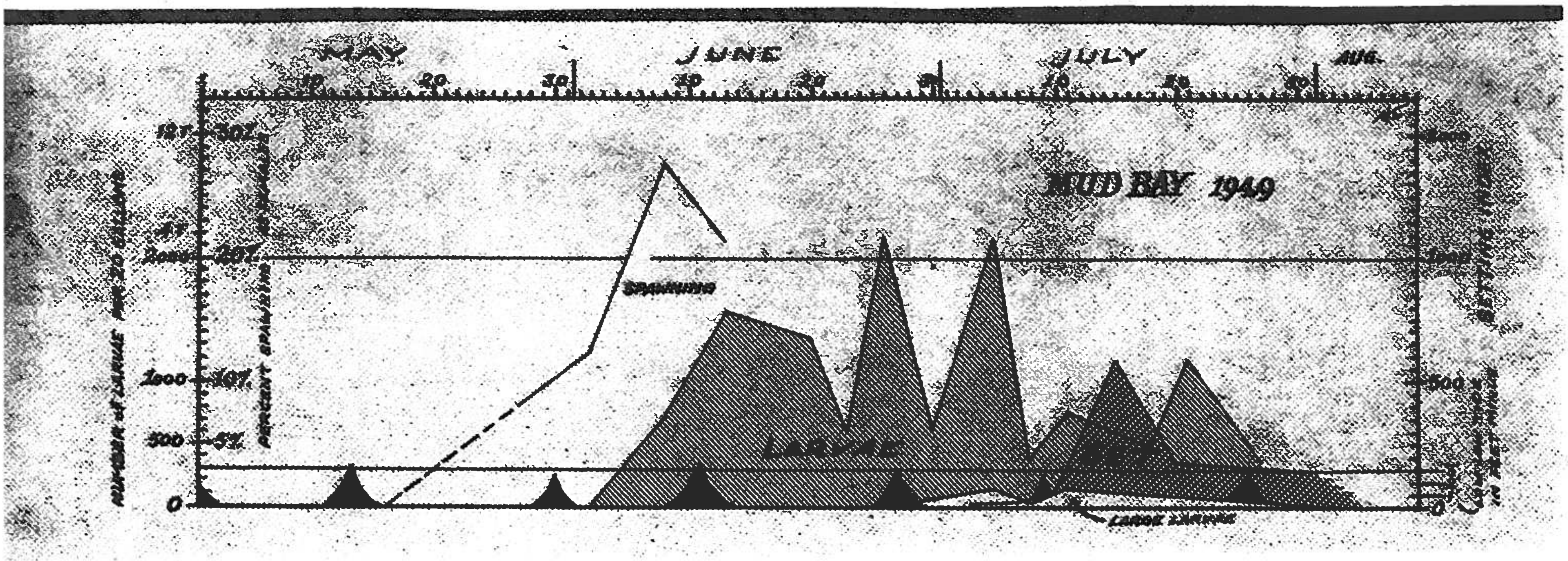
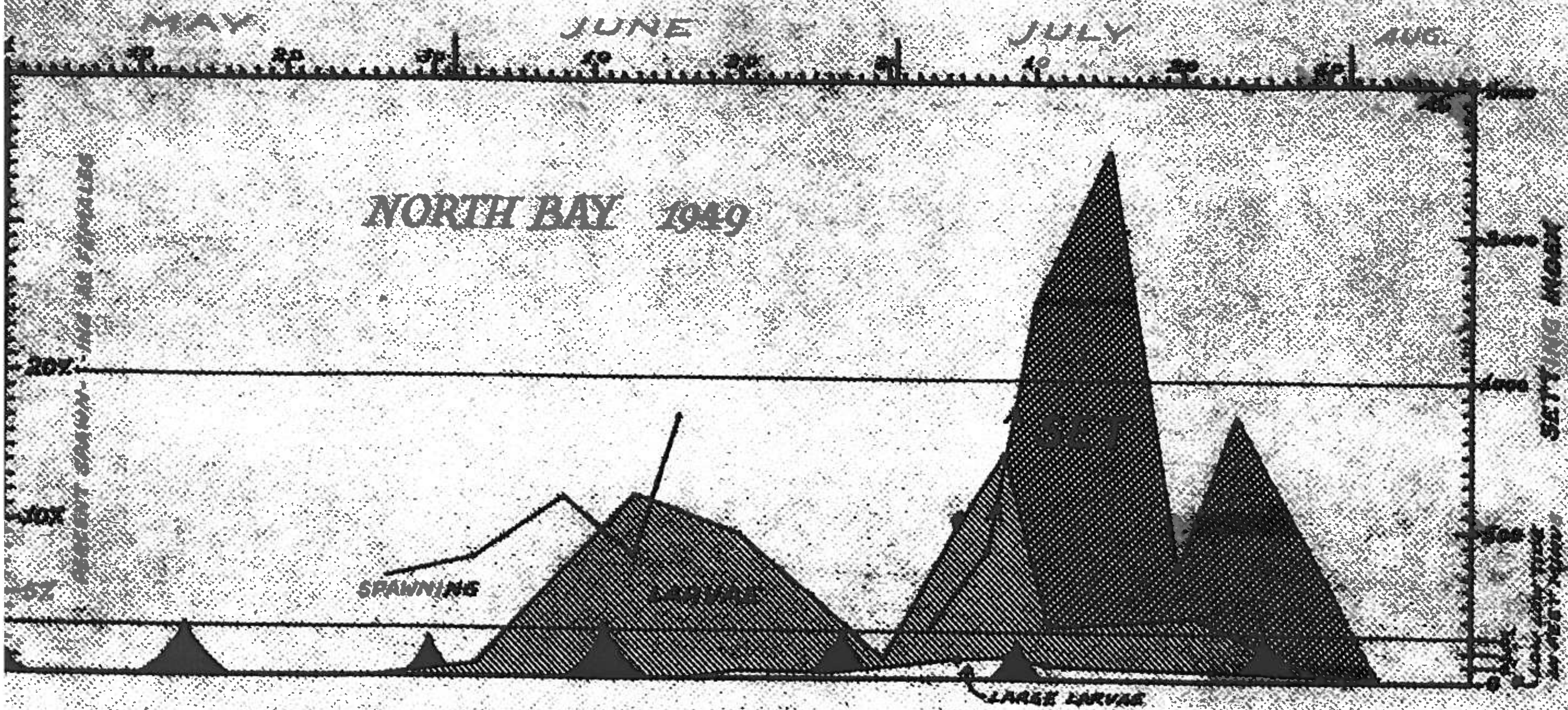


Figure 33 Mud Bay Reproductive Season, 1949



4 North Bay Reproductive Season, 1949

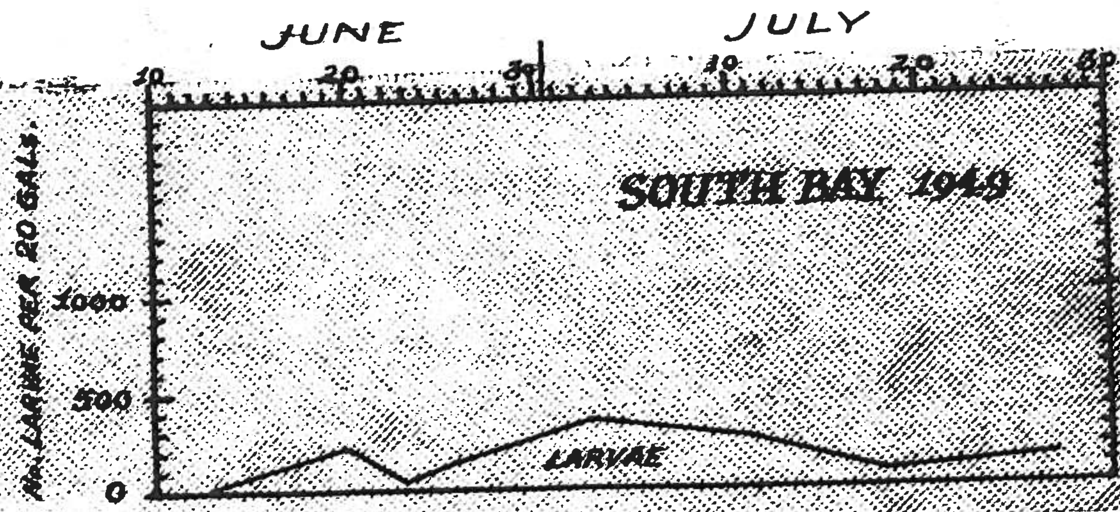


Figure 35 South Bay Reproductive Season, 1949

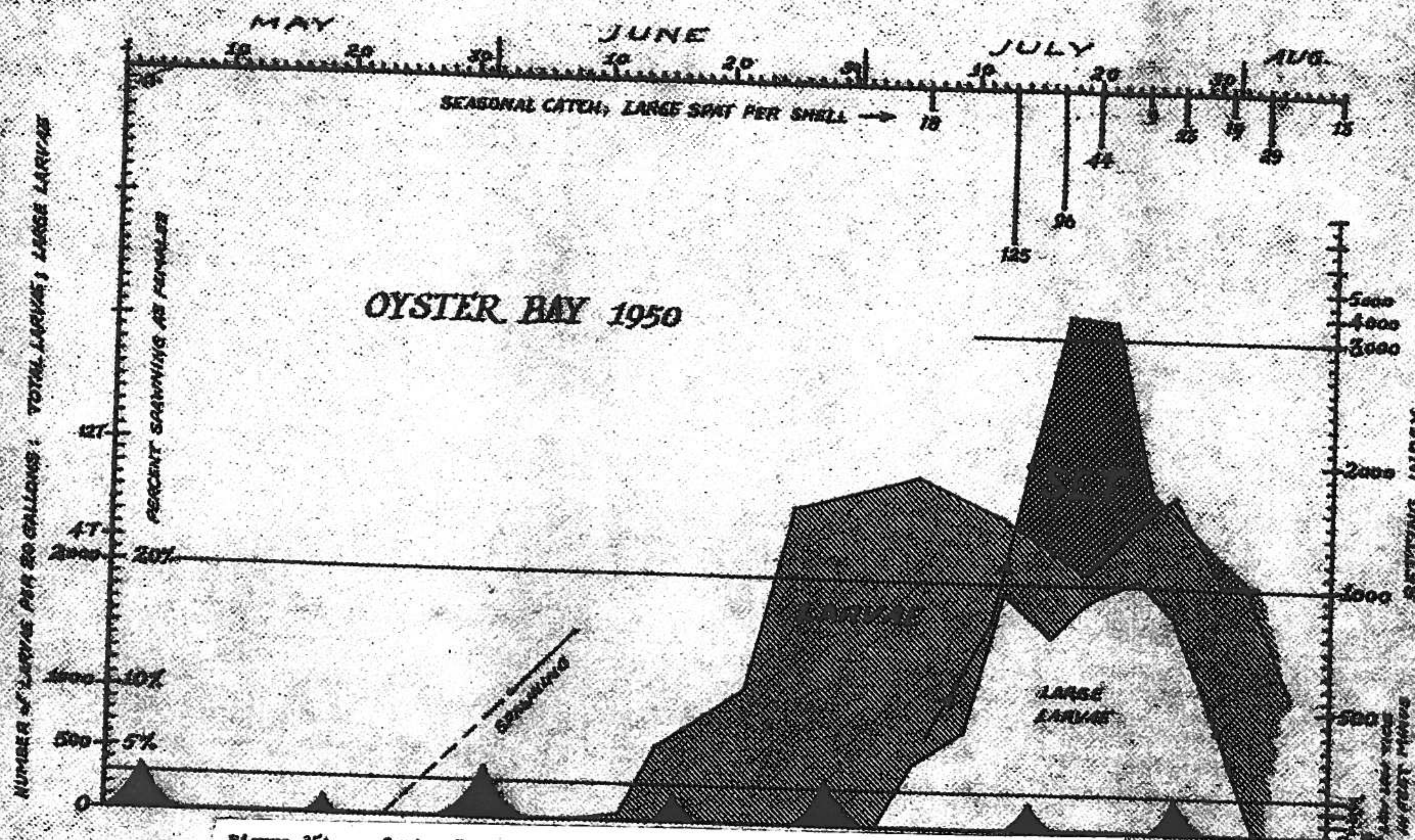


Figure 35A Oyster Bay Reproductive Season, 1950

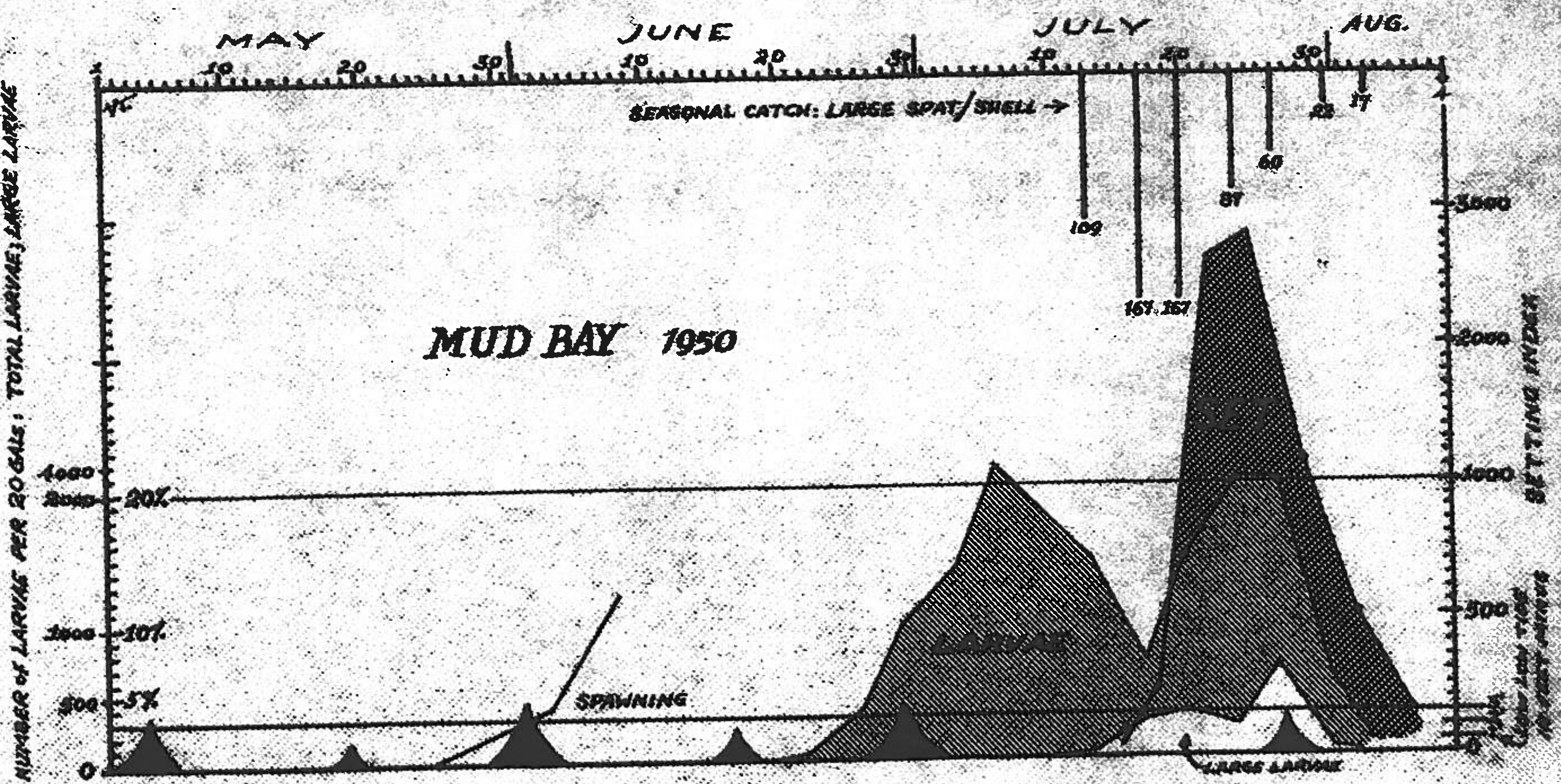


Figure 36 Mud Bay Reproductive Season, 1950

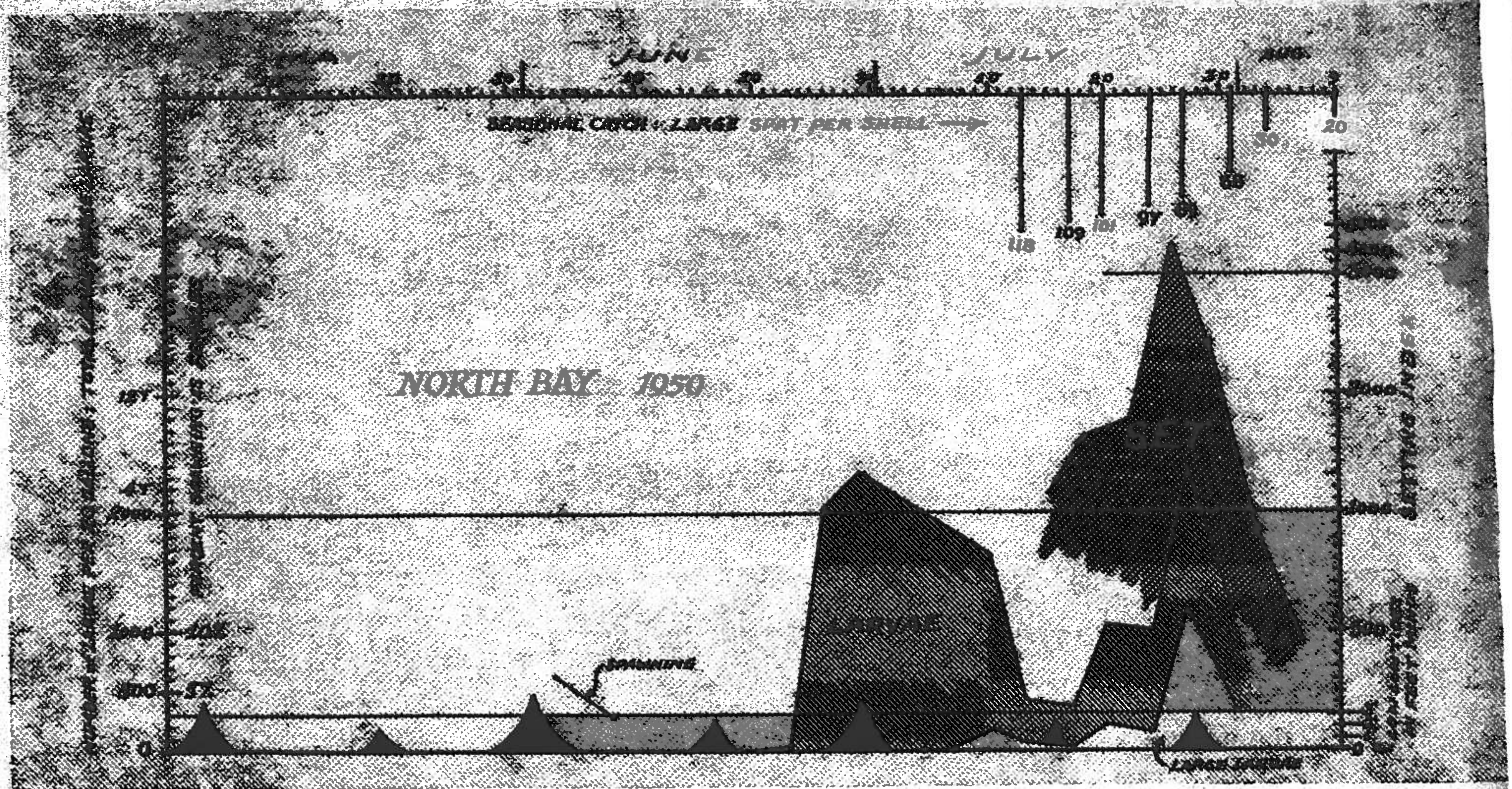


Figure 37 North Bay Reporductive Season, 1950.

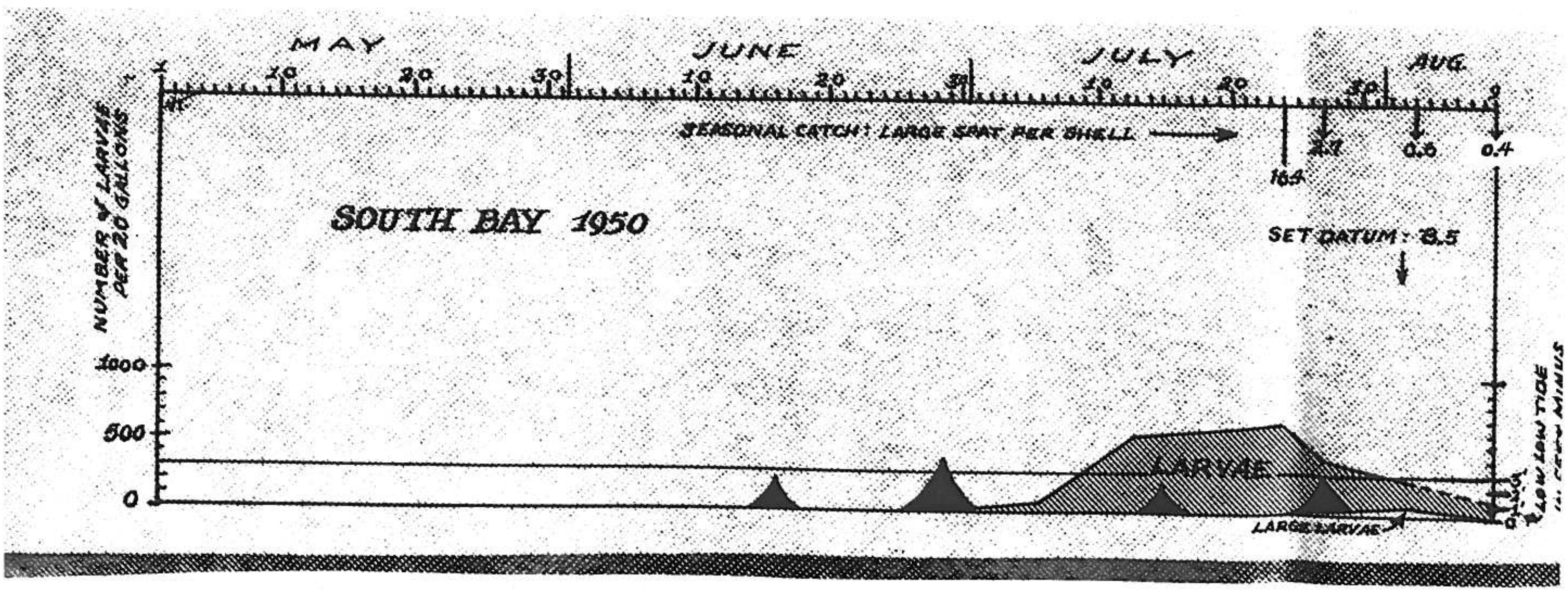


Figure 38 South Bay Reproductive Season, 1950

Figure 39 Oyster BAY Correlation between Time of Beginning Spatfall and Spring Thermal Trend (algebraic sum of deviations from normal of air temperatures at Priest Point Park, Olympia, January through April).

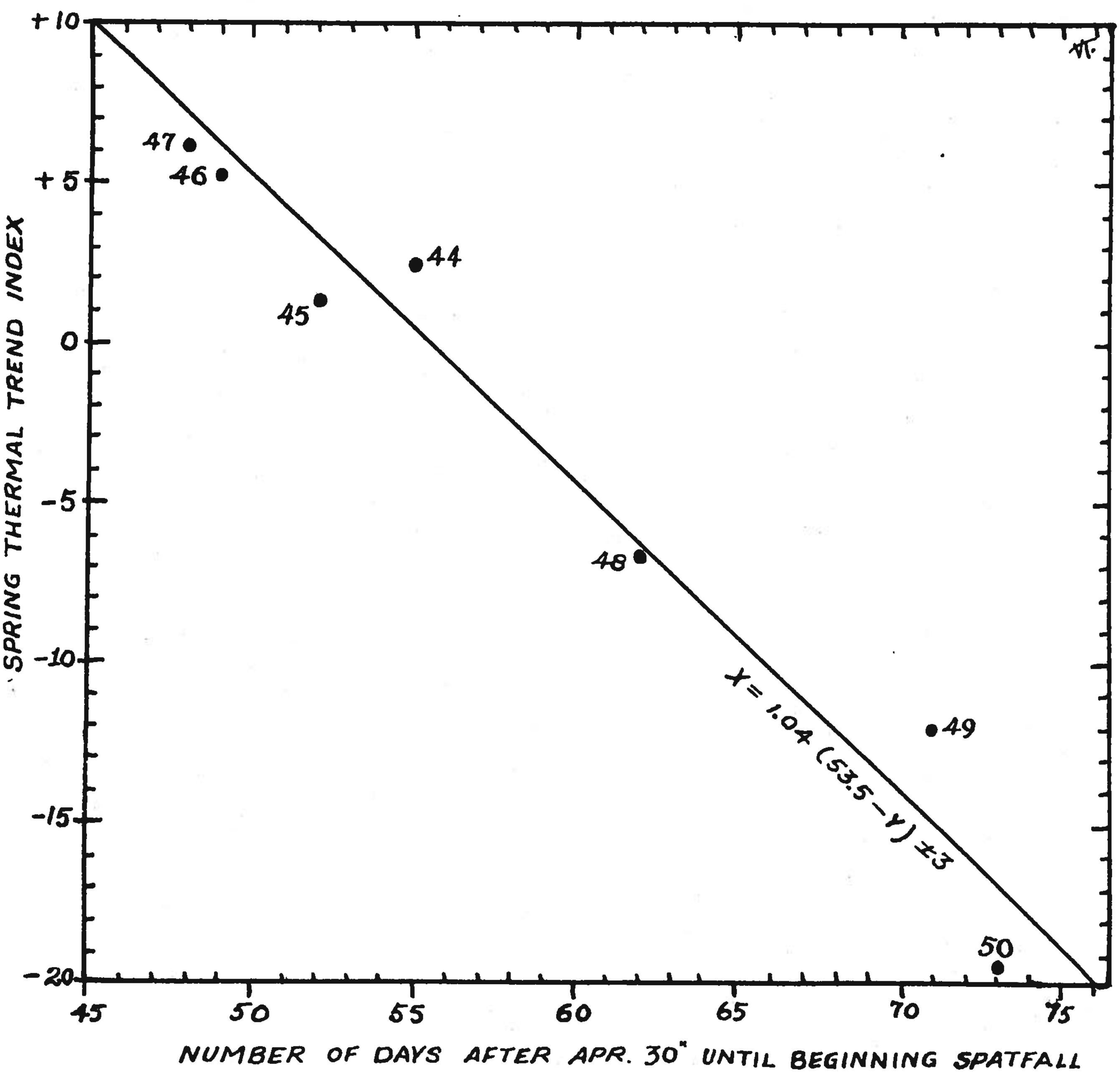
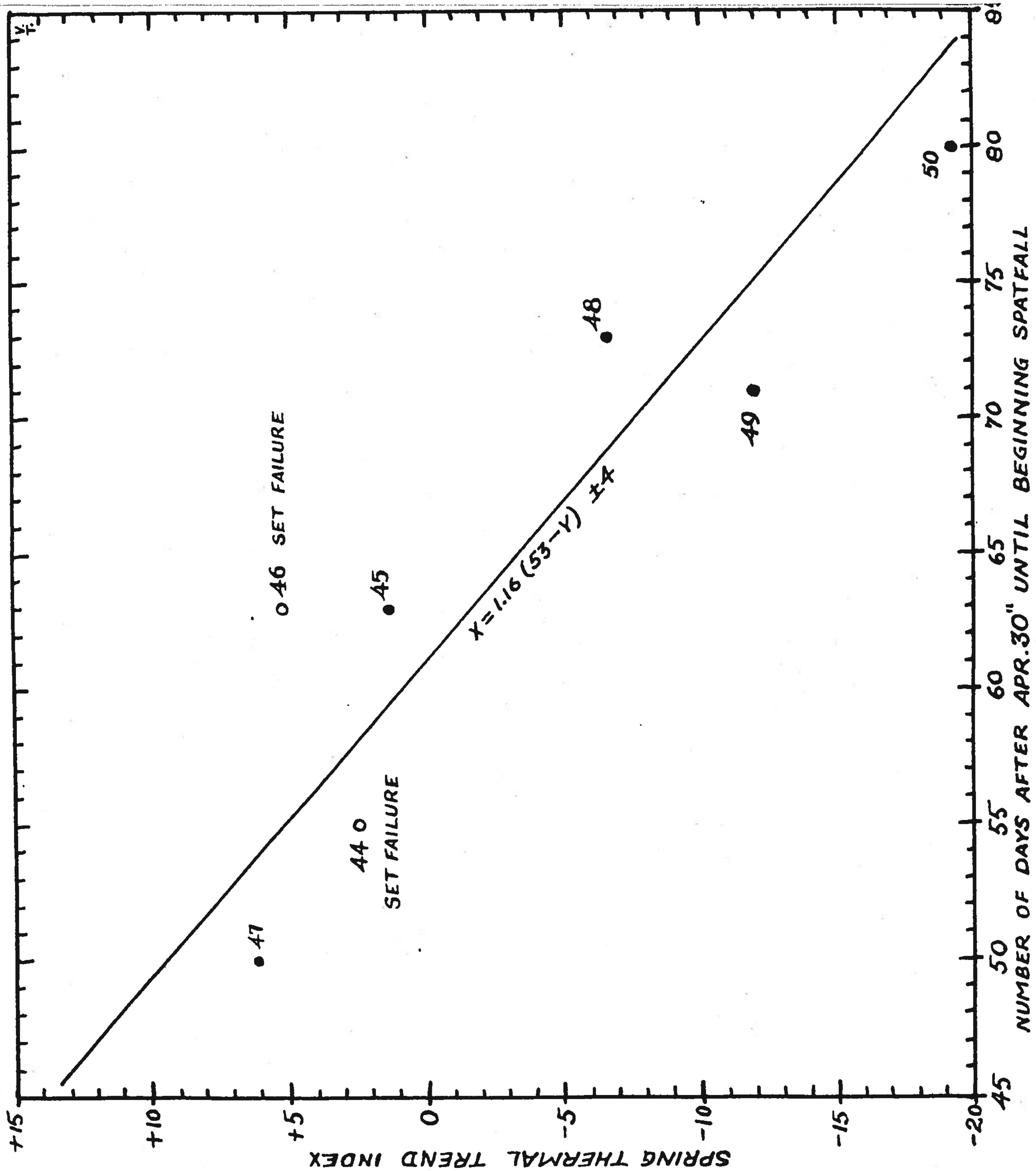


Figure 40 MUD BAY Correlation between time of beginning oyster set and Spring Thermal Trend (algebraic sum of the deviations from normal of air t/emperatures at Priest Point Park Olympia, January through April).



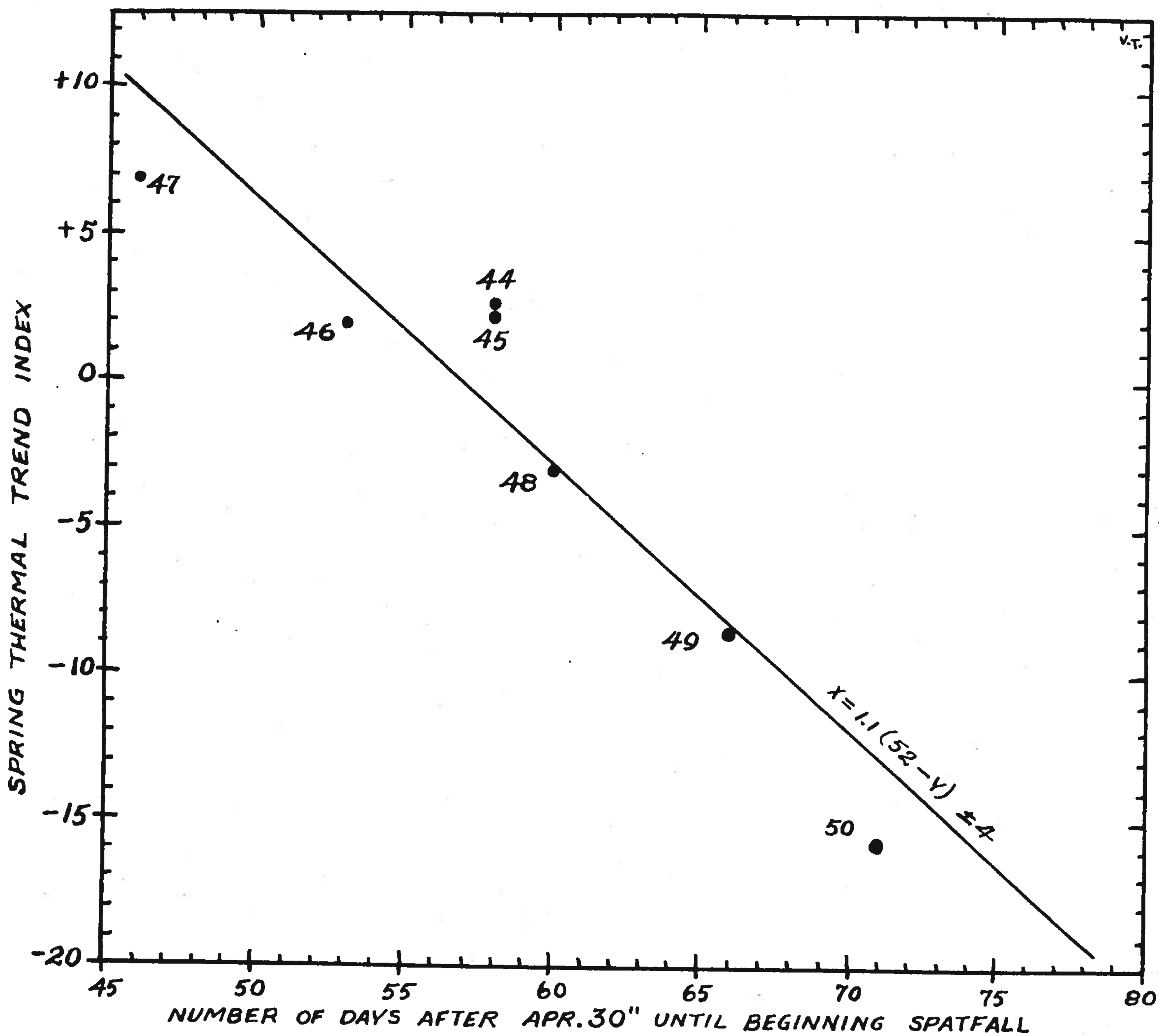


Figure 41 NORTH BAY Correlation between Time of Beginning Spatfall and Spring Thermal Trend (Algebraic sum of deviations from normal of air temperatures at Grapeview during January through April).

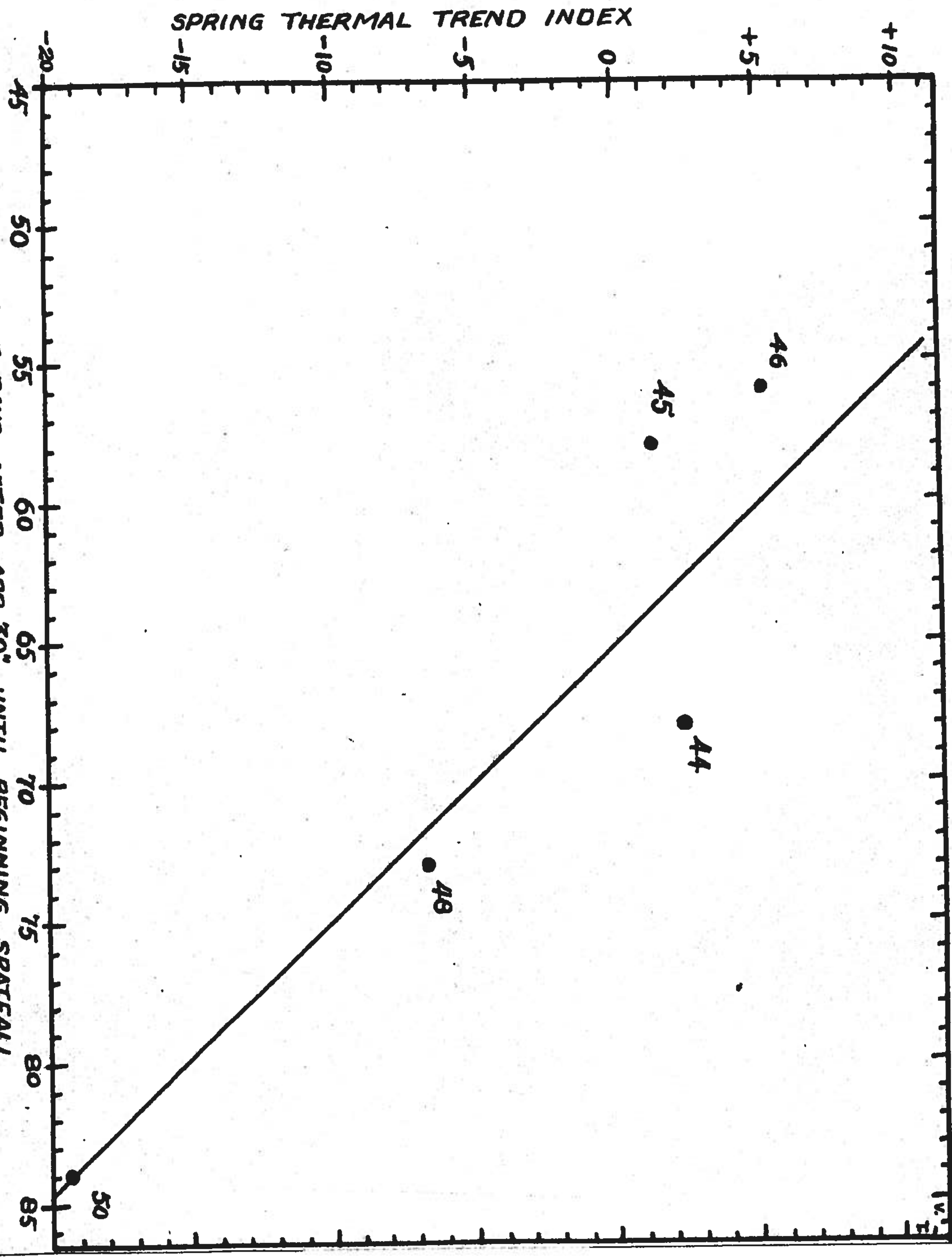
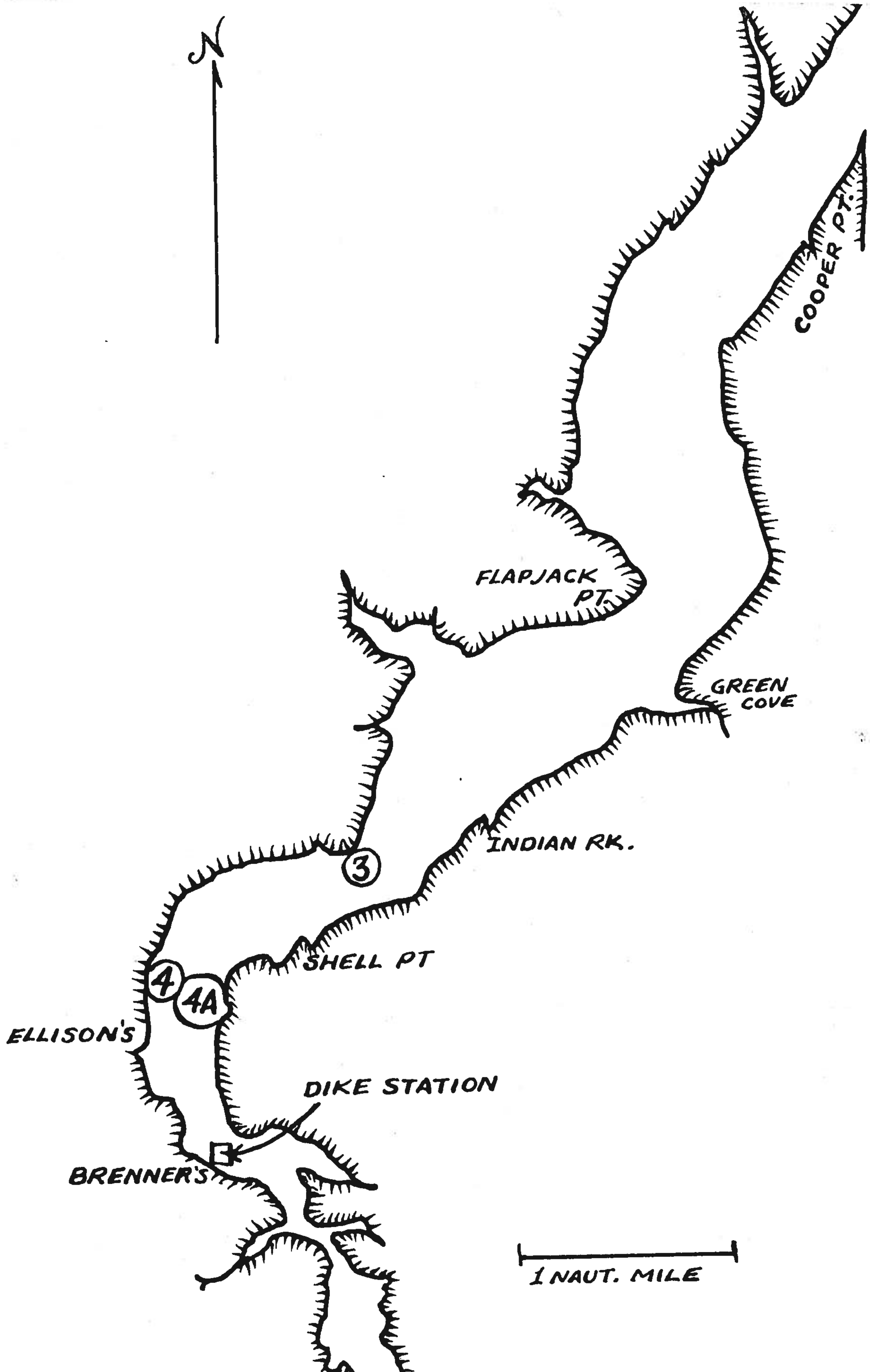


Figure 42 SOUTH BAY Correlation between Time of Beginning Spatfall and Spring Thermal Trend (Algebraic sum of deviations from normal of air temperatures at Priest Point Park, Olympia, January through April).

Figure 42A Map of Mud Bay Showing Dike Station (Spawning and Setting Samples and Areas of Sampling for Planktonic Larvae.



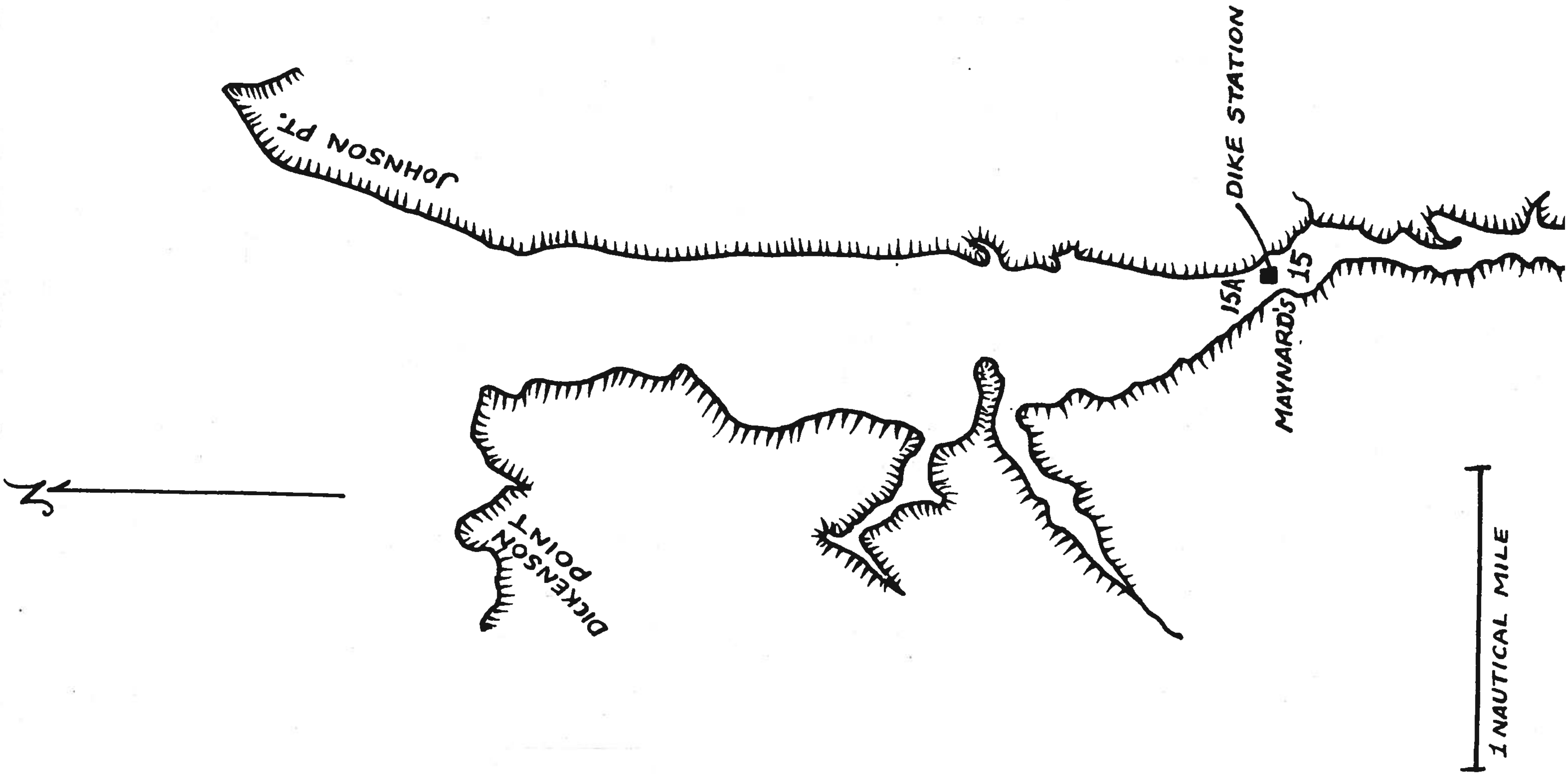


Figure 42B Map of SOUTH BAY Showing Dike Station (Spawning and Setting Sampler) and Areas of Sampling for Planktonic Larvae.

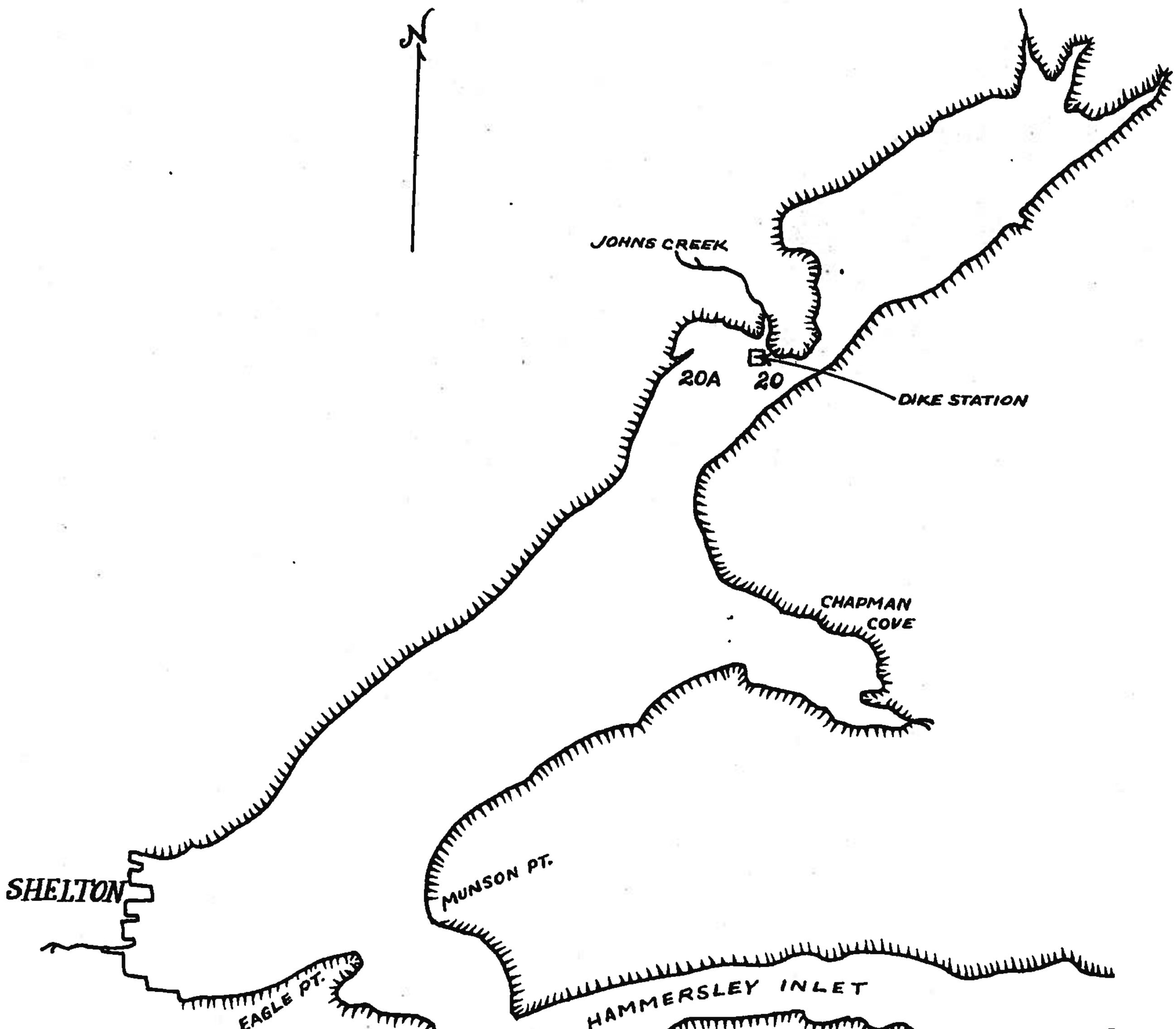


Figure 420 Map of OAKLAND BAY Showing Dike Station (Spawning and Setting Samples) and Areas of Sampling for Planktonic Larvae.

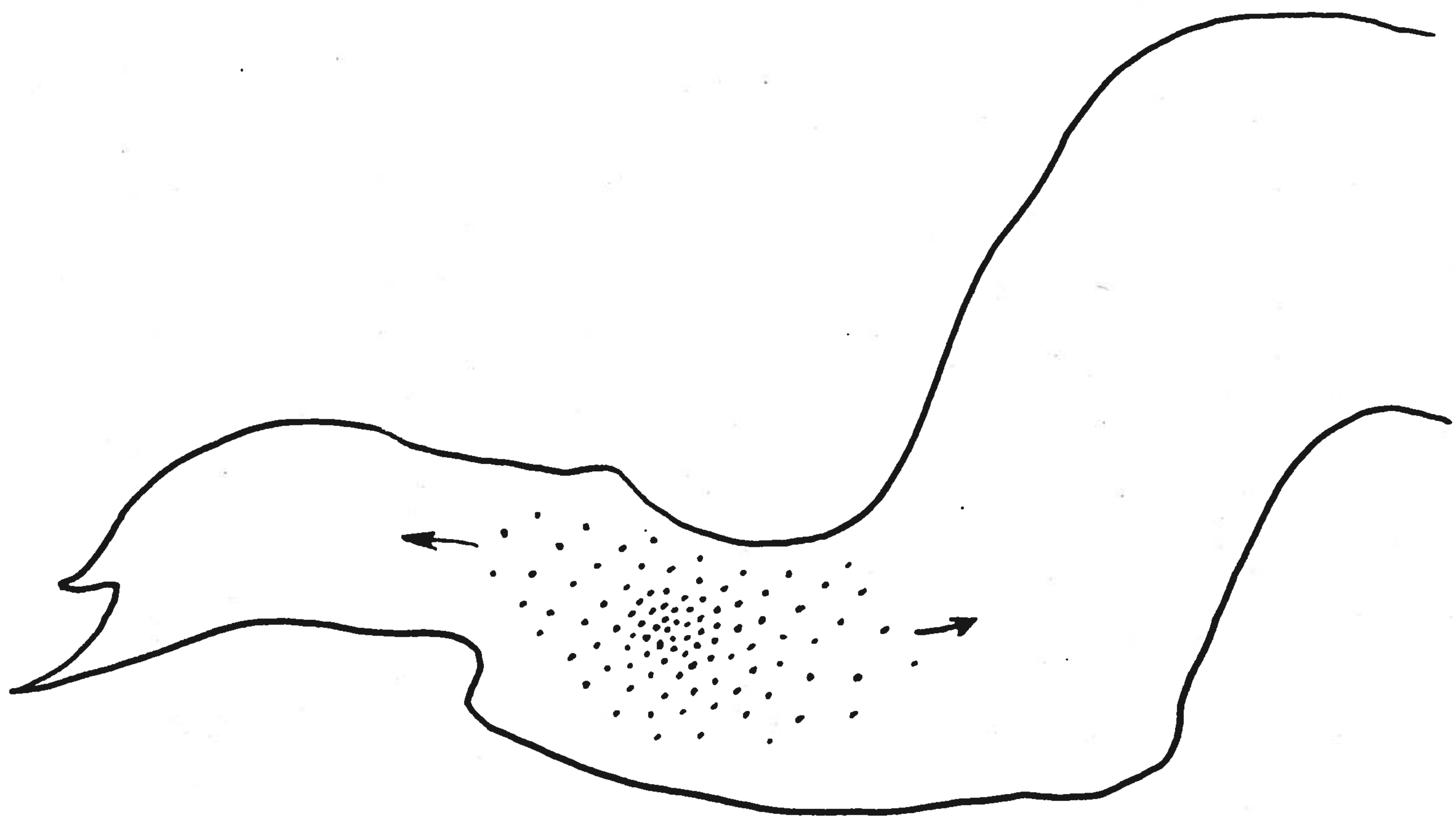


Figure 43 Conception of Larvae Mass moving Up and Down Bay with the tide.

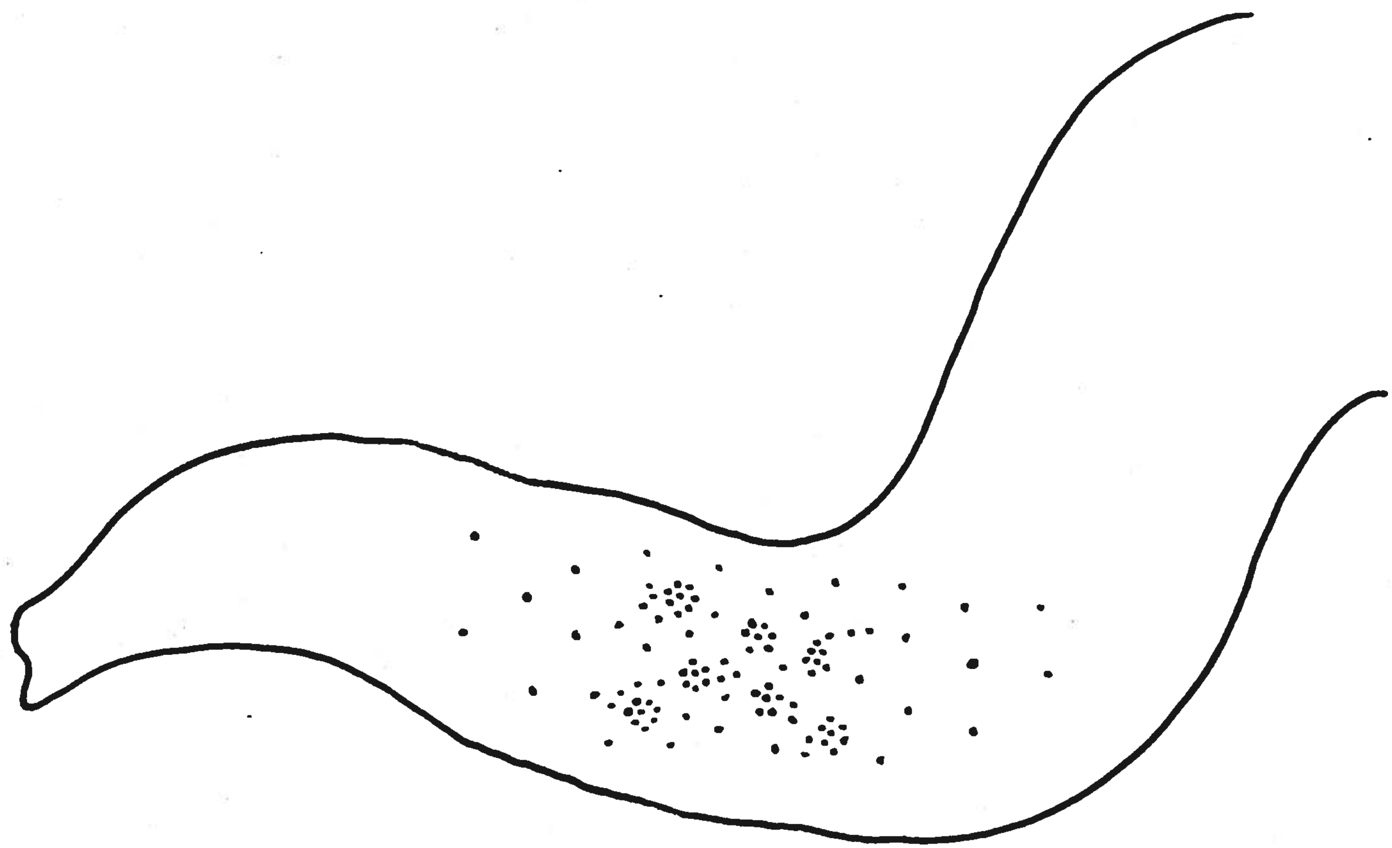
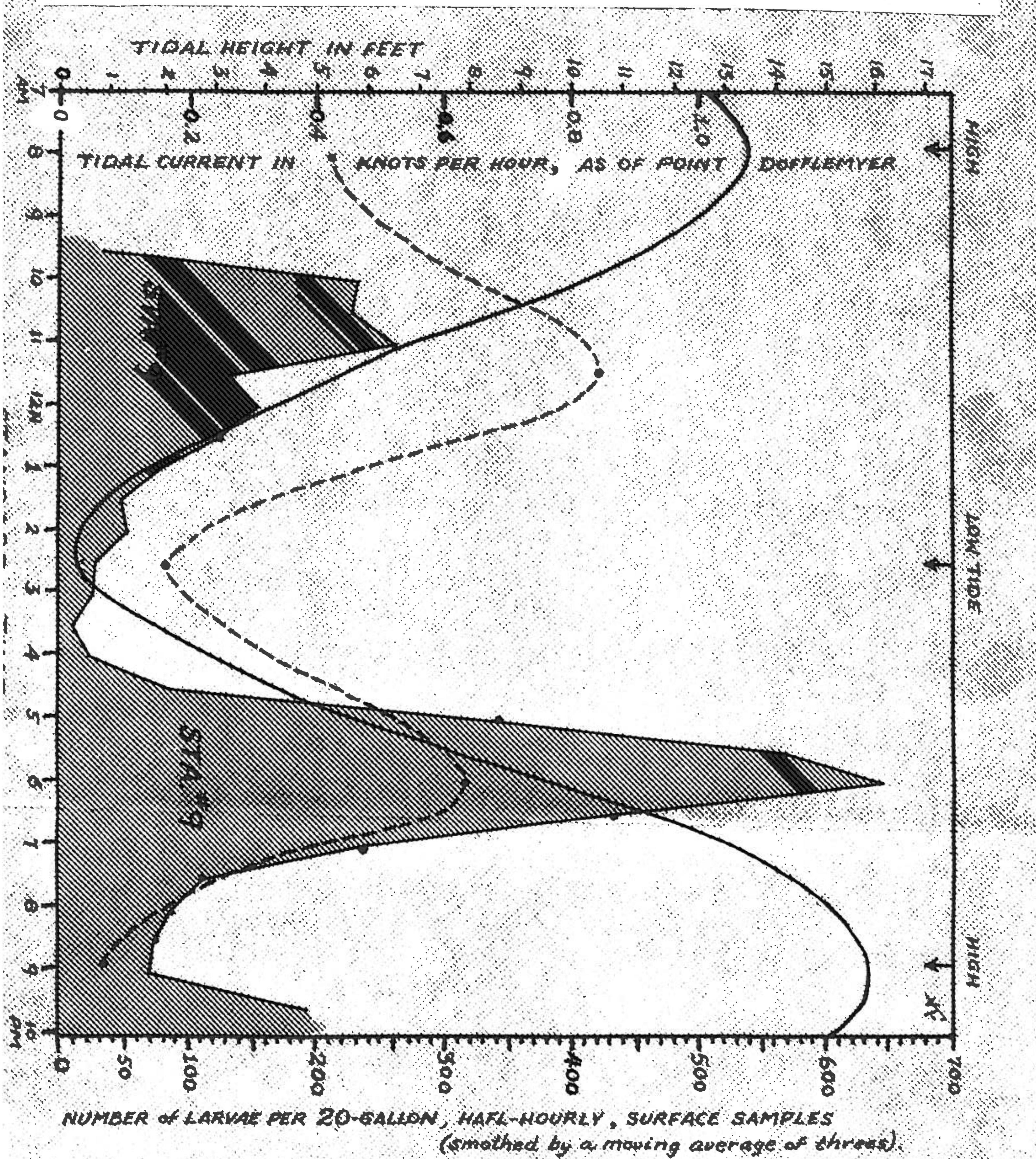


Figure 44 Conception of Spotty Concentrations of Larvae within the Larvae Mass.

Figure 45 Tidal Plankton Cycle at one Station in Oyster Bay on August 8, 1944.



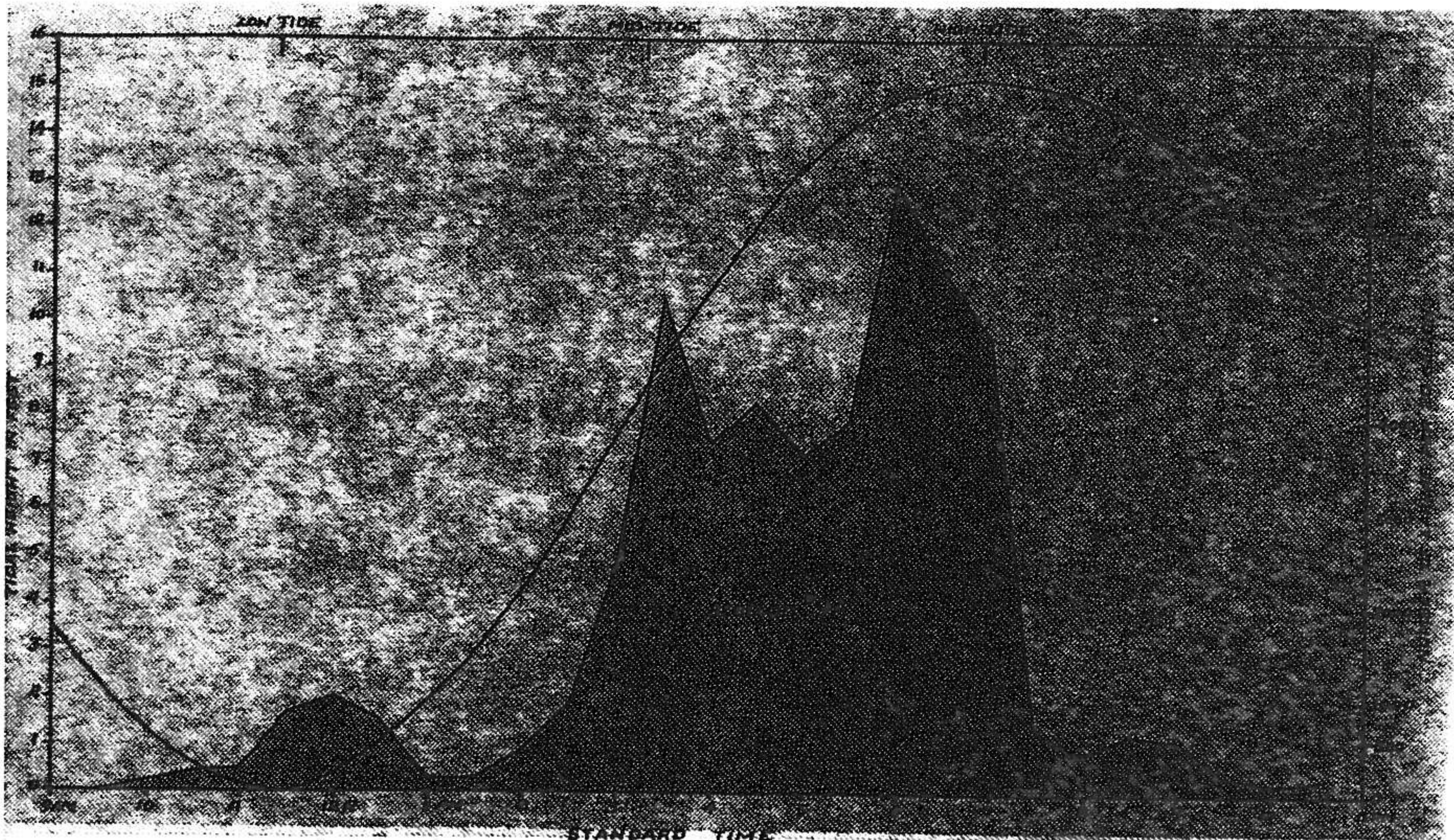


Figure 46 Tidal Plankton Cycle at one station in Oyster Bay on July 9, 1955. (Average of samples at all depths, grouped to nearest half hour.

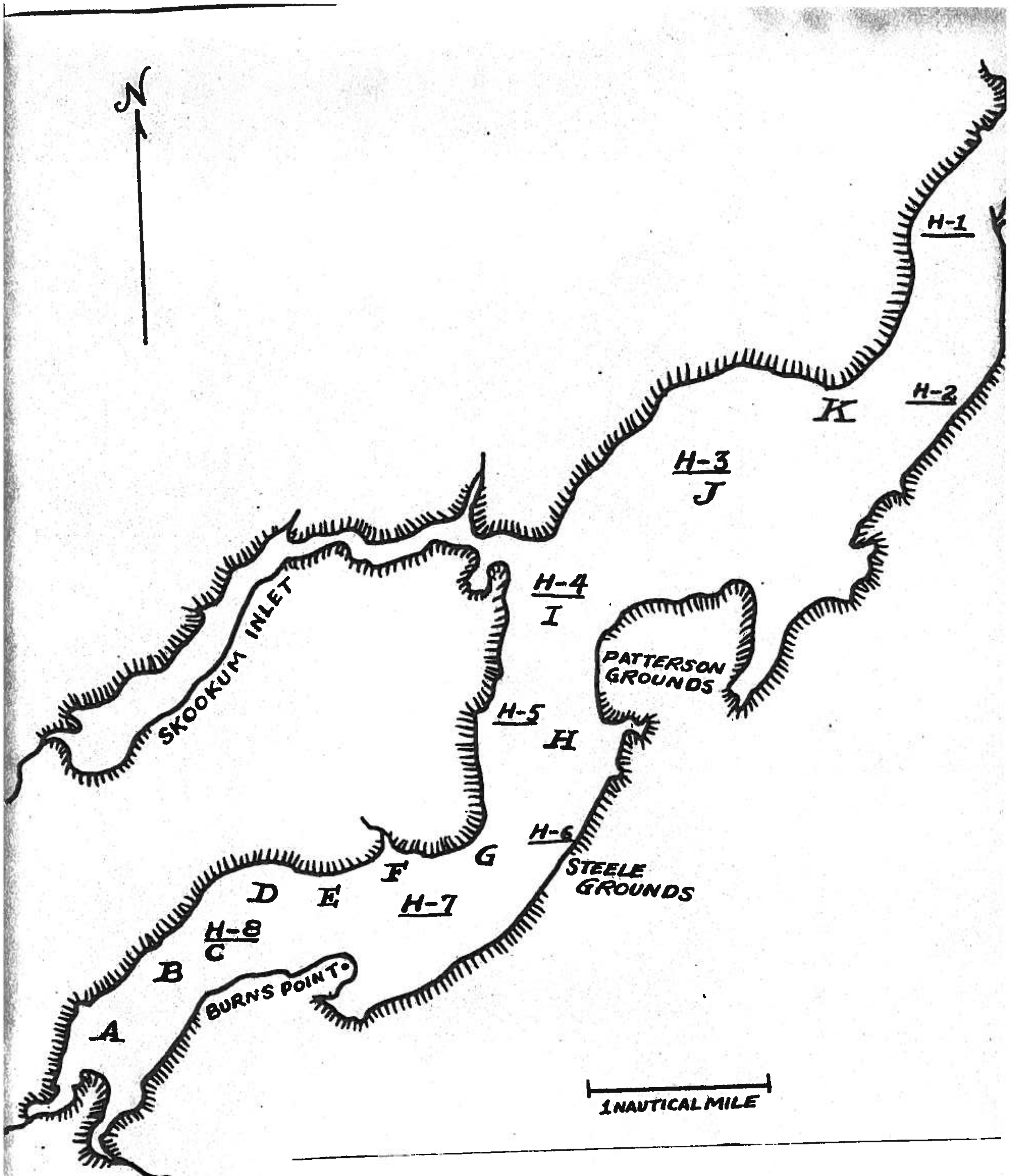


Figure 17 Map of Oyster Bay Showing Stations of Plankton Ti Cycle Studies of July 24 and Aug. 23, 1945, and J 1st, 1946.

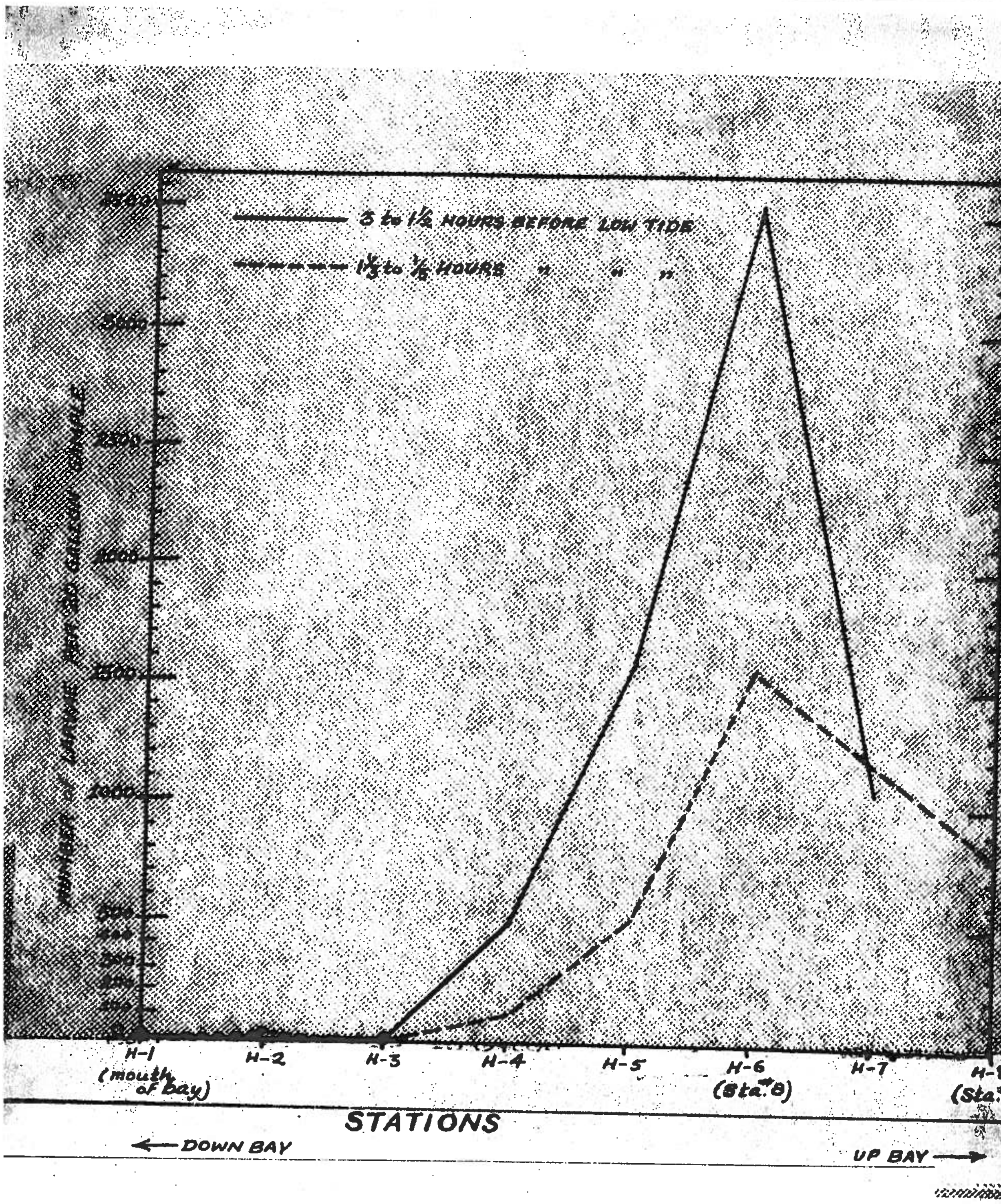


Figure 48 Tidal Plankton Study of Eight Stations in Oyster Bay on July 24, 1945. (For location of stations see

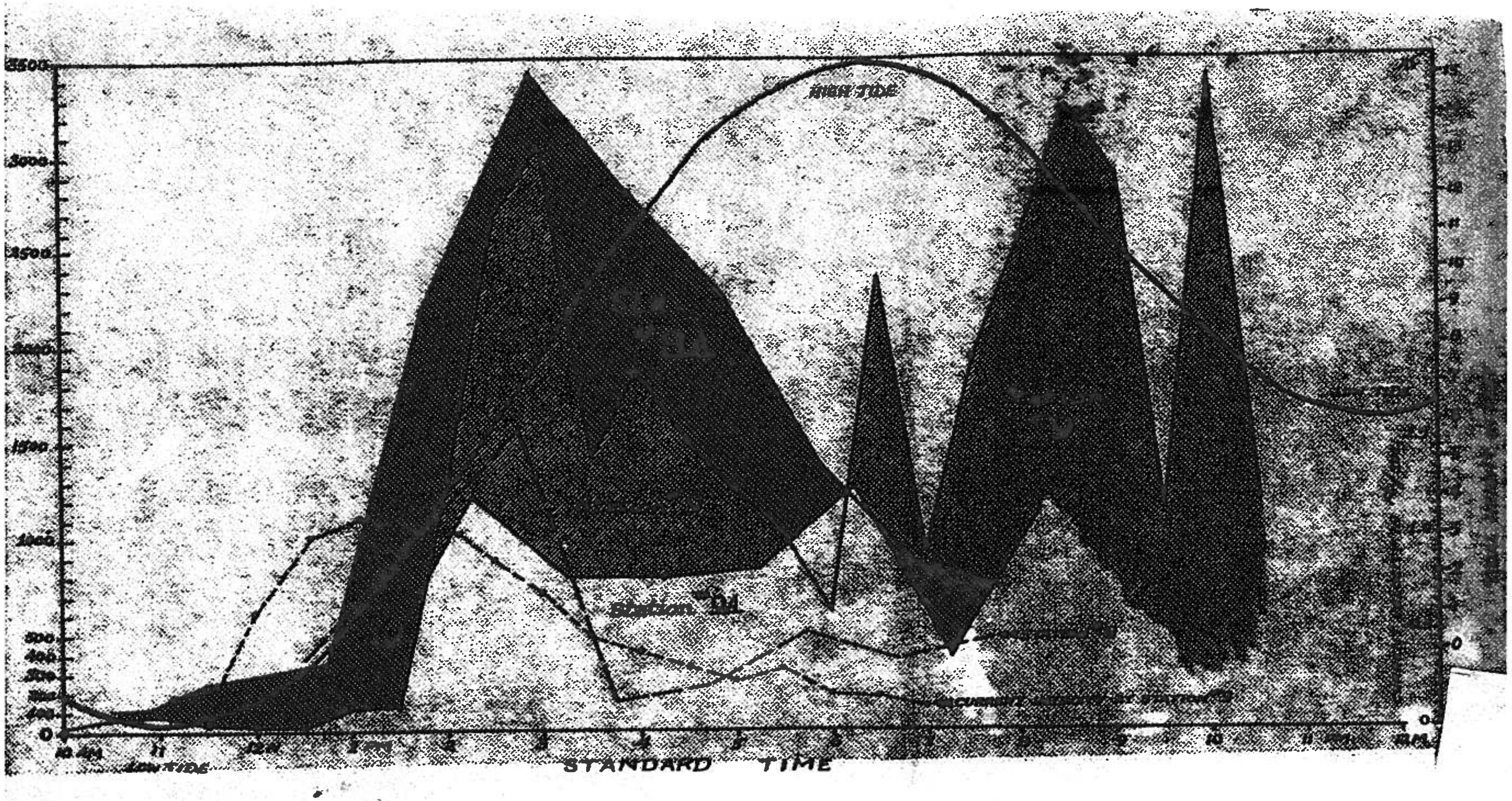


Figure 49 Tidal Plankton Cycle at Four Stations in Oyster bay on August 7, 1945. (For location of Stations see

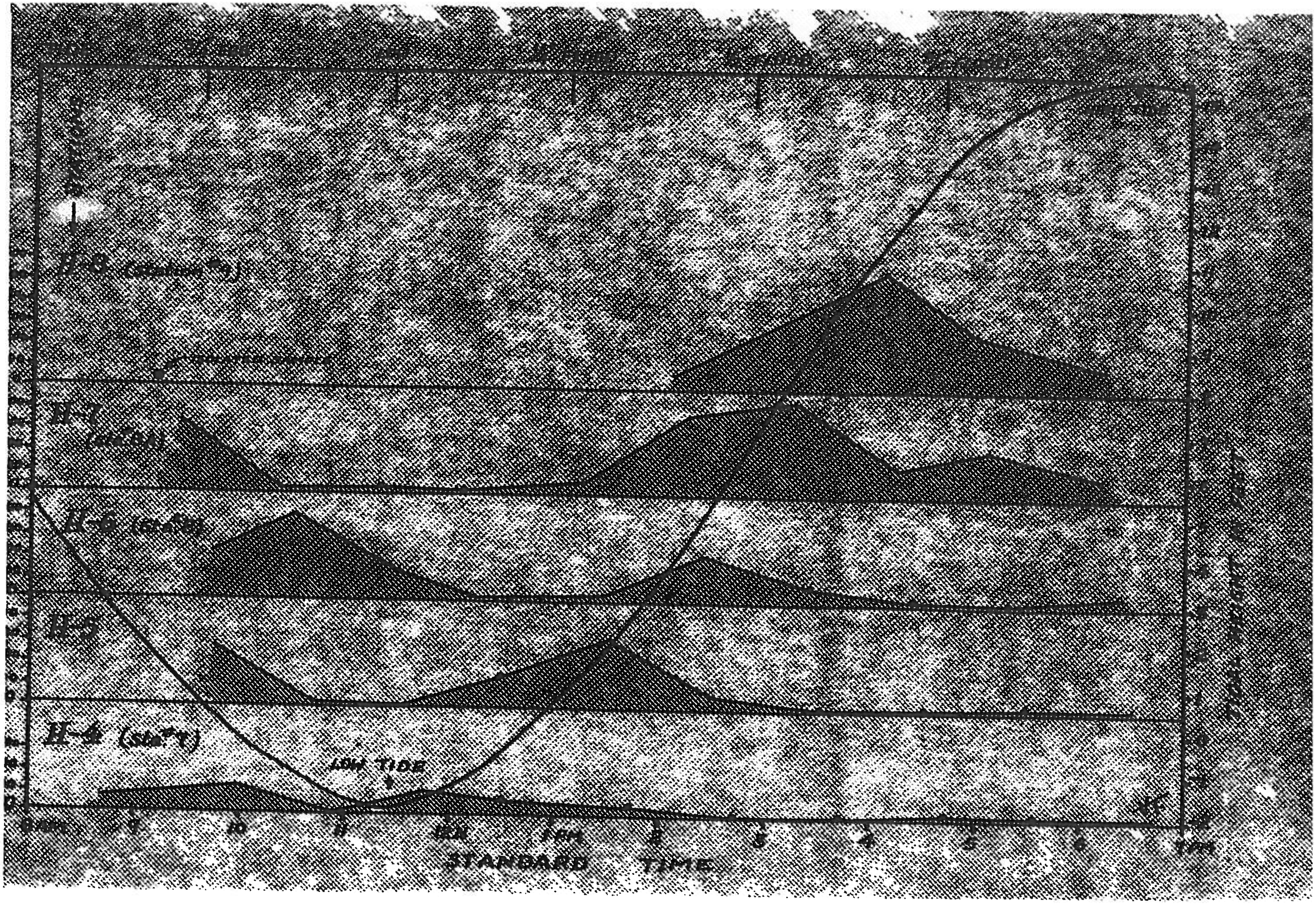
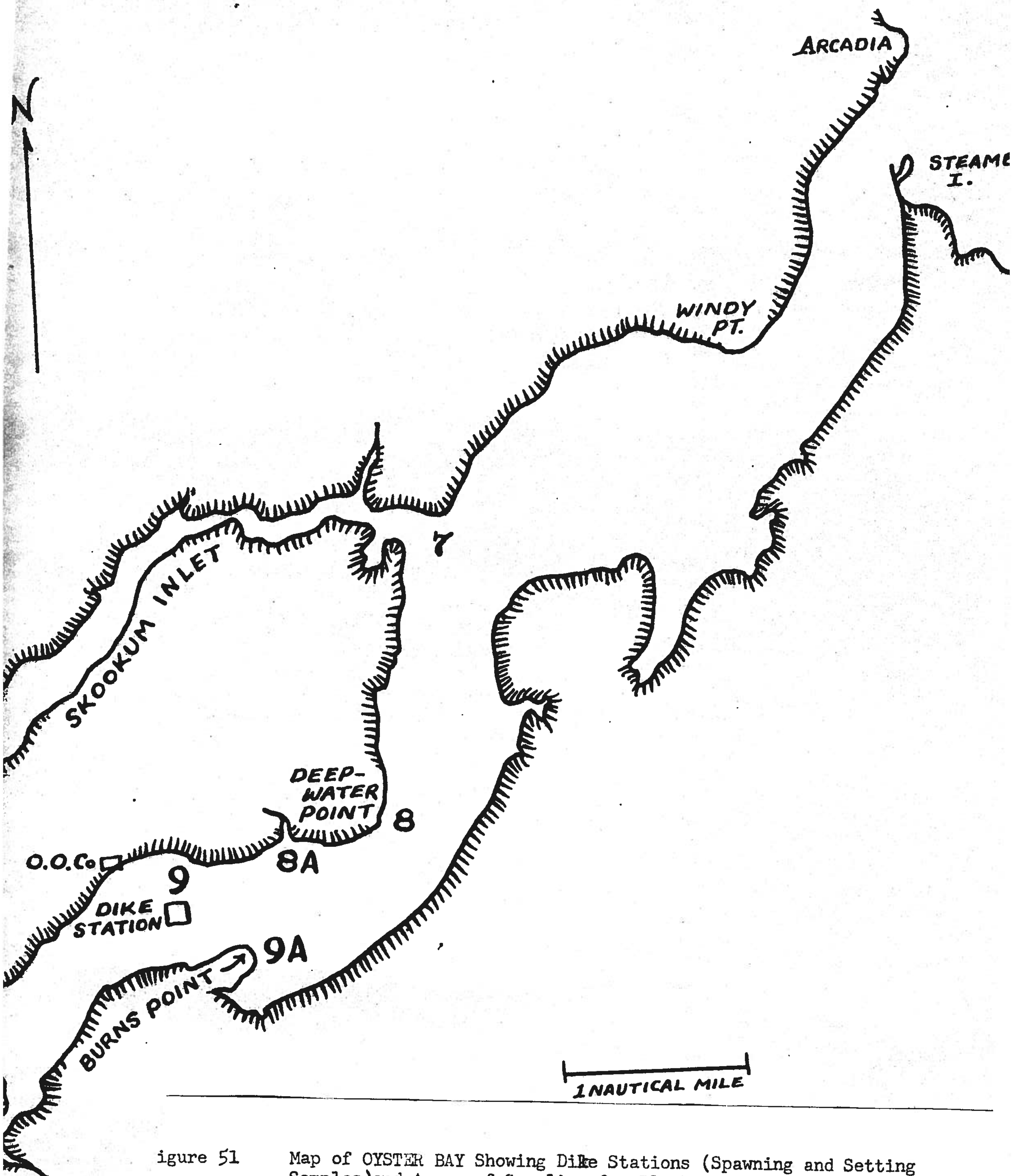


Figure 55 Tidal Plankton Cycle at Five Stations in Oyster Bay on August 23, 1945. (For location of Stations see



igure 51 Map of OYSTER BAY Showing Dike Stations (Spawning and Setting Samples) and Areas of Sampling for Planktonic Larvae.

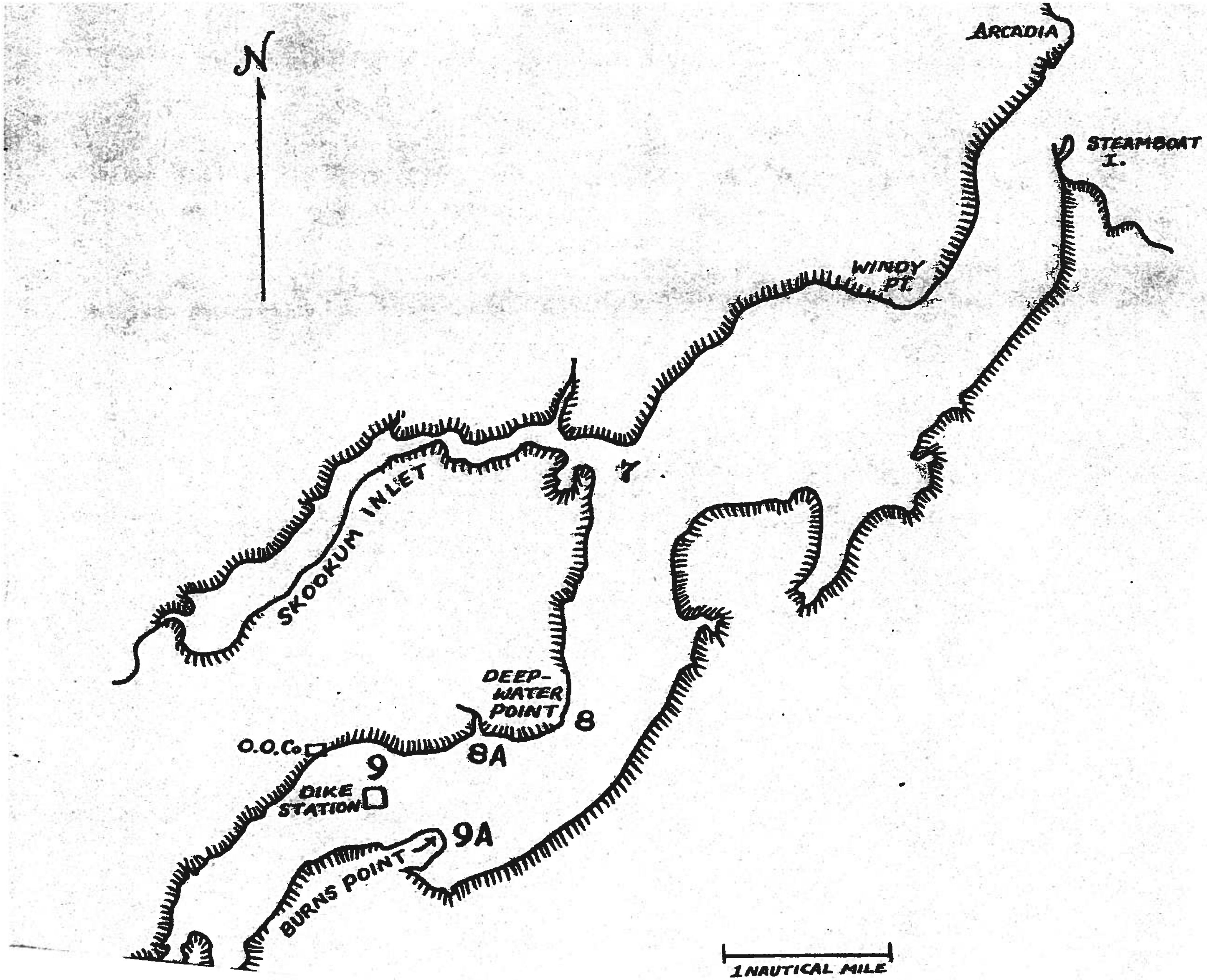
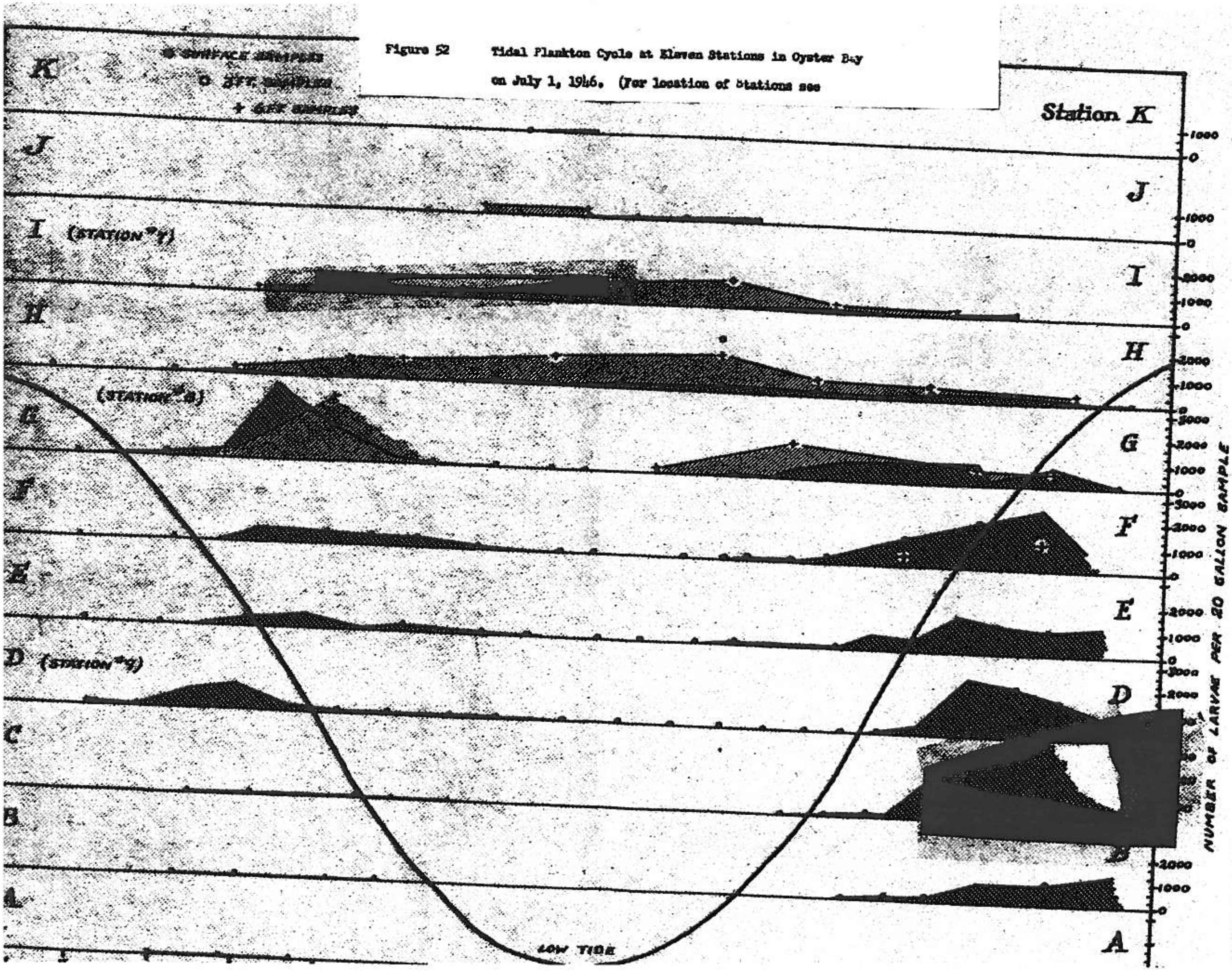


Figure 51 Map of OYSTER BAY Showing Dike Stations (Spawning and Setting Samples) and Areas of Sampling for Planktonic Larvae.

Figure 52 Tidal Plankton Cycle at Eleven Stations in Oyster Bay on July 1, 1946. (For location of Stations see



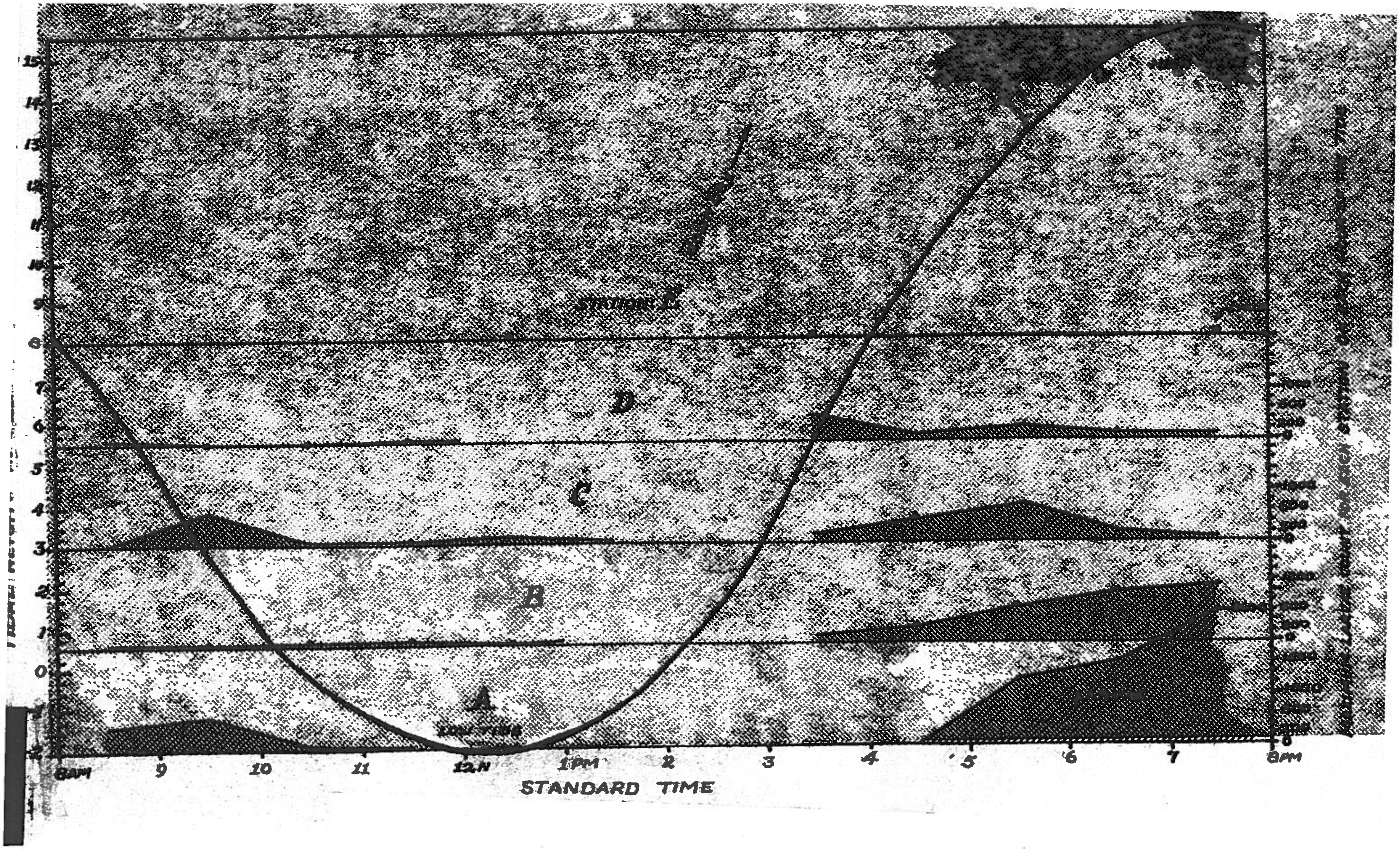


Figure 53 Tidal Plankton Cycle at five Areas in Mud Bay on July 30, 1950

(For location of Stations see Figure 54.)

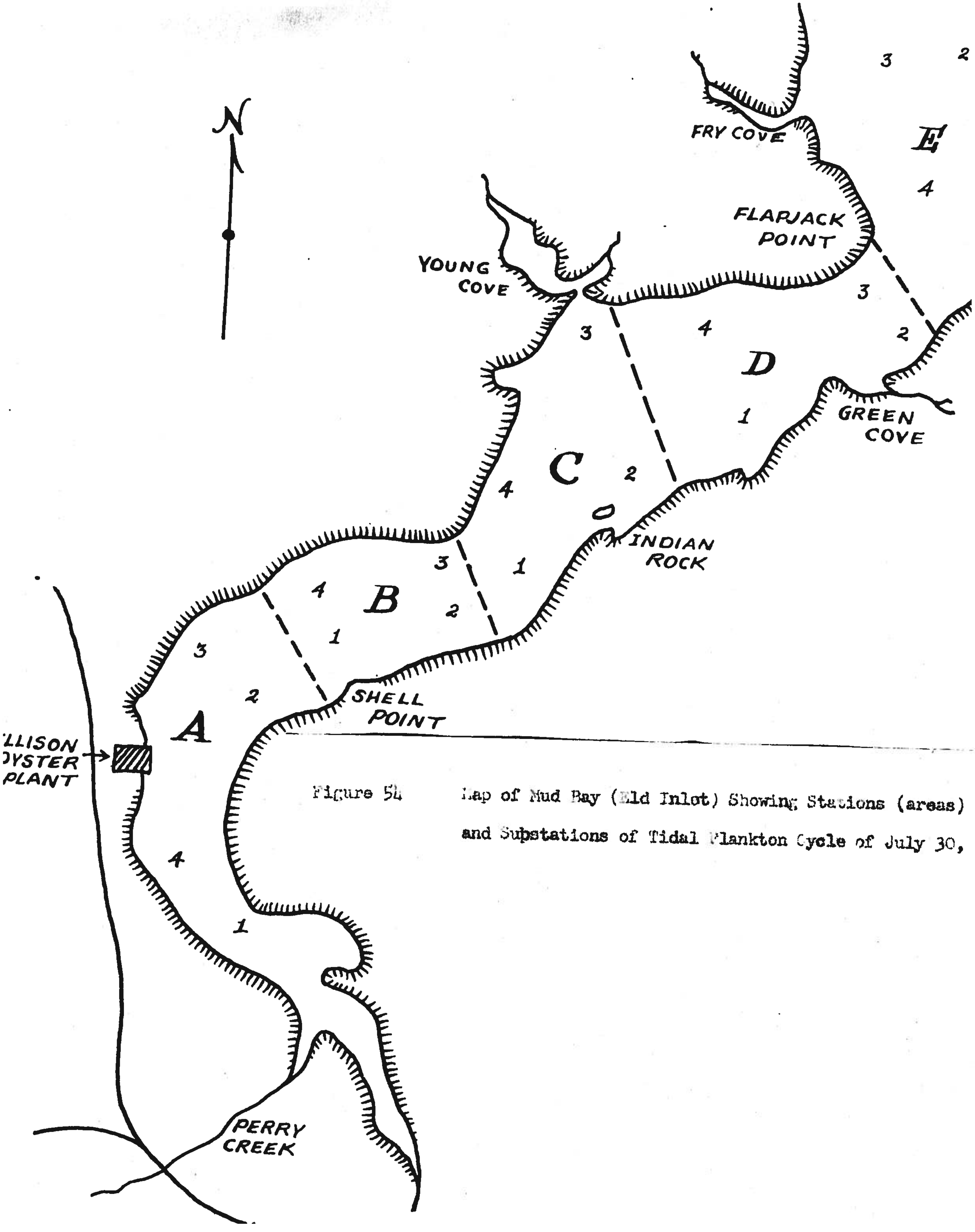
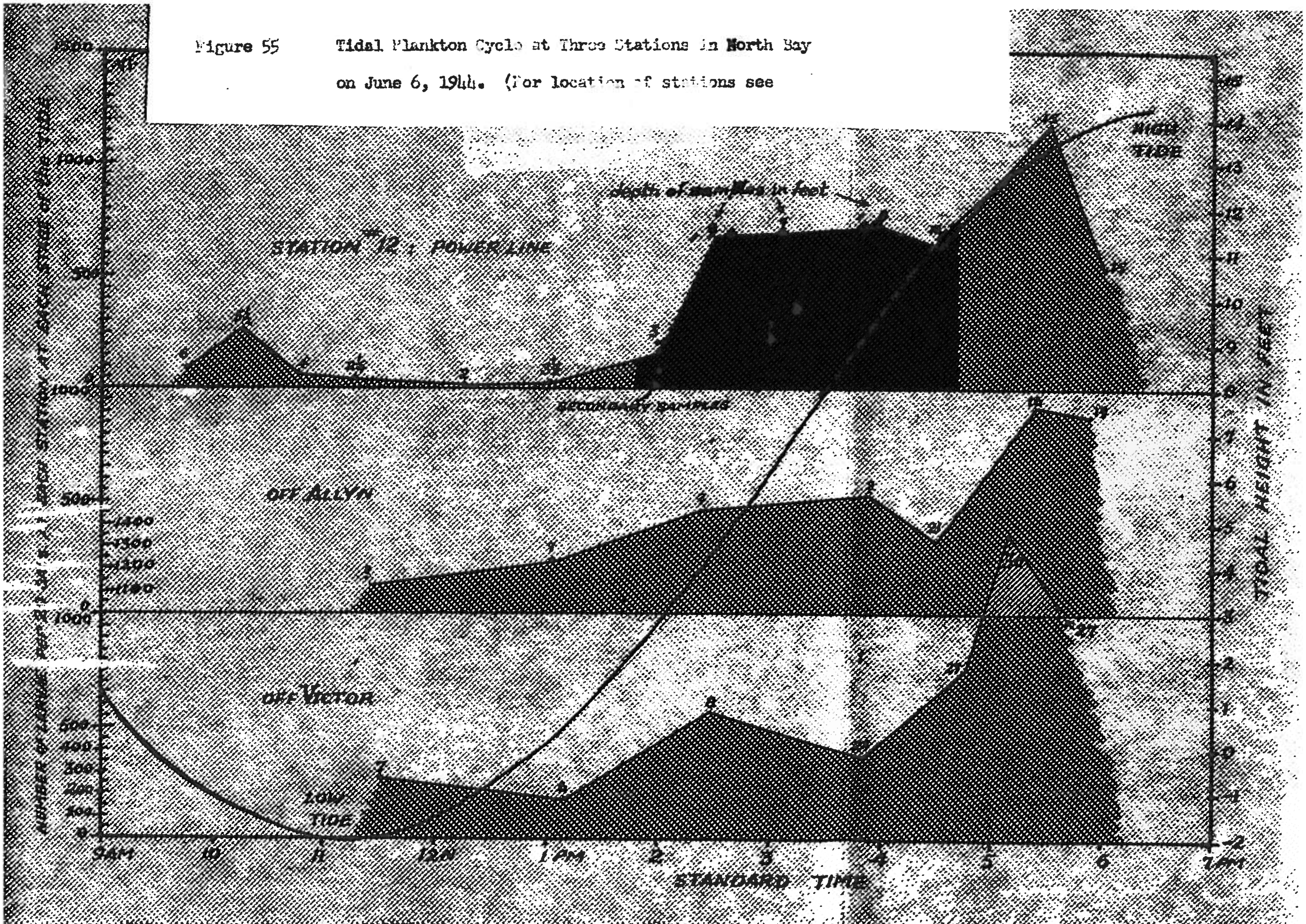


Figure 54 Map of Mud Bay (Eld Inlet) Showing Stations (areas) and Substations of Tidal Plankton Cycle of July 30,

Figure 55 Tidal Plankton Cycle at Three Stations in North Bay on June 6, 1944. (For location of stations see



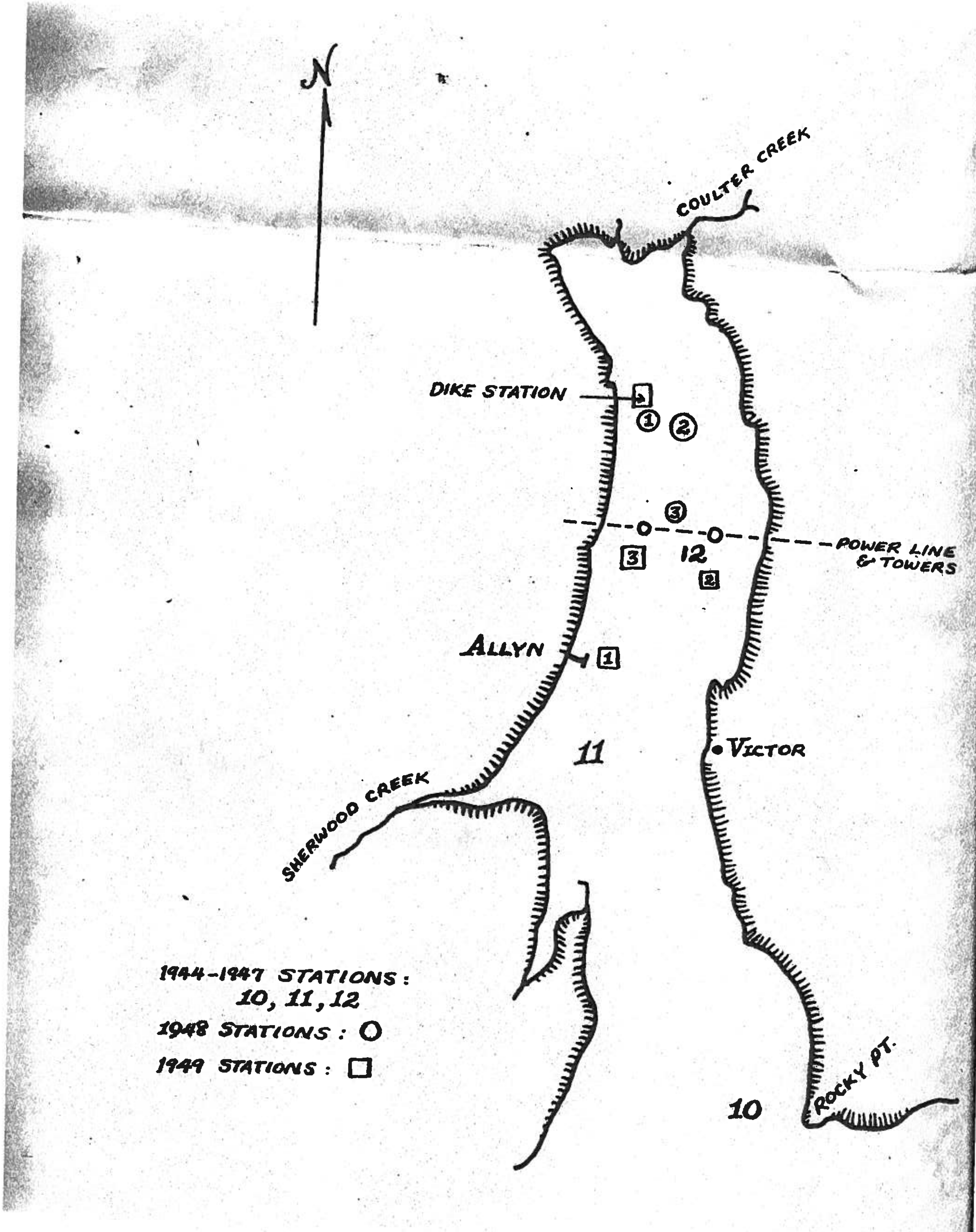
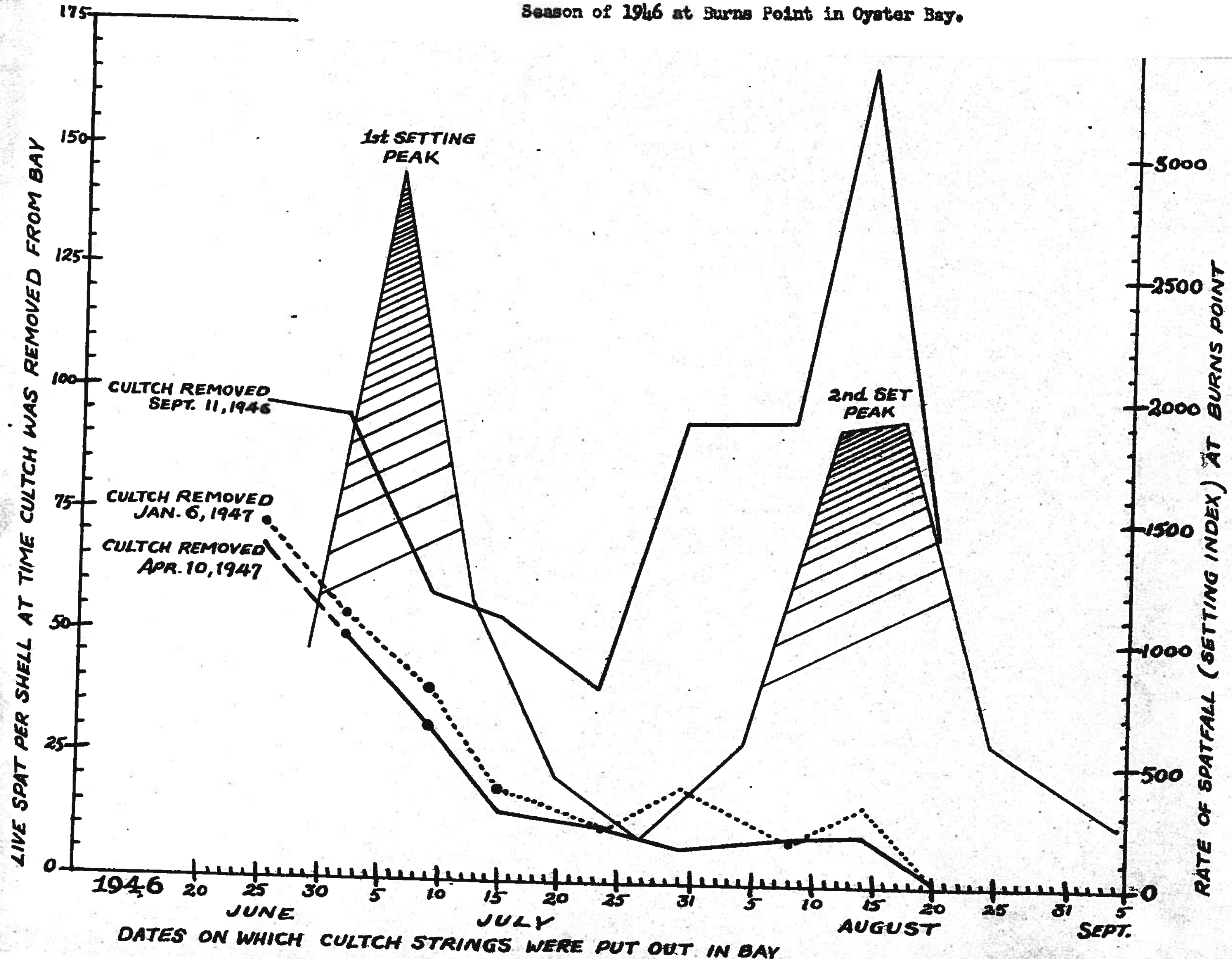


Figure 55A Map of NORTH BAY SHOWING Dike Station (Spawning and Samples) and Areas of Sampling for Bl...

Figure 56 Survival of Spat in Relation to Time of Setting during the Season of 1946 at Burns Point in Oyster Bay.



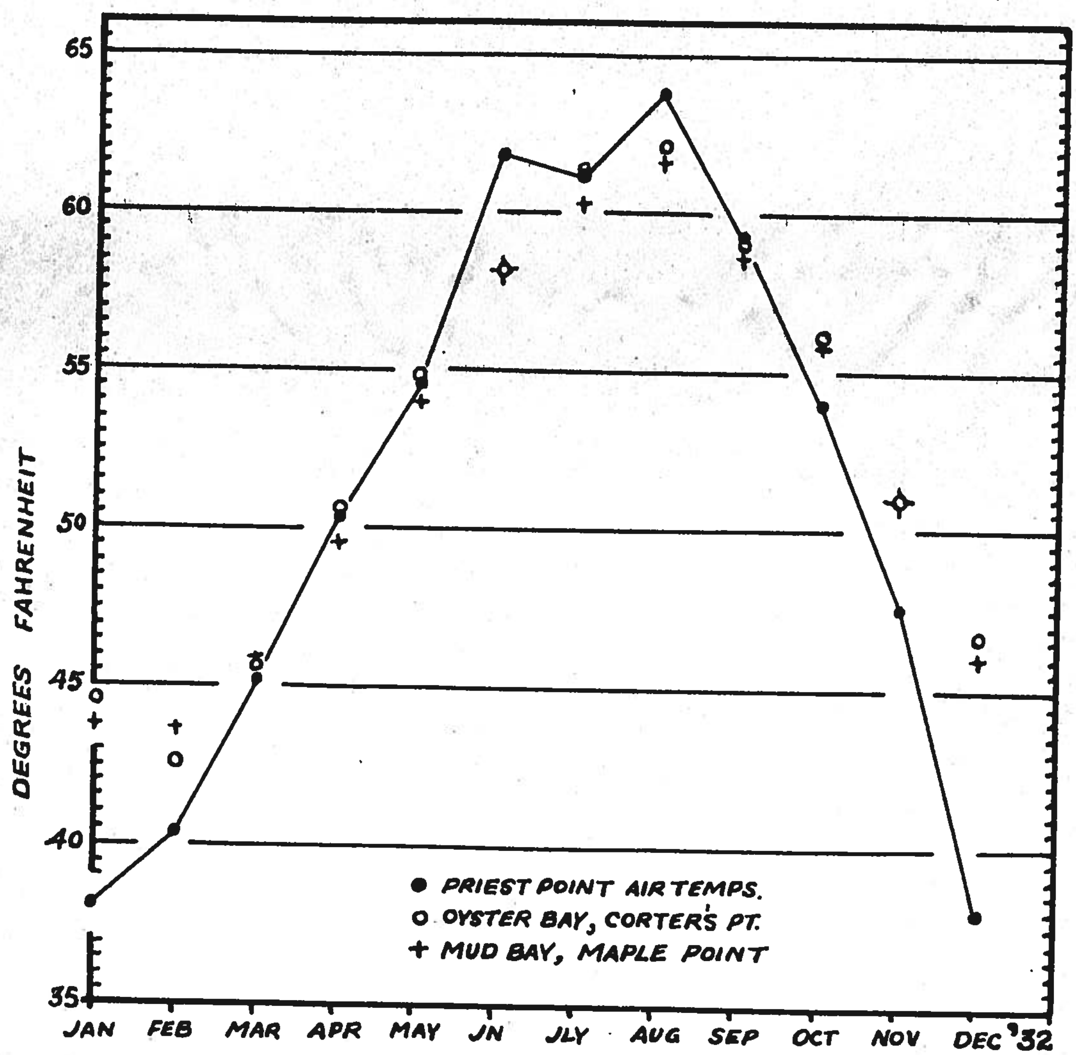


Figure 57 Correlation between Average Monthly Air and Water Temperatures, Olympia and Two Bays (data of Hopkins, 1937).

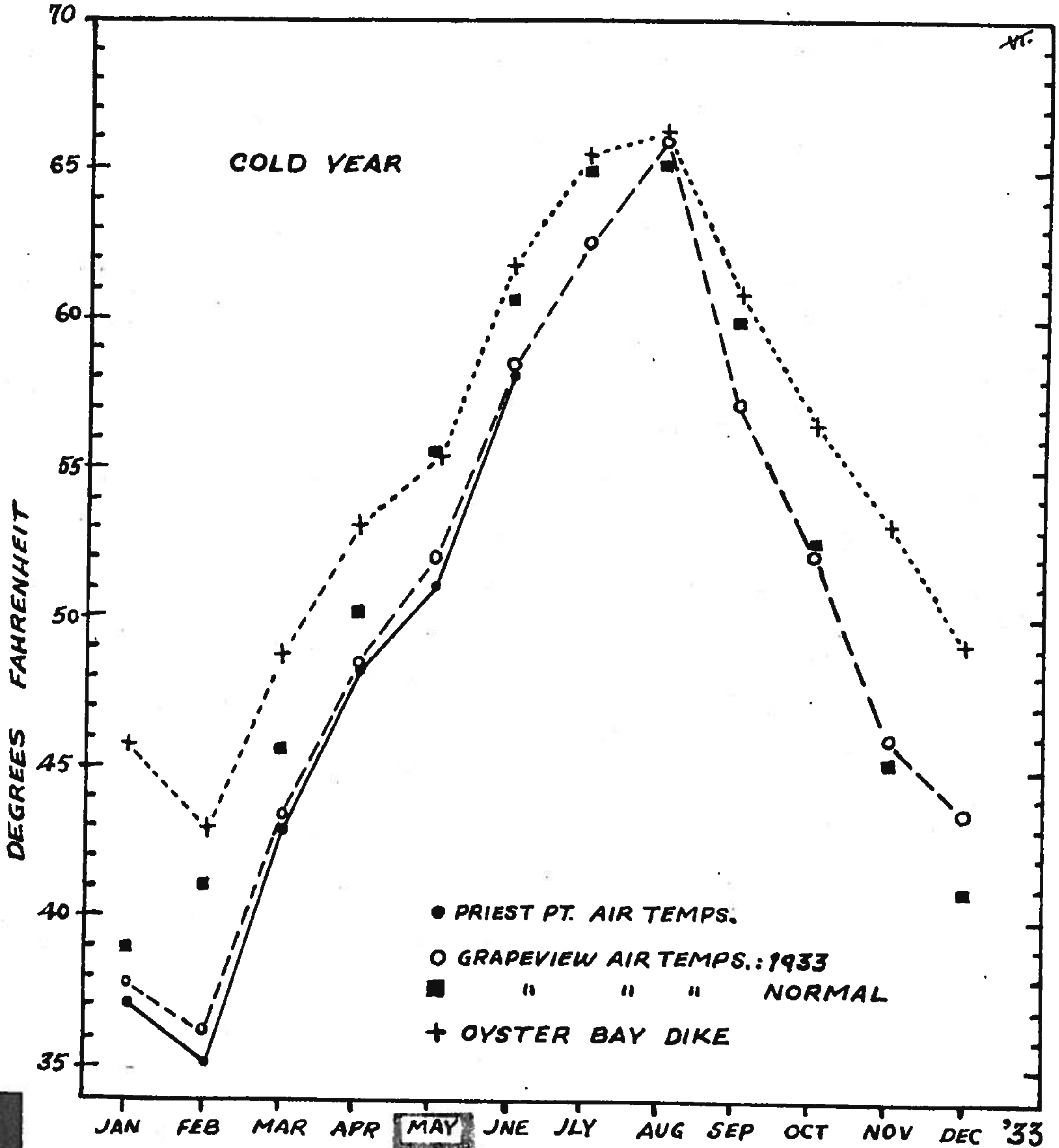


Figure 58 Average Monthly Temperatures during the Cold Year of 1933. Water at an Oyster Bay Dike (data of Hopkins, 1937)

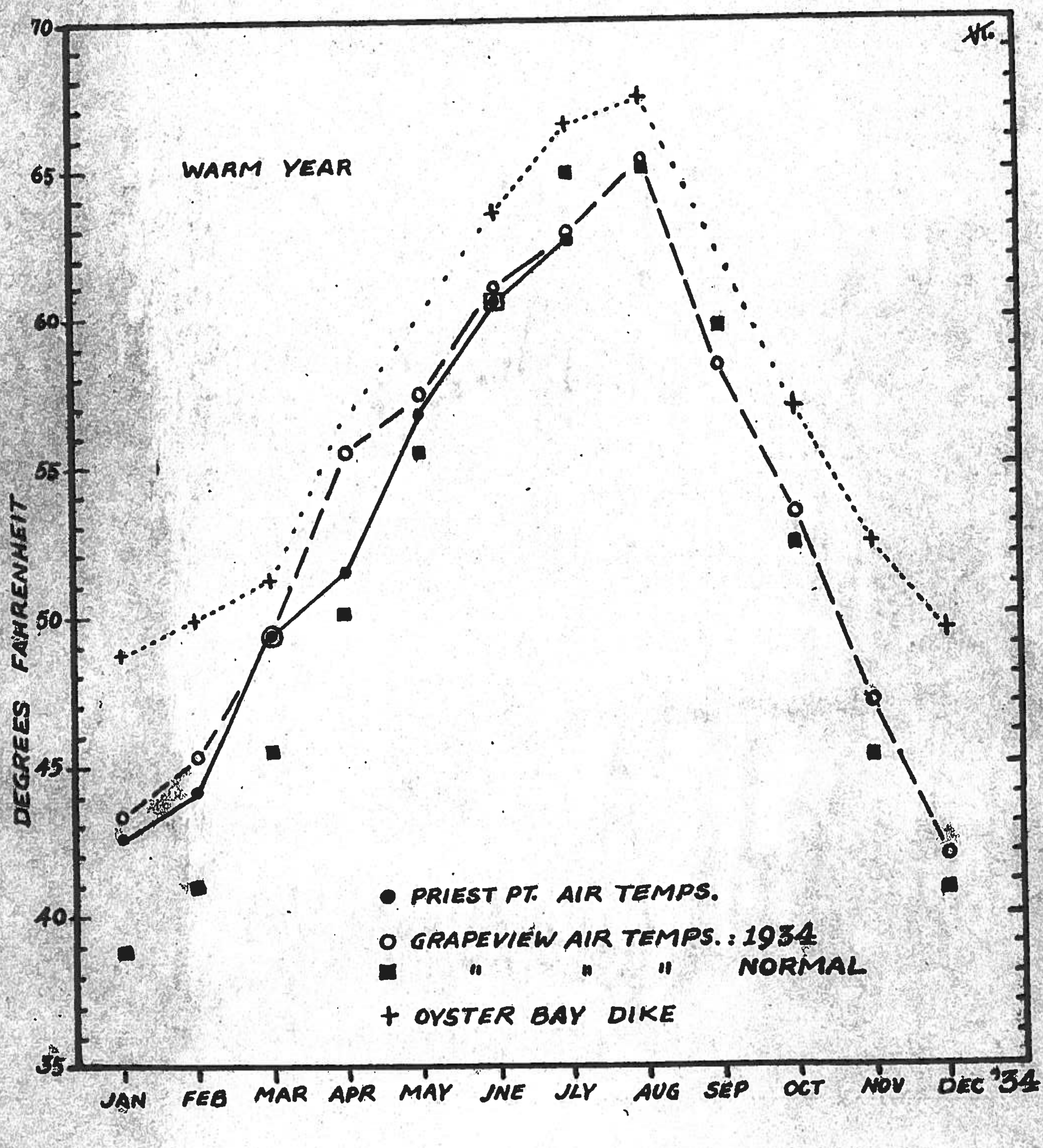


Figure 59 Average Monthly Temperatures during the Warm Year of 1934

Water at an Oyster Bay Dike (data of Hopkins, 1937)

Compared with Air Temperatures at Two Weather Bureau Stations.

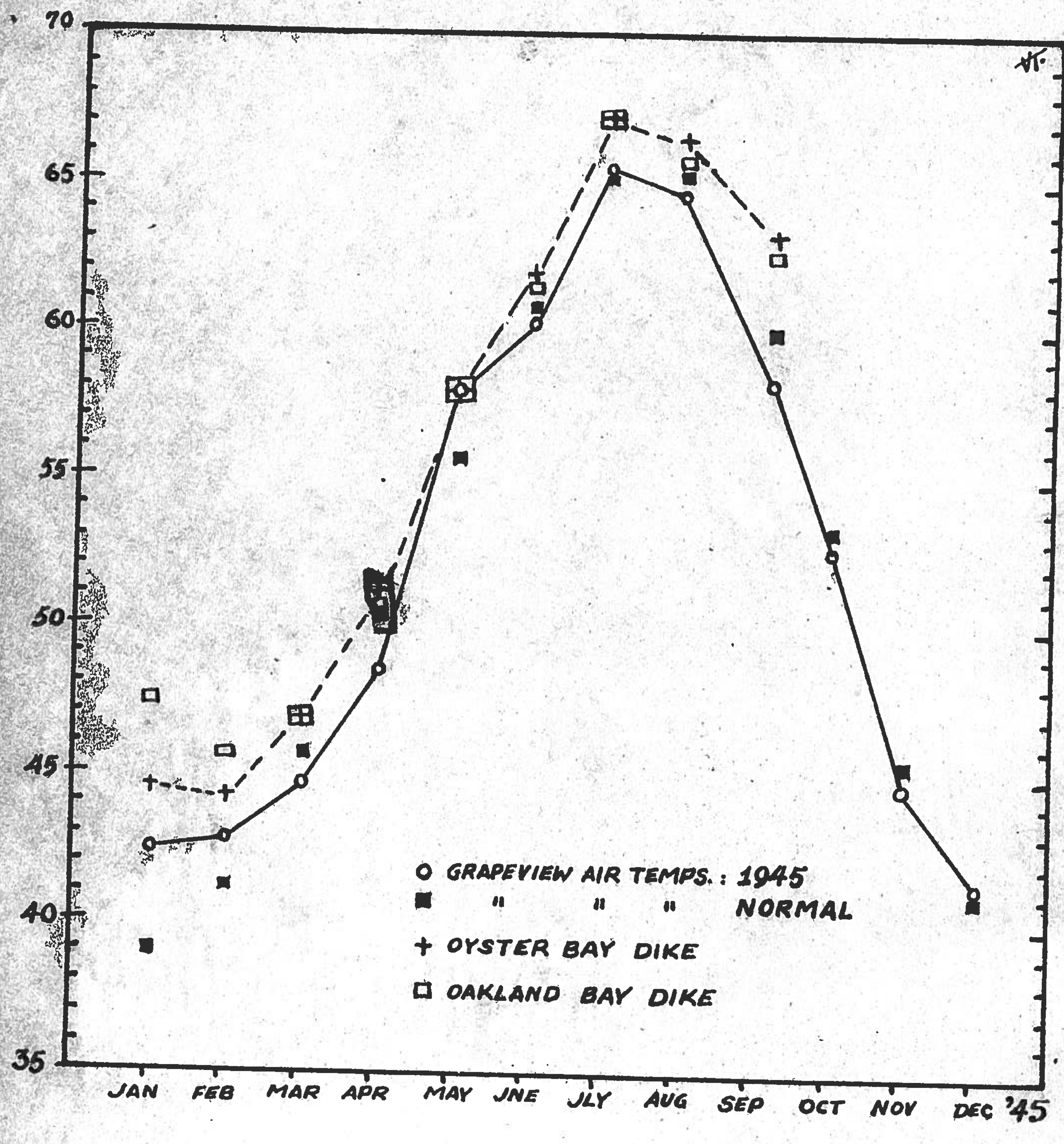
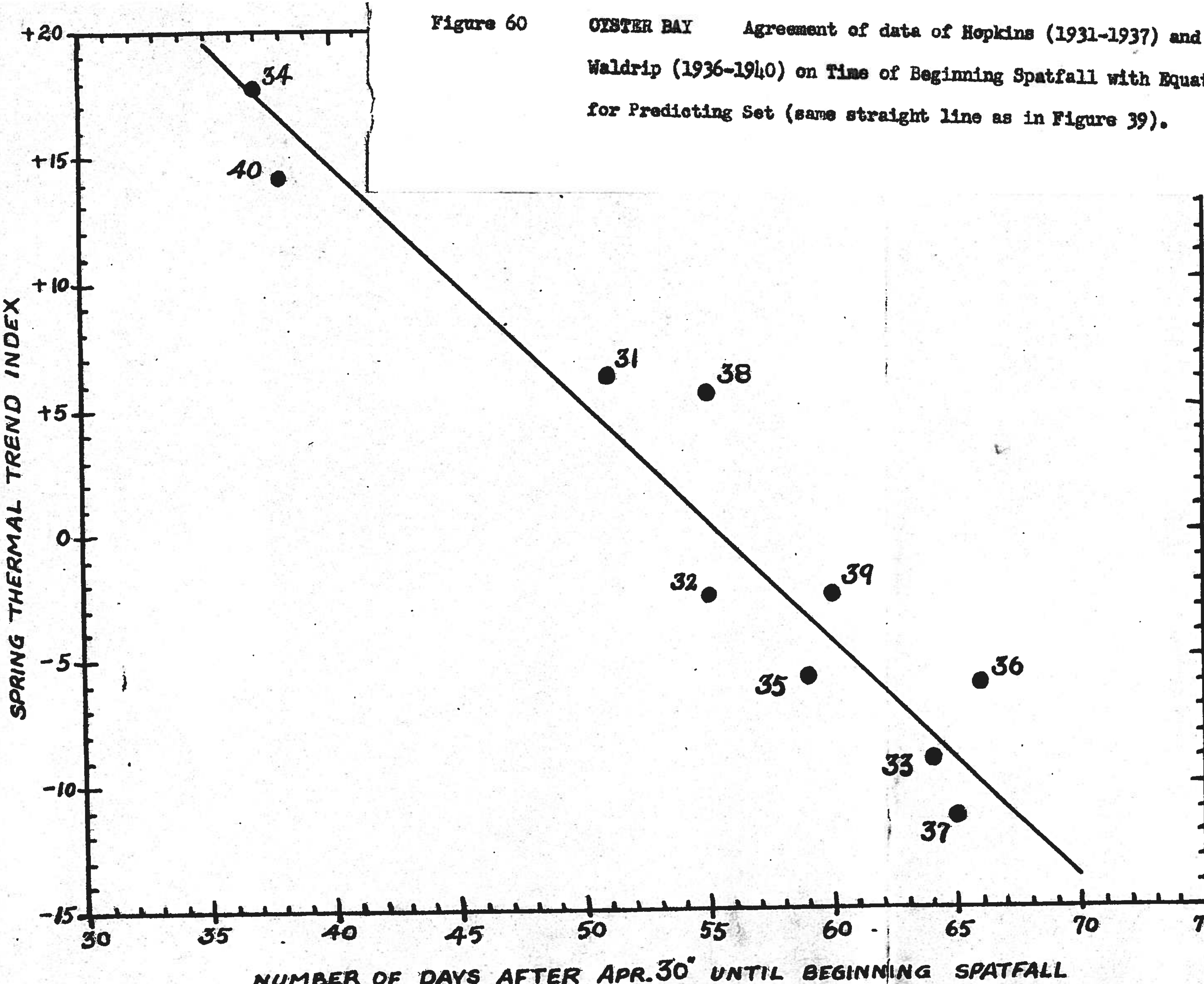


Figure 59A Average Monthly Temperatures During 1945. Waters at Dikes in Oyster Bay and Oakland Bay Compared with Grapeview Air Temperatures.

Figure 60 OYSTER BAY Agreement of data of Hopkins (1931-1937) and of Waldrip (1936-1940) on Time of Beginning Spatfall with Equation for Predicting Set (same straight line as in Figure 39).



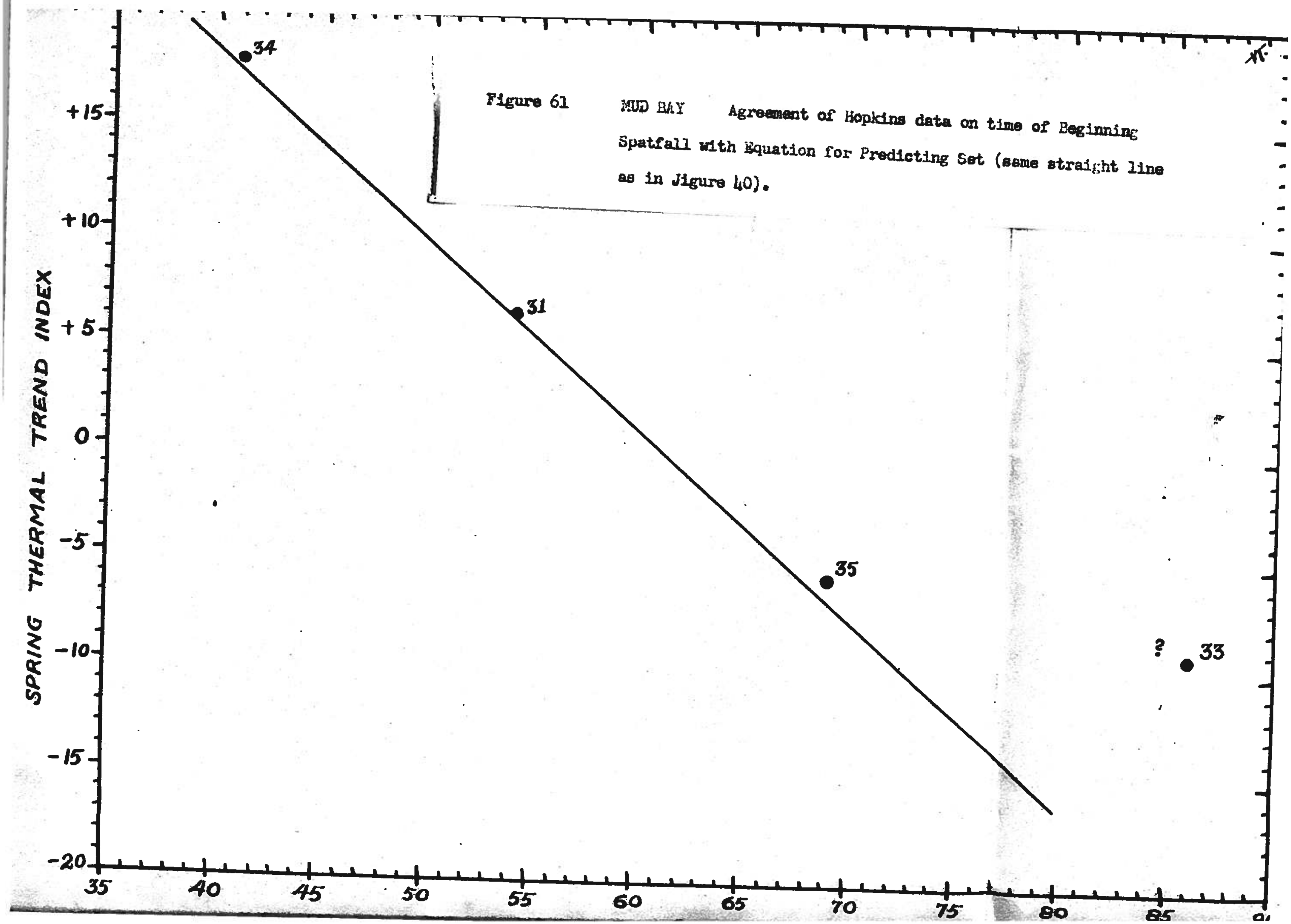


Figure 61 MUD BAY Agreement of Hopkins data on time of Beginning Spatfall with Equation for Predicting Set (same straight line as in Jigure 40).

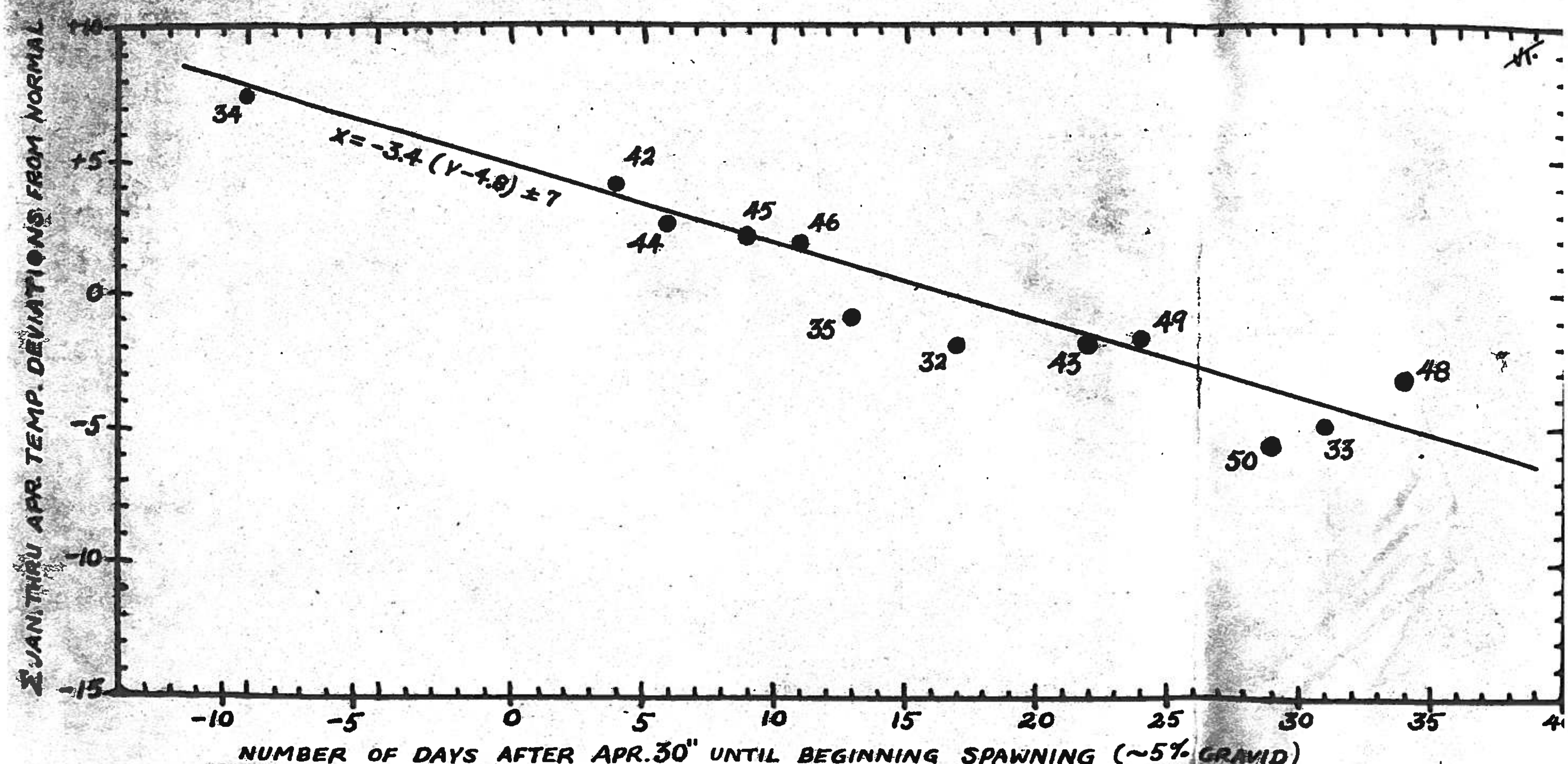
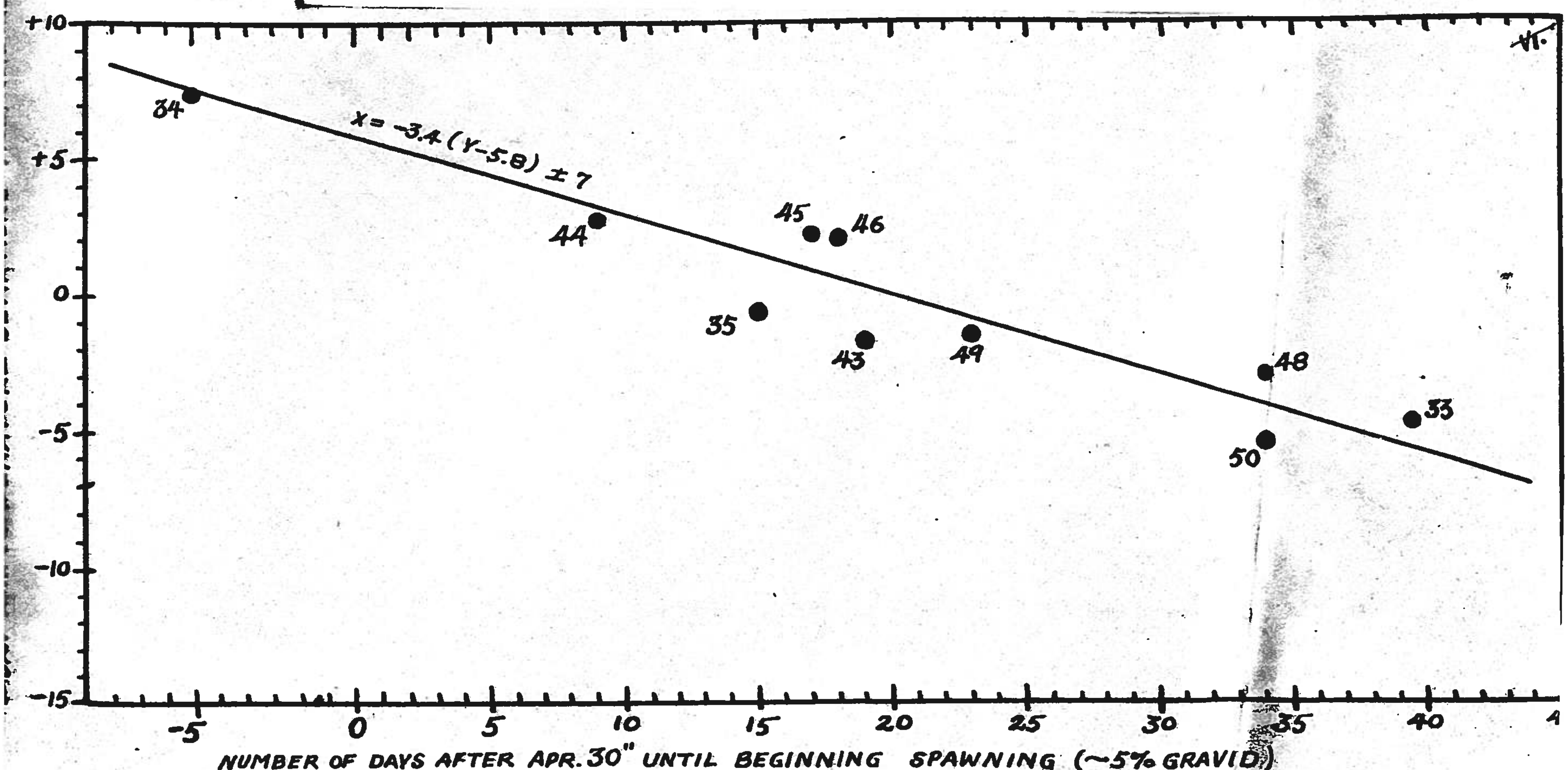


Figure 62 OYSTER BAY Correlation between Time of Beginning Spawning and Algebraic Sum of Deviations from Normal of Air Temperatures at Grapeview, January through April (omitting lowest January Deviations, see text).

Figure 63 MUD BAY Correlation between Time of Beginning Spawning and Algebraic Sum of Deviations from Normal of Air Temperatures at Grapeview, January through April (omitting lowest January Deviations, see text).



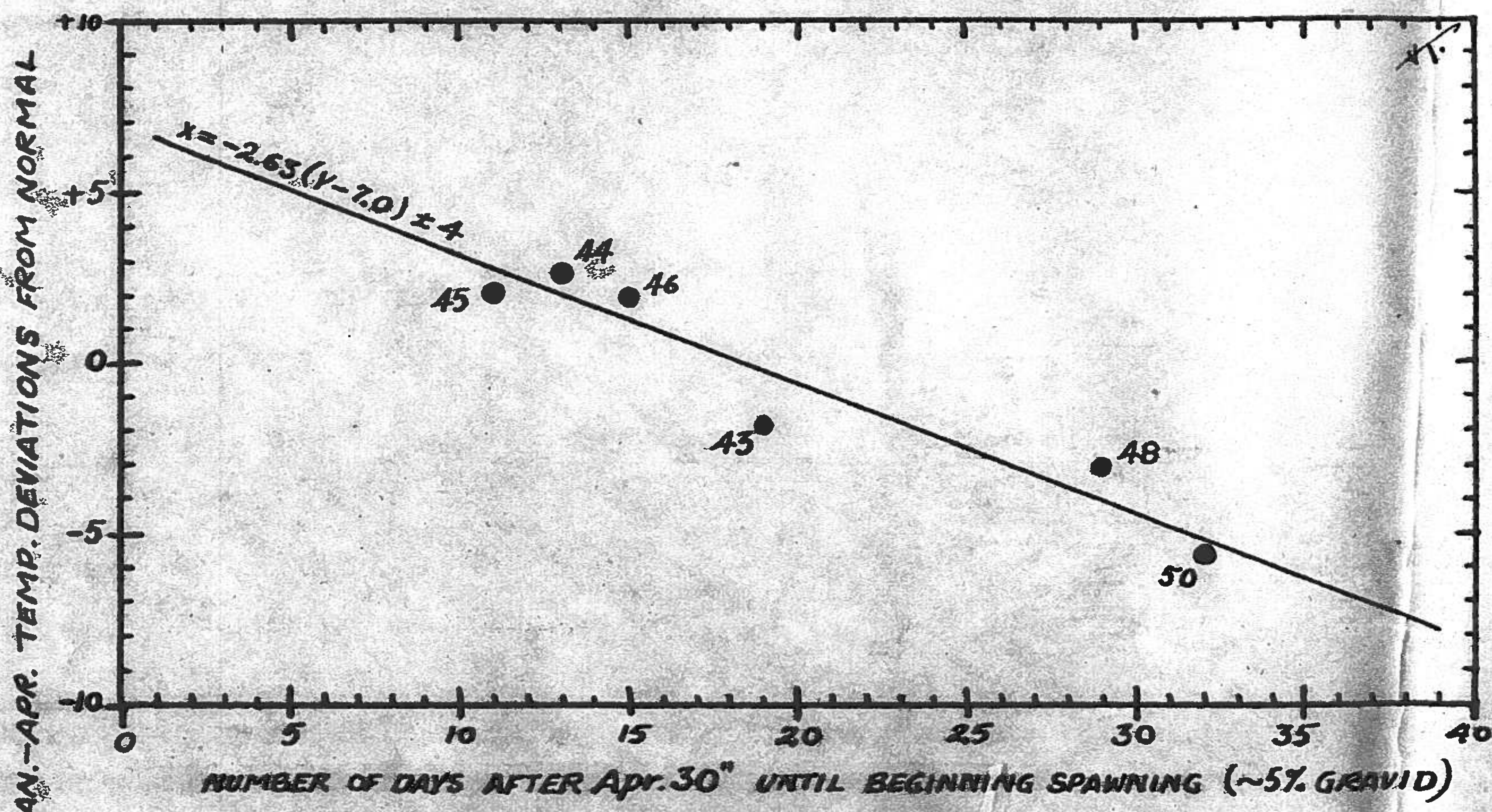


Figure 6h NORTH BAY Correlation between Time of Beginning Spawning and Algebraic Sum of Deviations from Normal of Air Temperatures at Grapeview, January through April (omitting lowest January Deviations, see text).

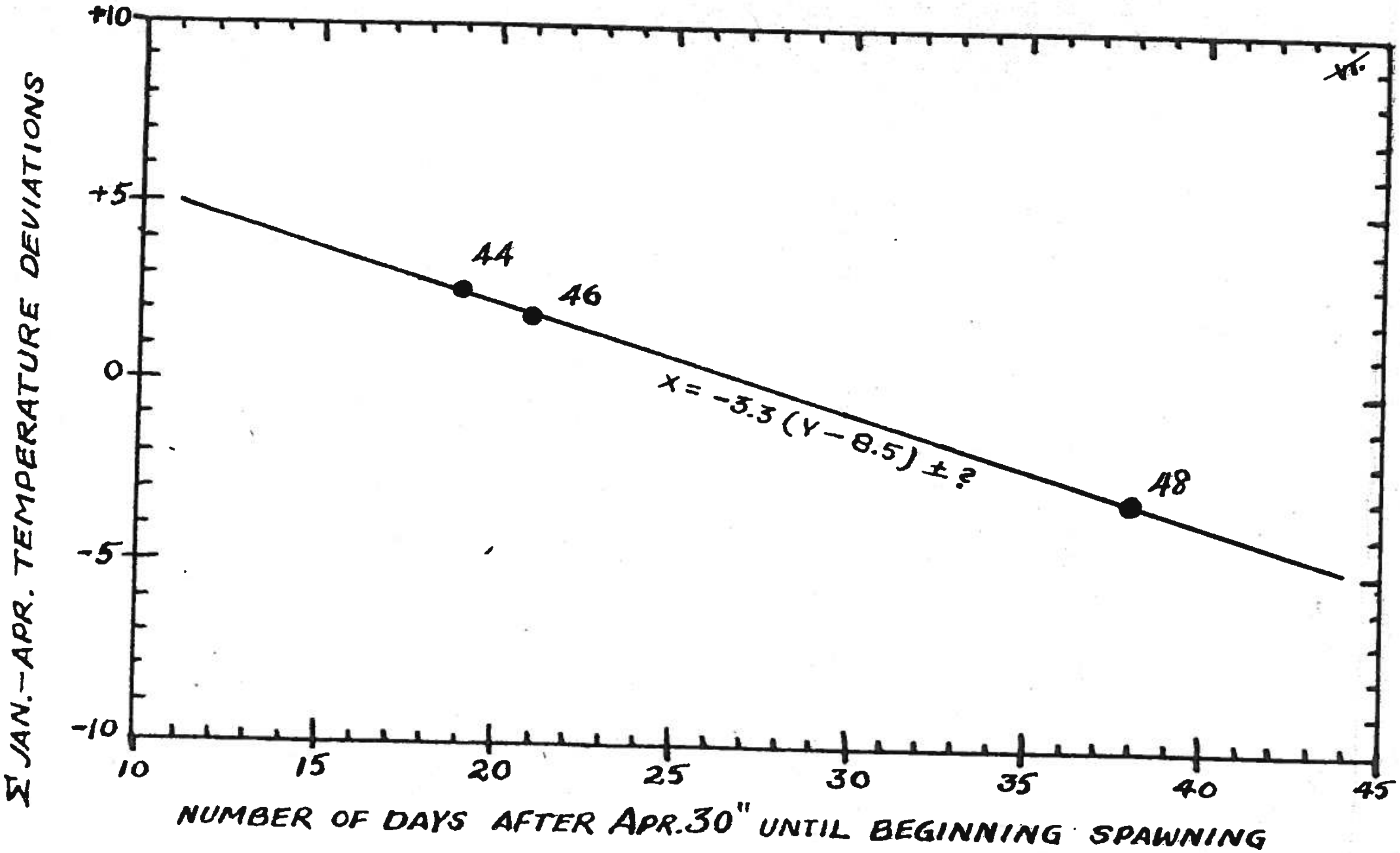


Figure 65 **SOUTH BAY** **Correlation between Time of Beginning Spawning and Algebraic Sum of Deviations from Normal of Air Temperatures** at Grapeview, January through April (omitting lowest Jan. Dev. see text)

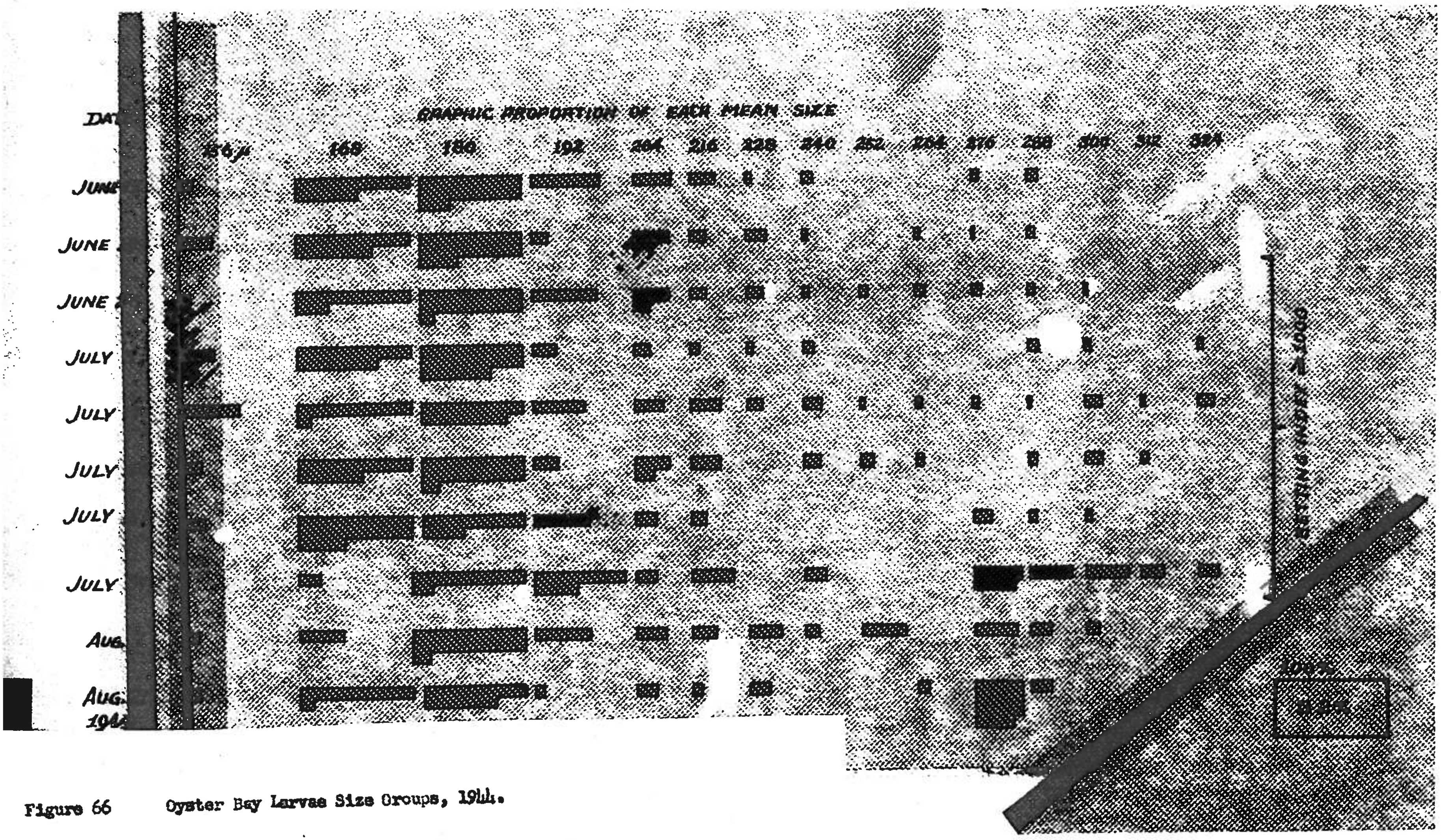


Figure 66 Oyster Bay Larvae Size Groups, 1944.

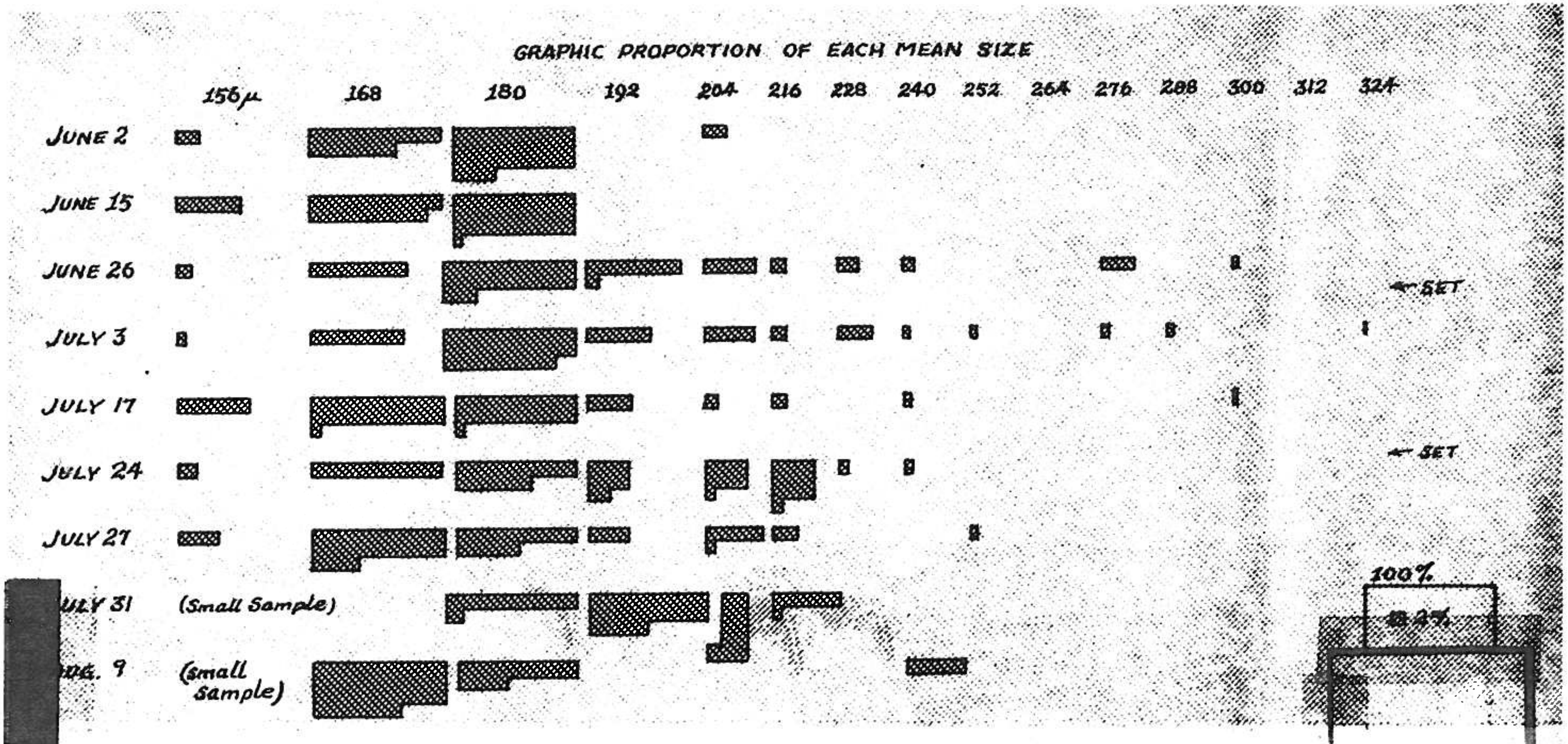


Figure 67 Mud Bay Larvae Size Groups, 1944.

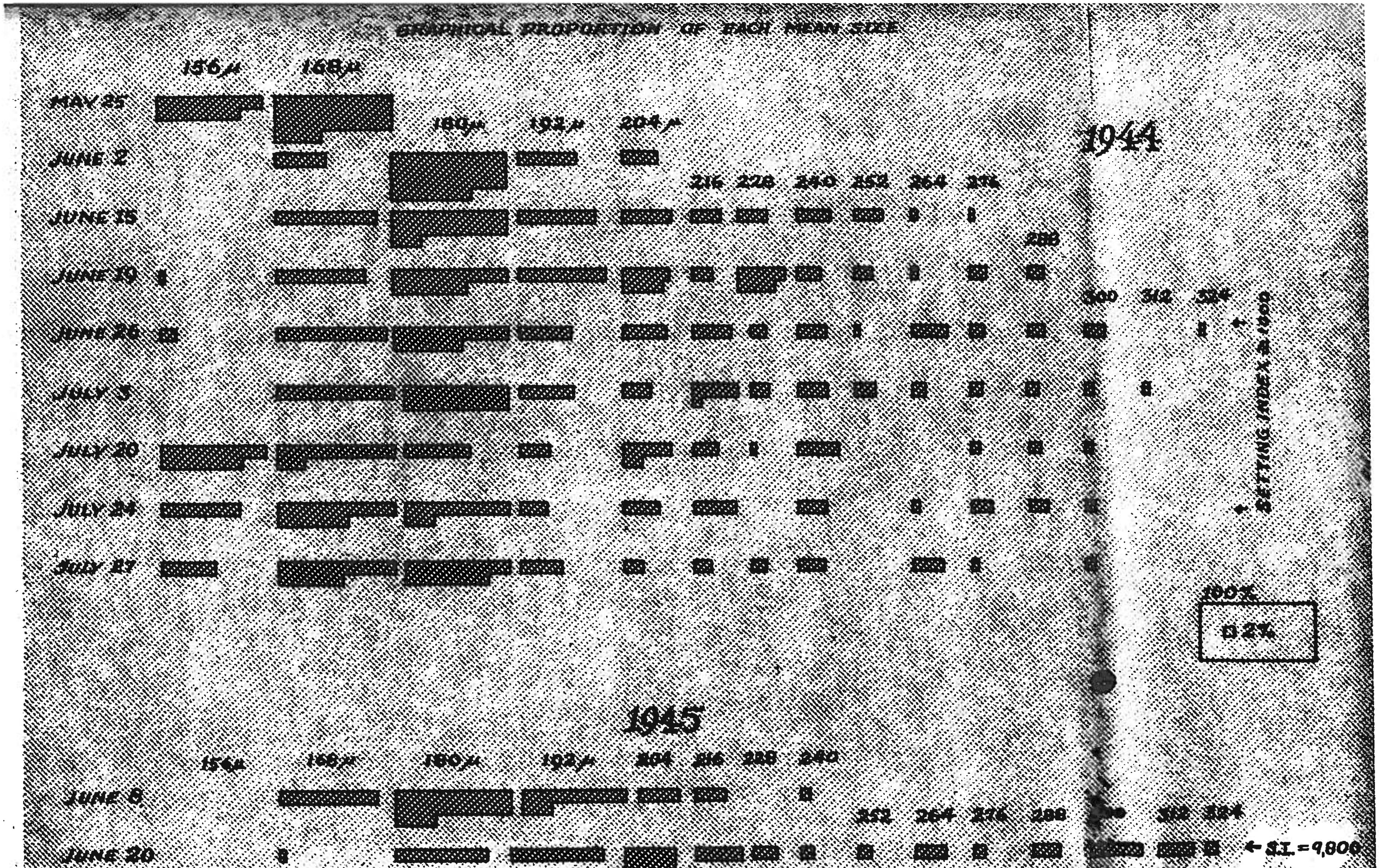


Figure 68 NORTH BAY Distribution of Larvae Size in Dated Plankton Samples during Two Years.

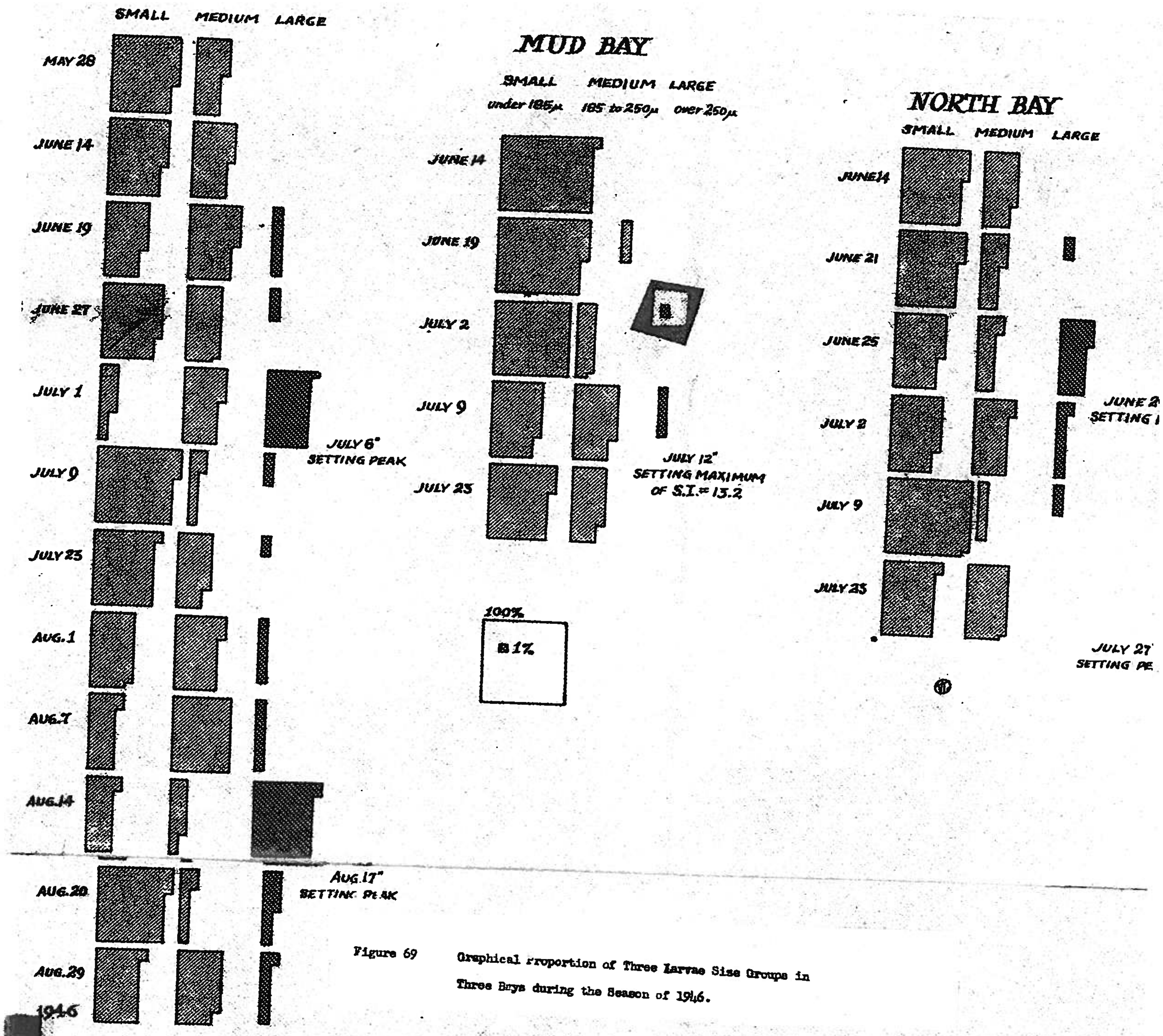


Figure 69 Graphical Proportion of Three Larvae Size Groups in Three Bays during the Season of 1946.

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1st sec. Cut down acknowledgements. (Suggest back of paper anyway)

Consider dividing paper into pieces.

Hopkins sec in acknowledgments. rather than a separate.

Consider "piling" graphs

check inconsistencies in graphs.

P. 14 – put out at or before the initial spotfall –

Olympia Oyster Publications (from "Practical Biol. of Olympia Oyster in Puget Sound")

p. 29
p. 73--- Distribution of pelagic Olympia oyster larvae in Puget Sound

1) What we know concerning vertical distrib'n of larvae.
- including size distribution.
2) Spatting in relation to depth on floating cultch strings
We do not agree with Hopkins in this matter.
3) Tidal cycles in Oyster B, Mud B, & North Bay.
4) Concept of the Larvae Mass.
5) Implications:
a) Regarding design of floating catch racks.
How deep?
Main point is that they should allow circulation of larvae-bearing water.
b) Each bay is a separate, geographically isolated breeding population because the long inlets retain the spawn. Openers can identify them races as to bay of origin.
c) Best cultching ground is under mid-point of oscillation of the Larvae Mass. (Cf. Hopkins's poor up-bay & down-bay catches.
d). Knowledge of the distribution & movement of the larvae is essential to adequate larvae sampling for (1) prediction of intensity of spatting, & (2) understanding an important aspect of the reproductive season.
6) Compare these findings w Korringa's in the Oosterschelde, etc.
7) Importance of transport of larvae to the cultch.
Tests on egg-case fillers laid flat, stringled, & stood upright (p. 38)
Refer also to Hopkins' work on angle of cultch & effectiveness of catch.

p. 41..
p. 57.. Effective seasonal catch of Olympia oysters in Puget Sound

1) The question of saturation of cultch. (p. 41)
2) Difference in survival in different years in relation to Setting Index: eg. good survival w Low S.I. during 1953
3) Mortality of late-caught spat
   a) As shown by regular seasonal strings.
   b) As shown by Tollefson's tests.
   c) Subsequent tests
   d) Description of condition of seasonal shells: a few large, good spat plus multitudes of tiny dead spat.
   e) Relative predation of drills on large & small spat.
4) Cf. Hopkins: discovered second wave of spatting & thought they could be catched w profit.
5) Implications:
   Best catching date is at initial spatfall of season.
6) Possible causes of lack of survival of late-caught spat:
   a) They cannot survive low fall temperatures?
   b) They are more susceptible to predation, smothering & silting?

p.114 <u>Spatting failures of Olympia oysters in a bay of Southern Puget Sound (Mud Bay)</u>

1) The record — an anomaly for the region.
2) Possible explanations:
   a) Abnormal salinity due to rainfall
   b) Tidal heights at time of spatting as affecting transport of larvae to the cultch.
3) Provisional rules for predicting years of spat failure.

p.43 <u>Pests of Olympia oysters in Puget Sound</u>

1) Japanese oyster drill
2) Eastern oyster drill
3) "Keyhole"-producing worm
4) Black-clawed crab
5) Crepidula
6) Moon snail + mud shrimps
7) Shell worm
8) Mytilicola
9) Bryozoa
10) <u>Not</u> the stone crab.

Stages in the reproductive cycle of the Olympia oyster in relation to effective catch of seed oysters.

0) p.52... Methods by which quantitative data were obtained.

1) Records of female-spawning: in a season
   a) Show that some oysters must spawn twice, once as males, again as females ——— as described by Coe for the "California oyster".

2) Proportion spawning bears no relation to effectiveness of catch. (Cf. Korringa also, in Oosterschelde.) This is expected, since it is the number of larvae produced which counts.

3) Abundance of larvae & of large larvae in relation to height of Setting Index.

4) Rate of spatfall (S.I.) in relation to effective seasonal catch.

5) Reproductive performance of the bays during 10 yrs. is shown in quantitative terms: proportion spawning, larvae abundance from year to year, Setting Index, seasonal catch.

p.105 — Empirical rules for predicting time of spawning of Olympia oysters in Puget Sound

2) Description of the formulae
1) Graphs date of beginning spawning in relation to early spring air temperatures.
3) Explain that the empiricism will be removed when, by laboratory experiments, the relation of gonadal ripening to water temperature is defined. The implications of the rules for physiological response are noted, e.g. as long as water temp. is cold enough to inhibit ripening, any further drop in temperature does not "count". completely Discuss Davis' studies on O. lurida