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UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, Secretary

FISH AND WILDLIFE SERVICE
IRA N. GABRIELSON, Director

Special Scientific Report No. 22

STUDIES ON THE PACIFIC PILCHARD OR SARDINE

(SARDINOPS CAERULEA)

6.—Thermal and Diurnal Changes in the Vertical Distribution of Eggs and Larvae

By

Ralph P. Silliman

R. F. SHUMAN

Chicago 1943

Explanatory Note

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6. — Thermal and Diurnal Changes in the Vertical Distribution of Eggs and Larvae[1/]

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Ralph P. Silliman

CONTENTS

	Page
Introduction	1
Methods	1
Period and area covered	1
Classification of material	2
Standardization of hauls	2
Effect of temperature	3
Diurnal changes	4
Summary and conclusions	5
Literature cited	17
Appendix A - Tables of detailed towing data	6
Appendix B - Lists showing time and location of hauls, depths fished, and numbers of eggs and larvae taken	15

1/ This report, without appendix A, was originally published in Sears Foundation: Journal of Marine Research, Vol. V, No. 2, under the title, "Thermal and Diurnal Changes in the Vertical Distribution of Eggs and Larvae of the Pilchard (Sardinops caerulea)." It is reproduced by permission of the editors of that publication.

The original data used were collected as part of a joint program of oceanographic research carried on by the United States Fish and Wildlife Service and the Scripps Institute of Oceanography. Mr. O. E. Sette, in charge of the South Pacific Investigation of the Fish and Wildlife Service, suggested the investigation of the particular problems discussed in this report, and gave much helpful advice. Sorting of the plankton collections was accomplished with the assistance of Works Progress Administration projects Nos. 10917 and 65-2-08-286.

INTRODUCTION

Knowledge of the vertical distribution of pilchard eggs and larvae is of interest from two standpoints: first, in adding to the general knowledge of the early life of this species in the sea; and second, in defining the vertical range of its early stages so that regular surveys of the spawning grounds may be designed to sample all strata in which eggs and larvae are to be found. In reference to the second point it was desired, if possible, to relate vertical distribution to physical characteristics of the sea, so that the depth to which nets must be sent might be predicted. It was felt that the concentration of organisms at a given depth would be controlled chiefly by temperature, density, and light intensity. The analyses described in this paper have been designed to discover and define the relationships between these three variables and the vertical distribution of pilchard eggs and larvae.

METHODS

The field technique employed throughout the experiment was to make at each station successive net hauls, each sampling a layer of water below that of the preceding haul. In 1939, hauls were approximately horizontal. In 1941, however, oblique hauls were adopted to preclude the possibility of missing concentrations of larvae in the gaps between hauls. Each oblique haul extended diagonally from the top of the layer to be sampled by the next haul, to the bottom of the layer sampled by the preceding haul. The "surface" haul was made with an open net, while for the others the net was lowered closed to the desired level, hauled for from 15 to 20 minutes, closed, and brought to the surface.

Closing nets used were identical, except for dimensions and materials, with the one described by Leavitt (1935), and the tripping device was the one figured by him in a later paper (Leavitt, 1938, fig. 2). Sizes of nets and materials used are given in the list of stations at the end of this paper.

Temperatures were taken in 1939 with reversing thermometers, and in 1941 with a bourdon-type bathythermograph modified from the one described by Spilhaus (1940).

Water flow was measured in the 1939 hauls by a meter consisting of an impellor and counter. "Stray angle" (departure of the towing wire from the vertical) was measured with a pendulum protractor.

PERIOD AND AREA COVERED

Stations were located within a radius of 120 miles of San Diego, California, and were in an area somewhat to the south and east of the areas of heaviest pilchard spawning as indicated by other surveys. Four series of hauls were made in April, 1939, and seven in April, May, and June, 1941. Exact locations, dates, and depths fished are given in the list at the end of the paper.

CLASSIFICATION OF MATERIAL

Eggs and larvae were of course treated separately. Also, to take account of the fact that motility increases with size of larvae, these were divided into two categories: "large" and "small". A dividing line of 8 mm. had previously been used in other work, with which it was desired to compare the results of this analysis. Since this line did not split a mode in the length frequency distribution of larvae in the vertical serial hauls, it was retained for the present study.

Some larvae of the "small" group were lost through the meshes of the one-meter nets used. This, however, does not necessarily invalidate comparisons between numbers caught at different levels with the same net, since the loss should be a constant percentage of the total number caught.

STANDARDIZATION OF HAULS

Because of unavoidable variations in the speed of the ship and time of hauling, the amount of water strained by the net varied from haul to haul, even within a single series. These variations were discounted by putting all the hauls in each series on the basis of a standard volume of water strained. For the 1939 hauls, flow of water through the nets was measured directly by a current meter, but for the 1941 hauls, the relative amount was computed from the formula $\frac{W_1}{W_2} = \frac{\tan \angle 1}{\tan \angle 2}$, where $\frac{W_1}{W_2}$ = the ratio between the amounts of water strained for any two hauls, and $\angle 1$ and $\angle 2$ = their respective stray angles. Actual volumes of water strained averaged around 400 cubic meters for the one-meter nets, and 100 cubic meters for the half-meter nets. The numbers of organisms in the hauls were multiplied by factors ($\frac{V_s}{V_h}$, where V_s = standard volume of water and V_h = volume strained in given haul) which made the numbers the same as if the standard volume of water had been strained, and had contained the same concentration of organisms as the water actually strained.

Because of the great range in numbers of organisms (from 6 to 6,000 in a single series of hauls) they could not be represented graphically on the same scale. Since the change in concentration from one series to another was not of interest, but only the changes from haul to haul within a series, the graphing difficulty was overcome by representing each vertical series by a polygon of equal area. To do this, the product of numbers of organisms by thickness of layer sampled was obtained for each haul. These products were summed for each station, and the original counts of organisms were multiplied by factors which made the sum of such products a constant for all stations. Besides overcoming the graphing difficulty, this computation placed the numbers at each level for all of the stations on a comparable basis, permitting direct comparison of catches at different levels even though they were not taken at the same station.

To avoid excessive random variability from small numbers, series containing less than 100 eggs, 50 small larvae, or 5 large larvae, were omitted from the analysis.

In order to construct the polygons mentioned above, it was necessary to compute the average depth for each haul. For the 1939 hauls, when the stray angle was measured two or three times during a haul, the angles were simply averaged and the depth computed from the average angle and the length of the towing wire. In 1941, when angles were measured each minute during a haul, it was possible to construct a plot of the course of each haul, (fig. 1). Average depths were computed from the plots by measuring the area bounded by each one and its baseline, and dividing by the length of the baseline.

EFFECT OF TEMPERATURE

Inspection of the vertical profiles for relative numbers of eggs and larvae, together with the corresponding temperature profiles (fig. 2) indicates a possible relationship between temperature and vertical distribution. Such a relationship could arise as the result of the seeking of an optimum temperature by the larvae, and by the adult fish which lay the eggs. Since pelagic fish eggs tend to remain in water of the same specific gravity as that in which they were fertilized (Walford, 1939), the vertical distribution of eggs should tend to reflect that of the parent fish at the time of spawning. This relationship is complicated by vertical turbulence above the thermocline, which tends to disperse passive bodies like fish eggs.

Whatever the nature of the relationship between temperature and the distribution of pilchard eggs, the larvae may be expected to respond directly to changes in temperature, since they are capable of locomotion. Again the relationship is probably complicated by other factors, such as the amount of fodder organisms present.

To measure the correlation between temperature and concentrations of eggs and larvae, the relative numbers were plotted as regressions on degrees centigrade (fig. 3). Hauls above a depth of 10 meters were omitted because of the reversals in egg and larvae profiles which often occurred in that layer. Also excluded were zero hauls below the first. Inclusion of either of these two categories of hauls would obscure the decrease from the maximum concentrations down to zero, which is the point of chief interest in the regressions in so far as they are to be used in determining the depth of net hauls for regular surveys. Correlation coefficients were .590 for eggs, .557 for small larvae, and .548 for large larvae, corresponding to probabilities of .010, .041, and .024 of chance occurrence. Combining these probabilities by the method of Fisher (1936, p. 105) indicates that the result, as a whole, is highly significent (P = .0009).

Of special interest in the foregoing correlations are the intersections of the computed regression lines with their baselines, since these should indicate the temperature below which we would not expect to find eggs or larvae: The indicated minimum temperatures are 10.5° for eggs, 12.4° for small larvae, and 12.0° for large larvae. Since the regressions for large and small larvae were found by Fisher's (1936 p. 146) "t" test not to differ significantly in slope, they were combined, giving an indicated minimum of 12.0° for both size categories.

DIURNAL CHANGES

To determine the extent and nature of diurnal changes in the vertical distribution of pilchard larvae, two special pairs of serial hauls were run in June, 1941, the first of each pair being occupied around midnight, and the other around noon. Due to unavoidable movements of the vessel the two members of each pair were not located at exactly the same point geographically, but approximately the same position was maintained and they were probably in water of similar characteristics.

One of the chief differences between the night and day hauls was that the former contained many more large larvae than the latter (fig. 4). This could result from any one of three causes: (1) location of the day hauls in an area of lesser concentration than the night hauls, as a result of movement of the ship through the water between the two series; (2) migration of most of the larvae below the levels fished, during the daytime; (3) dodging of the net by the larvae, in the daytime.

The first explanation is a highly improbable one, since the larger catches at night have been observed many times previously, for other plankton organisms and larvae of other species of fish. Also, our regular surveys of the spawning grounds show the night catches of larvae to be consistently larger than the day.

The second explanation has been most widely entertained by others investigating vertical migrations. For instance, it was advanced by E. S. Russel (1928) to explain the larger catches of clupeoid and gobioid larvae at night, but he was later forced to abandon it when subsequent daylight hauls near the bottom (Russel, 1930) did not average larger catches than the ones in the upper layers of water. For our own data, the taking of at least two blank hauls (fig. 4) below those which contained any larvae, argues against the probability of a concentration of larvae below the levels sampled.

Elimination of the first two explanations leaves only the third - dodging of the net in the daytime. Russel (1926) and Johansen (1925) admit this possibility, but doubt that fish larvae could swim fast enough for successful dodging. On this point it may be well to consider how fast it would be necessary for larvae to swim in order to get out of the way of the net. All nets towed in the conventional manner give warning of their approach by means of the piece of line which attaches them to the towing wire. In our gear this line was about 5 meters long, while our average speed of towing was around 50 cm. per second. The larvae would thus have about 10 seconds to swim out of the way. Since the maximum distance they would have to swim would be the radius of the net, or 50 cm., a swimming rate of 5 cm. per second would be sufficient if the direction of swimming were favorable. This does not seem an incredible rate for pilchard larvae of the size in question (over 8 mm. in length). Likewise it does not seem unreasonable that they should swim away from the center of disturbance, and therefore in a direction favorable to escape from the oncoming net.

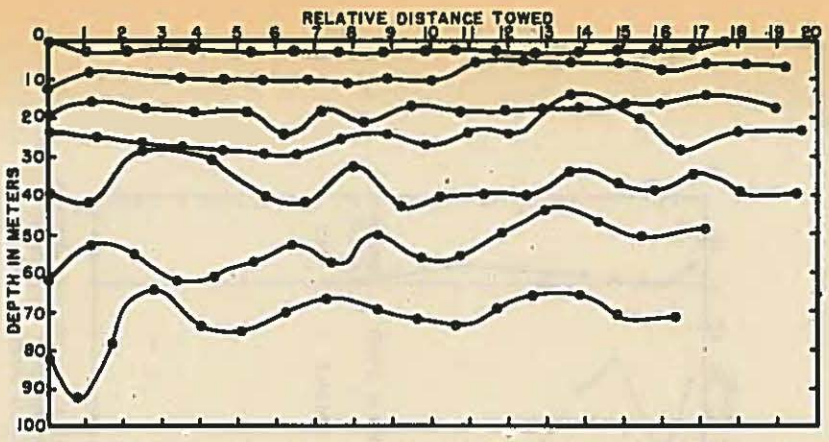

Figure 1. Course of serial hauls for a typical station (No. 2046). "Relative distance was computed from the product of time and average tangent of angle of stray for each one-minute interval of the hauls. Depths were computed from cosine of angle of stray.

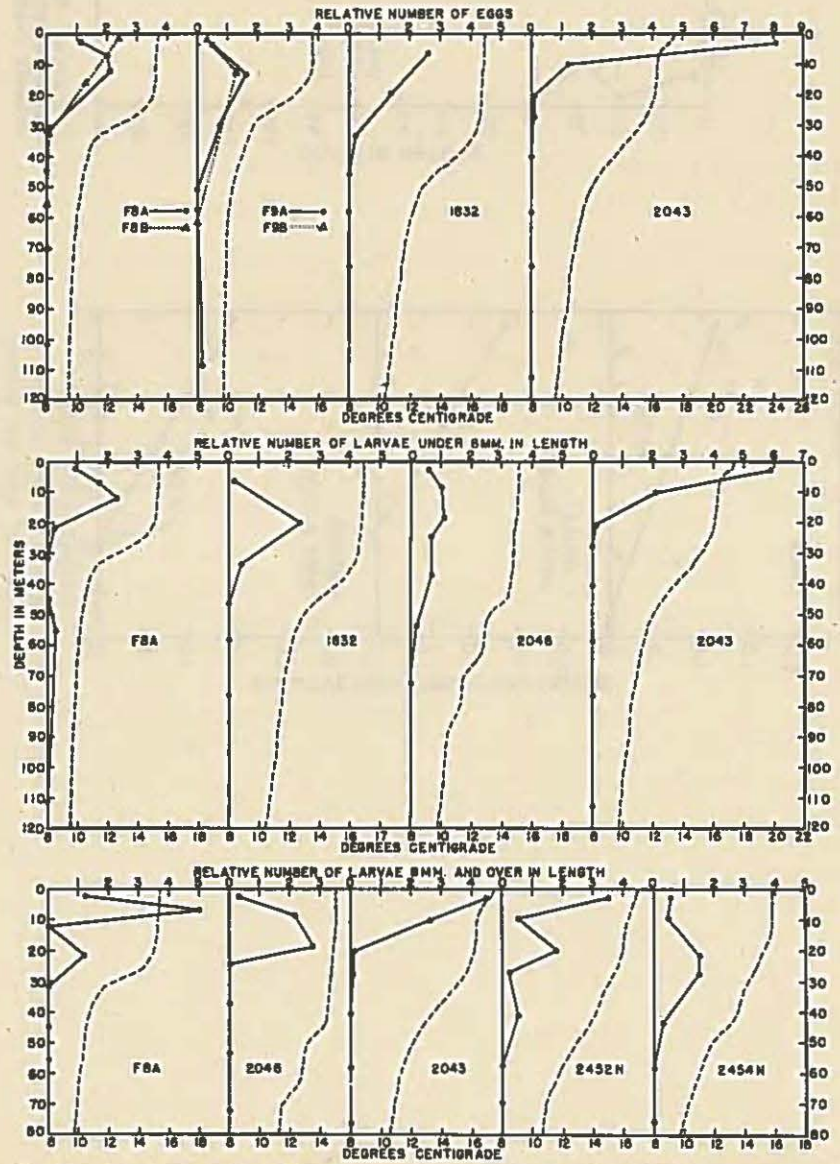

Figure 2. Relative numbers of eggs and larvae taken at each depth. Broken line shows temperature. For the large larvae two series taken around noon have been omitted because of the effect of light. They are shown in figure 4.

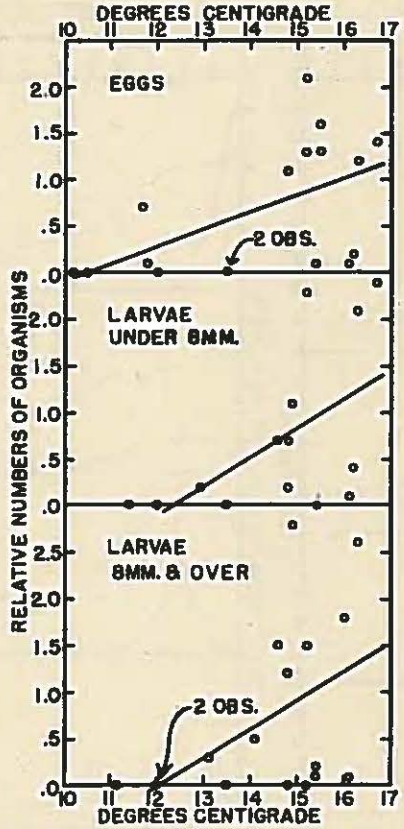

Figure 3. Regressions of numbers of eggs and larvae on temperature. Lines shown are "least squares fits".

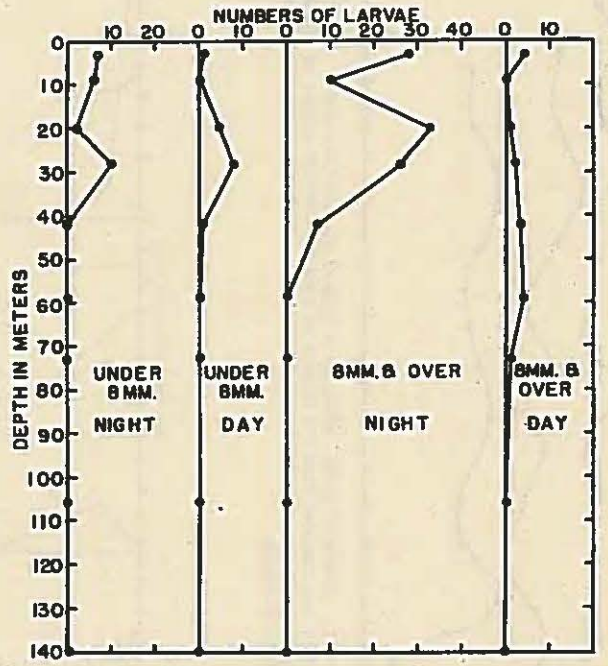

Figure 4. The combined catches of stations 2452 and 2454, comparing day and night hauls at each depth. Numbers represent actual numbers caught.

29940

In the day hauls the large larvae were not only less numerous than in the night hauls, but also appeared to be distributed in somewhat deeper levels. A greater relative number of larvae at the deeper levels in the daytime than at night might result from more successful dodging of the net in the better illuminated upper layers of water. A greater absolute number, however, could result only from downward migration in the daytime, providing the overall concentration were not greater. Such a downward migration might well occur as a result of negative phototropism. Comparison of the night and day hauls for stations 2452 and 2454 (fig. 4) reveals that there actually were more larvae at the deeper levels in the day hauls. Four larvae were taken in the day series at 59 meters, and one at 73 meters, while none were taken at either of these levels in the night series. The significance of these differences was tested by means of Bayes' theorem, (using the formulation of Pearson, 1930, page lxx) considering a success, the presence of a larva at the indicated depth, and assuming the same overall concentration for day and night (in other words assuming that the lesser numbers in the upper layers in the daytime were due to dodging of the net). The computation gave values of P of .06 at 59 meters and .50 at 73 meters. The latter, of course, does not indicate a significant difference between day and night hauls, but the former, closely approaching the conventional significance level of .05, gives some indication of an actually deeper distribution in the daytime.

In applying this result to the prediction of vertical distribution, a knowledge of the penetration of light at various times of day is necessary. Unfortunately, no empirical data for the area of our survey are available, and we are forced to argue by analogy with data collected elsewhere. G. L. Clarke (1934) has shown in his graphs that submarine irradiation in the Atlantic Ocean reaches nearly its maximum value shortly after sunrise, and is maintained there until shortly before sunset. Accordingly, extension of the regular hauls below 73 meters between sunrise and sunset would seem to be necessary in order to make sure of sampling all strata in which larvae were to be found.

SUMMARY AND CONCLUSIONS

Analysis of catches of pilchard eggs and larvae taken in serial hauls in 1939 and 1941 indicates the following relationships and effects:

1. A positive correlation of concentrations of eggs and larvae with temperature, at least within the range of 10° to 17° C.

2. An apparent dodging of the nets by the larger larvae, in the layers of water which are illuminated in the daytime.

3. A negative phototropism for the larger larvae.

Such relationships with physical conditions as have been indicated by the present study may, of course, hold true only for the particular set of oceanographic conditions prevailing at the times and places where the data were gathered. For instance, the relationship between the horizontal distribution of pilchard eggs and temperature as indicated by our regular spawning surveys for 1941 was quite different from that found in 1940.

However, the data for the present study were gathered in two different years (1939 and 1941) and over a considerable area, so that they may permit of some generalization.

It may have been noted that the concentrations of eggs and larvae are correlated with depth as well as temperature, since the latter two are themselves highly correlated. However, there are some instances where the deeper extension of warm water corresponds with a deeper distribution of eggs or larvae (cf. fig. 2). Also, there is some logical basis for a correlation with temperature, which might act either as the cause of direct reaction of the larvae, or as an indicator of density differences affecting the distribution of eggs.

It is not intended to argue that temperature itself necessarily controls the vertical distribution of pilchard eggs and larvae. Their location may be determined by complex reactions of the spawners to a combination of physical conditions, including salinity, food, density, etc. To the extent that these would induce spawning in a homologous portion of the layer of water above the thermocline, temperature may be merely an indicator and not a cause. This, of course, does not detract from the usefulness of temperature as a guide to vertical distribution.

As a basis for predicting the proper depths to which to send nets on regular surveys, the regressions of egg and larvae concentrations on temperature indicate that hauls should be made deep enough to go below temperatures of 10.5° C. for eggs and 12.0° for larvae. Distribution of the large larvae during the daytime shows the need for fishing to a depth greater than 73 meters between sunrise and sunset.

APPENDIX A

TABLES OF DETAILED TOWING DATA

Explanation of tables: The hauls at each station and the observations during each haul are arranged chronologically and numbered consecutively, beginning with one. Time is ship's time, with hours numbered from 1 for 1:a.m. to 24 for midnight. Meters of wire out (m. out) refers to the length of towing wire from the surface of the sea to the point of attachment of the net. The stray angle (°/) is the departure of the towing wire from the vertical, expressed in degrees. A dash (-) represents a missing observation.

Table 1.--Towing data for Station F8A, April 19, 1939. (See page 6 for explanation.)

Observation number	Haul number 1			2			3			4			5			6			7			8		
	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠
1	3:25	3	-	4:15	10	-	4:46	20	-	5:14	30	-	5:51	40	-	6:30	60	-	7:16	90	-	9:24	150	-
2	3:41	3	-	4:16	10	47	4:47	20	35	5:15	30	40	5:52	40	40	6:32	60	40	7:17	90	48	9:25	150	42
3				4:20	10	35	4:50	20	70	5:17	30	35	5:57	40	42	6:39	60	42	7:21	90	60	9:30	150	40
4				4:25	10	52	4:56	20	55	5:22	30	55	6:01	40	32	6:42	60	43	7:27	90	48	9:39	150	44
5				4:29	10	50	5:01	20	-	5:29	30	-	6:08	40	-	6:45	60	-	7:32	90	-			
6				4:30	10	-																		

Table 2.--Towing data for Station F8B, April 19, 1939. (See page 6 for explanation.)

Observation number	Haul number 1			2			3			4			5			6		
	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠
1	15:18	2	-	15:44	20	32	16:12	40	30	16:44	70	-	17:16	100	-	18:55	200	-
2	15:33	2	-	15:52	20	40	16:20	40	44	16:45	70	41	17:18	100	44	18:56	200	31
3				15:59	20	-	16:28	40	-	16:50	70	34	17:23	100	47	19:00	200	24
4										17:02	70	-	17:32	100	-	19:05	200	35
5																19:12	200	-

Table 3.--Towing data for Station F9A, April 20, 1939. (See page 6 for explanation.)

Observation number	Haul number 1			2			3			4			5			6		
	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠
1	2:20	5	-	2:51	20	-	4:03	40	-	4:53	70	-	5:37	100	-	7:28	200	-
2	2:37	5	-	2:53	20	45	4:05	40	45	4:56	70	36	5:40	100	56	7:31	200	57
3				2:59	20	53	4:15	40	37	5:08	70	50	5:49	100	54	7:50	200	-
4				3:09	20	-	4:21	40	-				5:52	100	-			

Table 4.—Towing data for Station F9B, April 20, 1939. (See page 6 for explanation.)

Observation number	Haul number 1			Haul number 2			Haul number 3			Haul number 4		
	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠
1	8:46	2	:-	9:13	20	:-	10:52	100	:-	12.45	200	:-
2	8:57	2	:-	9:17	20	:48	10:53	100	:49	12:46	200	:51
3				9:28	20	:-	11:02	100	:55	12:57	200	:42
4							11:09	100	:-	13:02	200	:-

Table 5.—Towing data for Station 1832, April 10, 1941. (See page 6 for explanation.)

Observation number	Haul number 1			Haul number 2			Haul number 3			Haul number 4			Haul number 5			Haul number 6		
	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠
1	11:09	15	:30	12:38	30	:43	13:13	45	:36	13:49	60	:23	14:26	75	:28	14:59	100	:36
2	11:11	14	:48	12:40	29	:27	13:15	44	:28	13:51	59	:31	14:28	74	:34	15:01	98	:38
3	11:13	12	:40	12:42	28	:27	13:17	43	:34	13:53	58	:30	14:30	73	:37	15:03	97	:32
4	11:15	10	:27	12:44	27	:51	13:19	42	:26	13:55	57	:31	14:32	72	:33	15:05	96	:30
5	11:17	9	:47	12:46	26	:30	13:21	41	:36	13:57	56	:27	14:34	71	:32	15:07	94	:40
6	11:19	8	:26	12:48	25	:39	13:23	40	:29	13:59	55	:35	14:36	70	:37	15:09	92	:28
7	11:21	6	:32	12:50	24	:18	13:25	39	:26	14:01	54	:33	14:38	69	:34	15:11	91	:30
8	11:23	4	:30	12:52	23	:42	13:27	38	:34	14:03	53	:36	14:40	68	:31	15:13	90	:28
9	11:25	3	:33	12:54	22	:33	13:29	37	:39	14:05	52	:30	14:42	67	:31	15:15	88	:38
10	11:27	2	:28	12:56	21	:34	13:31	36	:27	14:07	51	:35	14:43	66	:-	15:17	86	:32
11	11:29	0	:-	12:58	20	:31	13:33	35	:37	14:09	50	:34	14:46	65	:36	15:19	85	:34
12	11:30	0	:-	13:01	20	:-	13:34	35	:-	14:10	50	:-	14:47	65	:-	15:20	85	:-

Table 6.--Towing data for Station 2046, April 30, 1941. (See page 6 for explanation.)

Observation number	Haul number 1			Haul number 2			Haul number 3			Haul number 4			Haul number 5			Haul number 6			Haul number 7		
	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠
1	17:10	0	42	17:38	15	37	18:08	25	41	18:38	40	54	19:35	60	48	20:04	85	43	20:32	110	42
2	17:11	4	48	17:39	15	57	18:09	30	52	18:39	40	-	19:36	60	45	20:05	85	51	20:33	110	33
3	17:12	4	56	17:40	15	50	18:10	30	-	18:40	40	48	19:37	60	62	20:06	85	50	20:34	110	45
4	17:13	4	60	17:41	15	47	18:11	30	51	18:41	40	45	19:38	60	59	20:07	85	43	20:35	110	54
5	17:14	4	49	17:42	15	46	18:12	30	35	18:42	40	46	19:39	60	48	20:08	85	45	20:36	110	47
6	17:15	4	48	17:43	15	50	18:13	30	53	18:43	40	44	19:40	60	46	20:09	85	47	20:37	110	47
7	17:16	4	49	17:44	15	40	18:14	30	43	18:44	40	43	19:41	60	57	20:10	80	48	20:38	105	48
8	17:17	4	54	17:45	15	52	18:15	30	55	18:45	40	52	19:42	60	44	20:11	80	44	20:39	105	50
9	17:18	4	34	17:46	15	40	18:16	30	50	18:46	40	52	19:43	60	48	20:12	80	50	20:40	105	48
10	17:19	4	42	17:47	10	54	18:17	25	44	18:47	35	40	19:44	60	50	20:13	80	45	20:41	105	47
11	17:20	4	48	17:48	10	-	18:18	25	47	18:48	35	48	19:45	55	44	20:14	80	46	20:42	105	45
12	17:21	4	47	17:49	10	50	18:19	25	44	18:49	35	44	19:46	55	52	20:15	75	48	20:43	100	46
13	17:22	4	44	17:50	10	54	18:20	25	48	18:50	35	66	19:47	55	47	20:16	75	54	20:44	100	48
14	17:23	4	46	17:51	10	41	18:21	25	46	18:51	35	56	19:48	55	45	20:17	75	50	20:45	100	48
15	17:24	4	43	17:52	10	52	18:22	25	53	18:52	35	36	19:49	55	51	20:18	75	47	20:46	100	44
16	17:25	4	47	17:53	10	42	18:23	25	45	18:53	35	49	19:50	55	44	20:19	75	49	20:48	100	-
17	17:26	0	-	17:54	10	45	18:24	25	-	18:54	35	-	19:51	55	-						

Table 7.--Towing data for Station 2043, May 2, 1941. (See page 6 for explanation.

Observation number	Haul number 1			2			3			4			5			6			7			8		
	Time	m. out	° ∠	Time	m. out	° ∠	Time	m. out	° ∠	Time	m. out	° ∠	Time	m. out	° ∠	Time	m. out	° ∠	Time	m. out	° ∠	Time	m. out	° ∠
1	19:58	0	39	20:30	15	33	20:58	30	30	21:24	40	50	21:51	60	28	22:22	85	38	22:52	110	27	23:41	160	33
2	19:59	4	35	20:31	15	49	20:59	30	46	21:25	40	49	21:52	60	35	22:23	85	31	22:53	110	31	23:42	160	41
3	20:00	4	47	20:32	15	30	21:00	30	39	21:26	40	40	21:53	60	44	22:24	85	38	22:54	110	40	23:43	160	45
4	20:02	4	27	20:33	15	35	21:01	30	38	21:27	40	35	21:54	60	31	22:25	85	47	22:55	110	46	23:44	160	46
5	20:03	4	45	20:34	15	43	21:02	30	41	21:28	40	47	21:55	60	32	22:26	85	52	22:56	110	49	23:45	160	38
6	20:04	4	45	20:35	15	43	21:03	30	41	21:29	40	41	21:56	60	36	22:27	85	40	22:57	110	44	23:46	160	41
7	20:05	4	34	20:36	15	43	21:04	30	45	21:30	40	36	21:57	60	46	22:28	80	37	22:58	105	46	23:47	150	42
8	20:06	4	22	20:37	15	44	21:05	30	42	21:31	40	39	21:58	60	54	22:29	80	45	22:59	105	46	23:48	150	43
9	20:07	4	30	20:38	15	43	21:06	30	40	21:32	40	48	21:59	60	60	22:30	80	49	23:00	105	49	23:49	150	47
10	20:08	4	38	20:39	10	38	21:07	25	37	21:33	35	44	22:00	55	44	22:31	80	45	23:01	105	43	23:50	150	45
11	20:09	4	35	20:40	10	43	21:08	25	38	21:34	35	36	22:01	55	26	22:32	80	48	23:02	105	44	23:51	150	19
12	20:10	4	38	20:41	10	34	21:09	25	41	21:35	35	35	22:02	55	47	22:33	75	43	23:03	100	43	23:52	140	30
13	20:11	4	37	20:42	10	45	21:10	25	41	21:36	35	43	22:03	55	48	22:34	75	30	23:04	100	47	23:53	140	42
14	20:12	4	46	20:43	10	42	21:11	25	40	21:37	35	44	22:04	55	27	22:35	75	45	23:05	100	44	23:54	140	46
15	20:13	0	-	20:44	10	24	21:12	25	44	21:38	35	39	22:05	55	42	22:36	75	45	23:06	100	36	23:55	140	41
16				20:45	10	45	21:13	25	48	21:39	35	42	22:06	55	52	22:37	75	-	23:08	100	-	23:56	140	-
17				20:46	10	-	21:14	25	-	21:40	35	-	22:08	55	-									

Table 8.—Towing data for Station 2452N, June 17-18, 1941. (See page 6 for explanation.)

Observation number	Haul number 1			2			3			4			5			6			7			8		
	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠
1	22:07	0	-	23:10	15	37	23:44	30	40	24:28	35	20	1:03	60	30	1:36	85	10	2:14	110	23	3:04	160	24
2	22:08	4	50	23:11	15	38	23:45	30	44	24:29	35	30	1:04	60	37	1:37	85	-	2:15	110	38	3:05	160	28
3	22:09	4	38	23:12	15	46	23:46	30	45	24:30	35	48	1:05	60	49	1:38	85	38	2:16	110	53	3:06	160	47
4	22:10	4	44	23:13	15	43	23:47	30	40	24:31	35	48	1:06	60	48	1:39	85	52	2:17	110	50	3:07	160	54
5	22:11	4	42	23:14	15	40	23:48	30	40	24:32	35	40	1:07	60	47	1:40	85	47	2:18	110	49	3:08	160	50
6	22:12	4	42	23:15	15	40	23:49	30	39	24:33	35	39	1:08	60	43	1:41	85	45	2:19	110	52	3:09	160	54
7	22:13	4	40	23:16	15	45	23:50	30	36	24:34	35	46	1:09	60	45	1:42	80	45	2:20	105	53	3:10	150	50
8	22:14	4	40	23:17	15	45	23:51	30	45	24:35	35	45	1:10	60	48	1:43	80	45	2:21	105	48	3:11	150	49
9	22:15	4	40	23:18	15	44	23:52	30	45	24:36	35	43	1:11	60	46	1:44	80	47	2:22	105	45	3:12	150	52
10	22:16	4	40	23:19	10	36	23:53	25	40	24:37	40	41	1:12	55	41	1:45	80	45	2:23	105	46	3:13	150	45
11	22:17	4	38	23:20	10	34	23:54	25	40	24:38	40	47	1:13	55	44	1:46	80	43	2:24	105	51	3:14	150	49
12	22:18	4	38	23:21	10	35	23:55	25	43	24:39	40	45	1:14	55	46	1:47	75	37	2:25	100	51	3:15	140	47
13	22:19	4	40	23:22	10	45	23:56	25	44	24:40	40	48	1:15	55	47	1:48	75	37	2:26	100	54	3:16	140	45
14	22:20	4	38	23:23	10	45	23:57	25	48	24:41	40	46	1:16	55	49	1:49	75	46	2:27	100	55	3:17	140	46
15	22:21	4	40	23:24	10	42	23:58	25	50	24:42	40	45	1:17	55	47	1:50	75	50	2:28	100	48	3:18	140	50
16	22:22	4	40	23:25	10	45	23:59	25	52	24:43	40	44	1:18	55	43	1:51	75	45	2:29	100	44	3:19	140	49
17	22:24	0	-	23:26	10	42	24:01	25	-	24:44	40	42	1:19	55	45	1:52	75	25	2:31	100	23	3:21	140	24
18				23:27	10	—	24:02	25	15	24:45	40	28	1:20	55	31									

Table 9.—Towing data for Station 2452D, June 18, 1941. (See page 6 for explanation.)

Observation number	Haul number 1			2			3			4			5			6			7			8			9		
	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠
1	8:58	0	37	9:35	15	39	10:05	30	51	10:35	40	25	11:05	60	45	11:38	85	45	12:14	110	45	13:02	160	19	13:43	210	42
2	8:59	4	33	9:36	15	41	10:06	30	46	10:36	40	30	11:06	60	45	11:39	85	50	12:15	110	46	13:03	160	41	13:44	210	48
3	9:00	4	38	9:37	15	45	10:07	30	45	10:37	40	40	11:07	60	44	11:40	85	47	12:16	110	46	13:04	160	51	13:45	210	48
4	9:01	4	40	9:38	15	44	10:08	30	50	10:38	40	47	11:08	60	46	11:41	85	41	12:17	110	45	13:05	160	53	13:46	210	46
5	9:02	4	38	9:39	15	50	10:09	30	54	10:39	40	44	11:09	60	45	11:42	85	40	12:18	110	48	13:06	160	47	13:47	210	46
6	9:03	4	45	9:40	15	43	10:10	30	45	10:40	40	35	11:10	60	47	11:43	85	38	12:19	110	49	13:07	160	46	13:48	210	48
7	9:04	4	44	9:41	15	40	10:11	30	42	10:41	40	42	11:11	60	46	11:44	85	43	12:20	105	47	13:08	150	43	13:49	200	50
8	9:05	4	35	9:42	15	41	10:12	30	43	10:42	40	47	11:12	60	45	11:45	80	43	12:21	105	44	13:09	150	44	13:50	200	51
9	9:06	4	40	9:43	15	42	10:13	30	50	10:43	40	40	11:13	60	44	11:46	80	43	12:22	105	48	13:10	150	46	13:51	200	47
10	9:07	4	45	9:44	10	34	10:14	25	46	10:44	40	34	11:14	55	44	11:47	80	41	12:23	105	50	13:11	150	46	13:52	200	43
11	9:08	4	42	9:45	10	41	10:15	25	41	10:45	40	37	11:15	55	47	11:48	80	44	12:24	105	49	13:12	150	42	13:53	200	43
12	9:09	4	42	9:46	10	53	10:16	25	44	10:46	40	45	11:16	55	45	11:49	75	41	12:25	105	45	13:13	140	45	13:54	190	46
13	9:10	4	43	9:47	10	43	10:17	25	56	10:47	35	44	11:17	55	47	11:50	75	42	12:26	100	47	13:14	140	46	13:55	190	48
14	9:11	4	45	9:48	10	40	10:18	25	51	10:48	35	39	11:18	55	45	11:51	75	45	12:27	100	45	13:15	140	47	13:56	190	45
15	9:12	4	45	9:49	10	51	10:19	25	43	10:49	35	39	11:19	55	43	11:52	75	46	12:28	100	45	13:16	140	45	13:57	190	45
16	9:13	4	35	9:50	10	46	10:20	25	37	10:50	35	40	11:20	55	43	11:53	75	46	12:29	100	46	13:17	140	46	13:58	190	43
17	9:14	0	–	9:51	10	44	10:21	25	42	10:51	35	39	11:21	55	44	11:56	75	–	12:30	100	46	13:19	140	38	14:00	190	37
18				9:52	10	–	10:22	25	–	10:53	35	–	11:23	55	–				12:32	100	36						

Table 10.—Towing data for Station 2454N, June 18-19, 1941. (See page 6 for explanation.)

Observation number	Haul number 1			2			3			4			5			6			7			8			9		
	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠	Time	m. out	∠
1	21:08	0:50	21:37	15:37	22:08	30:40	22:39	40:37	23:12	60:30	23:44	85:42	24:20	110:10	24:59	160:21	1:39	210:8									
2	21:09	4:15	21:38	15:35	22:09	30:40	22:40	40:40	23:13	60:37	23:45	85:45	24:21	110:35	1:00	160:45	1:40	210:38									
3	21:10	4:23	21:39	15:30	22:10	30:42	22:41	40:40	23:14	60:45	23:46	85:44	24:22	110:44	1:01	160:47	1:41	210:52									
4	21:11	4:34	21:40	15:45	22:11	30:38	22:42	40:40	23:15	60:50	23:47	85:37	24:23	110:45	1:02	160:44	1:42	210:54									
5	21:12	4:35	21:41	15:42	22:12	30:38	22:43	40:42	23:16	60:46	23:48	85:38	24:24	110:40	1:03	160:42	1:43	210:48									
6	21:13	4:35	21:42	15:43	22:13	30:35	22:44	40:42	23:17	60:36	23:49	85:38	24:25	110:46	1:04	160:45	1:44	210:46									
7	21:14	4:40	21:43	15:34	22:14	30:36	22:45	40:44	23:18	60:30	23:50	80:42	24:26	105:45	1:05	150:47	1:45	200:46									
8	21:15	4:50	21:44	15:35	22:15	30:37	22:46	40:45	23:19	60:33	23:51	80:47	24:27	105:47	1:06	150:47	1:46	200:48									
9	21:16	4:41	21:45	15:42	22:16	30:42	22:47	40:45	23:20	60:40	23:52	80:50	24:28	105:46	1:07	150:45	1:47	200:41									
10	21:17	4:43	21:46	10:37	22:17	25:38	22:48	35:44	23:21	55:43	23:53	80:47	24:29	105:40	1:08	150:44	1:48	200:36									
11	21:18	4:48	21:47	10:40	22:18	25:30	22:49	35:45	23:22	55:37	23:54	80:45	24:30	105:38	1:09	150:45	1:49	200:38									
12	21:19	4:37	21:48	10:42	22:19	25:35	22:50	35:46	23:23	55:33	23:55	75:44	24:31	100:48	1:10	140:40	1:50	190:42									
13	21:20	4:40	21:49	10:45	22:20	25:40	22:51	35:46	23:24	55:38	23:56	75:42	24:32	100:47	1:11	140:41	1:51	190:44									
14	21:21	4:44	21:50	10:30	22:21	25:40	22:52	35:42	23:25	55:44	23:57	75:40	24:33	100:43	1:12	140:50	1:52	190:50									
15	21:22	4:43	21:51	10:42	22:22	25:42	22:53	35:42	23:26	55:44	23:58	75:43	24:34	100:45	1:13	140:47	1:53	190:46									
16	21:23	0:-	21:52	10:40	22:23	25:40	22:54	35:45	23:27	55:40	23:59	75:40	24:35	100:49	1:14	140:44	1:54	190:44									
17			21:53	10:44	22:24	25:44	22:55	35:46	23:28	55:44	24:00	75:39	24:36	100:20	1:16	140:9	1:56	190:16									
18			21:54	10:40	22:25	25:43	22:56	35:46	23:30	55:46																	

Table 11.—Towing data for Station 2454D, June 19, 1941. (See page 6 for explanation.)

Observation number	Haul number 1			2			3			4			5			6			7			8			9		
	Time	m. out	° ′	Time	m. out	° ′	Time	m. out	° ′	Time	m. out	° ′	Time	m. out	° ′	Time	m. out	° ′	Time	m. out	° ′	Time	m. out	° ′	Time	m. out	° ′
1	8:26	0	30	8:50	15	20	9:16	30	32	9:43	40	25	10:10	60	40	10:37	85	40	11:09	110	48	11:44	160	41	12:28	210	19
2	8:27	4	38	8:51	15	32	9:17	30	44	9:44	40	35	10:11	60	45	10:38	85	42	11:10	110	49	11:45	160	44	12:29	210	26
3	8:28	4	50	8:52	15	48	9:18	30	50	9:45	40	52	10:12	60	43	10:39	85	45	11:11	110	46	11:46	160	45	12:30	210	38
4	8:29	4	42	8:53	15	44	9:19	30	42	9:46	40	40	10:13	60	41	10:40	85	42	11:12	110	45	11:47	160	46	12:31	210	38
5	8:30	4	44	8:54	15	40	9:20	30	34	9:47	40	30	10:14	60	45	10:41	85	36	11:13	110	45	11:48	160	45	12:32	210	43
6	8:31	4	46	8:55	15	44	9:21	30	32	9:48	40	40	10:15	60	43	10:42	85	38	11:14	110	44	11:49	160	47	12:33	210	42
7	8:32	4	42	8:56	15	45	9:22	30	40	9:49	40	43	10:16	60	38	10:43	80	42	11:15	105	46	11:50	150	43	12:34	200	44
8	8:33	4	44	8:57	15	40	9:23	30	45	9:50	40	45	10:17	60	42	10:44	80	46	11:16	105	41	11:51	150	43	12:35	200	47
9	8:34	4	44	8:58	15	42	9:24	30	45	9:51	40	44	10:18	60	44	10:45	80	44	11:17	105	38	11:52	150	40	12:36	200	52
10	8:35	4	42	8:59	10	44	9:25	25	35	9:52	35	35	10:19	55	47	10:46	80	40	11:18	105	37	11:53	150	40	12:37	200	49
11	8:36	4	35	9:00	10	45	9:26	25	45	9:53	35	45	10:20	55	49	10:47	80	38	11:19	105	45	11:54	150	42	12:38	200	51
12	8:37	4	43	9:01	10	47	9:27	25	47	9:54	35	48	10:21	55	46	10:48	80	44	11:20	100	46	11:55	140	43	12:39	190	51
13	8:38	4	44	9:02	10	45	9:28	25	44	9:55	35	48	10:22	55	38	10:49	75	45	11:21	100	41	11:56	140	45	12:40	190	43
14	8:39	4	37	9:03	10	42	9:29	25	43	9:56	35	47	10:23	55	35	10:50	75	42	11:22	100	35	11:57	140	41	12:41	190	40
15	8:40	4	45	9:04	10	45	9:30	25	40	9:57	35	44	10:24	55	34	10:51	75	36	11:23	100	35	11:58	140	44	12:42	190	40
16	8:41	0	—	9:05	10	46	9:31	25	32	9:58	35	38	10:25	55	45	10:52	75	38	11:24	100	40	11:59	140	41	12:43	190	49
17				9:06	10	47	9:32	25	33	9:59	35	32	10:26	55	42	10:53	75	46	11:26	100	46	12:02	140	35	12:45	190	33
18				9:07	10	47	9:34	25	34	10:00	35	40	10:27	55	37												

A P P E N D I X B

LISTS SHOWING TIME AND LOCATION OF HAULS, DEPTHS FISHED, AND NUMBERS OF EGGS AND LARVAE TAKEN

Data are given in the following order: Station number; date; time interval; latitude; longitude; type of net; depth interval for each haul; numbers of eggs; length and number of larvae for larvae of each .5 mm. interval of length. Time of day is given to the nearest hour with the hours numbered consecutively from 1 for 1 a.m. to 24 for midnight. Depths are in meters and lengths of larvae in millimeters.

Example: (Station) 1832; (Month) 4/ (Day) 10/ (Year) 41; (Start) 11h- (End) 15h: (North latitude) 33:13; (West longitude) 118:26; (Type of net) B; (Upper limit of stratum fished, depth) 0- (Lower limit of stratum fished, depth) 13: (Number of eggs taken) E 181; (Larvae) L: (Length) 2.5, (Number) 3; (Length) 3.0, (Number) 35; (length) 3.5, (Number) 4; (Limits) 17-26: (Number of eggs) E 103: (Larvae) L: (Length) 2.5, (Number) 22; (Length) 3.0, (Number) 366; etc.

Net types are as follows: Type A is a closing net of one meter diameter mouth; made of No. 24XXX grit gauze, with the last half meter of No. 56XXX grit gauze; and with a detachable "cod end" of No. 56XXX grit gauze. Type B is a closing net of one-half meter diameter mouth; made of No. 40XXX grit gauze, with the last 65cm. of No. 56XXX grit gauze. Type C is a closing net of one meter diameter of mouth; made of cotton scrim with openings approximately 1 mm. square, with the last half meter of No. 56XXX grit gauze; and with detachable "cod end" of No. 56XXX grit gauze. Approximate sizes of openings of XXX grit gauzes are: No. 24, 1.10 mm.; No. 40, .65 mm.; No. 56, .47 mm.

F8A; 4/19/39; 3h-9h; 32:48, 117:42; A; 0-3: E 1877; L: 4.0, 1; 4.5,1; 5.0,4; 5.5,2; 7.0,2; 8.0,1; 9.5,1; 6-8: E 2879; L: 4.0,1; 4.5,3; 5.0,7; 6.0,1; 6.5,2; 7.0,1; 7.5,1; 8.0,2; 9.0,2; 10.0,1; 10.5,1; 7-16: E 3878; L: 3.0,2; 3.5,1; 4.0,3; 4.5,8; 5.0,9; 5.5,2; 6.0,2; 17;25: E 1265; L: 5.0,1; 8.0,1; 30-34: E 56; L: 0; 44-46: E 5; L: 0; 45-60: E 0; L: 4.5,2; 108-115: E 6; L: 0.

F8B; 4/19/39; 15h-19h; 32:48, 117:44; A; 0-2: E 2892; L: 5.5,1; 6.5,1; 7.0,1; 15-17: E 1359; L: 3.5,1; 4.5,1; 29-35: E 88; L: 0; 53-58: E 8; L: 0; 68-72: E 0; L: 0; 164-183: E 4; L: 0.

F9A; 4/20/39; 2h-8h; 32:30, 117,32; A; 0-5: E 52; L: 3.5,6; 4.0,1; 4.5,2; 5.0,4; 5.5,6; 6.0,1; 6.5,3; 7.0,2; 12-14: E 194; L: 6.0,1; 28-32: E 54; L: 0; 45-57: E 1; L: 6.0,1; 56-59: E 1; L: 0; 109-*: E 7; L: 0.

F9B; 4/20/39; 9h-13h; 32:29, 117:39; A; 0-2: E 940: L: 5.5,2; 6.0,4; 6.5,5; 7.0,7; 8.0,3; 8.5,1; 9.0,1; 9.5,2; 10.0,1; 11.0,1; 14-*: E 4137; L: 3.5,1; 4.0,6; 5.0,1; 6.0,1; 57-66: E 6; L: 0; 126-149: E 4; L: 0.

*Only one stray angle reading.

1832; 4/10/41; 11h-15h; 33:13, 118:26; B; 0-13: E 181; L: 2.5,3; 3.0,35; 3.5,4; 17-26: E 103; L: 2.5,22; 3.0,366; 3.5,187; 4.0,2; 4.5,6; 5.5,1; 28-39: E 11; L: 2.5,1; 3.0,47; 3.5,31; 4.0,2; 4.5,6; 5.0,2; 41-55: E 0; L: 0; 53-66: E 0; L: 3.0,2; 3.5,2; 69-83: E 0; L: 2.5,1; 3.5,1; 5.0,1.

2046; 4/30/41; 17h-21h; 32:29, 119:26; B; 0-3: E 0; L: 3.0, 3; 3.5,3; 4.0,1; 4.5,2; 5.0,33; 5.5,36; 6.0,9; 6.5,1; 7.0,1; 9.5,1; 6-12: E 0; L: 3.5,2; 4.0,2; 4.5,2; 5.0,31; 5.5,51; 6.0,55; 6.5,20; 7.0,3; 7.5,4; 8.0,2; 8.5,2; 9.0,1; 9.5,1; 10.0,2; 14.0,1; 15-25: E 0; L: 2.5,1; 3.0,1; 3.5,2; 4.0,1; 4.5,3; 5.0,27; 5.5,37; 6.0,74; 6.5,23; 7.0,9; 7.5,5; 8.0,5; 8.5,2; 9.0,2; 9.5,2; 10.5,1; 14-29: E 0; L: 3.0,2; 3.5,11; 4.0,11; 4.5,12; 5.0,38; 5.5,29; 6.0,15; 6.5,3; 28-43: E 0; L: 2.5,3; 3.0,19; 3.5,30; 4.0,16; 4.5,11; 5.0,25; 5.5,3; 6.0,6; 6.5,3; 7.5,1; 44-62: E 3; L: 2.5,1; 3.0,13; 3.5,11; 4.0,4; 4.5,1; 5.0,1; 65-92: E 18; L: 6.0,1.

2043; 5/2/41; 20h-24h; 32:50, 118:18; C; 0-4: E 90; L: 3.0,1; 5.0,20; 5.5,30; 6.0,32; 6.5,20; 7.0,38; 7.5,43; 8.0,53; 8.5,48; 9.0,33; 9.5,17; 10.0,19; 10.5,6; 11.0,14; 11.5,13; 12.0,7; 12.5,4; 13.0,5; 13.5,3; 14.0,1; 14.5,1; 15.0,2; 7-13: E 16; L: 4.0,1; 4.5,4; 5.0,21; 5.5,19; 6.0,12; 6.5,6; 7.0,10; 7.5,9; 8.0,14; 8.5,15; 9.0,23; 9.5,13; 10.0,26; 10.5,12; 11.0,7; 11.5,11; 12.0,15; 12.5,9; 13.0,7; 13.5,6; 14.0,3; 14.5,3; 15.0,1; 16.0,1; 17-26: E 1; L: 4.5,1; 5.0,2; 5.5,1; 6.0,1; 7.0,1; 9.5,1; 11.5,1; 12.5,1; 13.5,1; 25-33: E 1; 1: 4.5,1; 11.5,1; 12.0,1; 14.0,2; 14.5,1; 15.5,1; 30-53: E 0; L: 11.5,1; 52-73: E 0; L: 0; 68-98: E 0; L: 0; 97-142: E 0; L: 0.

2452N; 6/17-18/41; 22h-3h; 32:23, 117:52; C; 0-3; E 1; L: 11.0,1; 12.0,5; 12.5,4; 13.0,3; 13.5,3; 14.0,2; 14.5,1; 15.5,1; 18.5,1; 7-12: E 0; L: 8.5,1; 13.5,1; 14.0,1; 15-24: E 0; L: 9.0,2; 11.0,2; 11.5,1; 12.0,1; 12.5,2; 13.0,1; 13.5,1; 15.0,2; 22-35: E 0; L: 13.0,1; 36-52: E 0; L: 10.5,1; 11.5,1; 14.5,1; 48-84: E 0; L: 0; 57-101: E 0; L: 0; 90-146: E 0; L: 0.

2452D; 6/18/41; 9h-14h; 32:17, 117:52; C; 0-3: E 0; L: 0; 6-12: E 0; L: 0; 14-21: E 0; L: 0; 25-36: E 0; L: 11.5,1; 38-43: E 0; L: 11.5,1; 12.5,1; 52-67: E 0; L: 17.5,1; 18.0,1; 68-81: E 0; L: 18.0,1; 96-152: E 0; L: 0; 125-156: E 0; L: 0.

2454N; 6/18-19/41; 21h-2h; 32:12, 118:38; C; 0-4: E 8; L: 4.5,1; 5.0,2; 6.0,1; 6.5,2; 7.0,1; 9.0,1; 9.5,1; 10.0,1; 10.5,3; 12.5,1; 7-13: E 15; L: 4.5,1; 5.0,2; 6.0,1; 6.5,2; 8.5,1; 9.0,2; 10.5,1; 11.0,1; 12.0,1; 12.5,1; 18-25: E 1; L: 5.0,1; 7.5,1; 8.0,1; 9.0,3; 9.5,4; 10.0,1; 11.0,2; 12.0,2; 12.5,1; 13.0,1; 13.5,1; 14.0,2; 14.5,2; 15.0,1; 24-32: E 0; L: 4.5,5; 5.0,2; 5.5,1; 7.0,2; 8.5,1; 9.0,2; 9.5,3; 11.0,5; 11.5,3; 12.0,3; 12.5,3; 13.0,4; 17.5,1; 38-52: E 0; L: 10.0,1; 11.0,2; 12.5,1; 52-69: E 0; L: 0; 66-108: E 0; L: 0; 90-149: E 0; L: 0; 122-208: E 0; L: 0.

2454D; 6/19/41; 8h-13h; 32:10, 118:39; C; 0-3: E 3; L: 6.0,1; 10.0,2; 12.0,1; 12.5,1; 7-14: E 1; L: 0; 17-25: E 0; L: 4.5,1; 6.0,3; 6.5,1; 10.0,1; 23-36: E 0; L: 4.0,2; 4.5,4; 5.5,2; 13.0,1; 36-47: E 0; L: 5.0,1; 12.0,1; 52-69: E 0; L: 21.0,1; 26.0,1; 70-85: E 0; L: 0; 99-121: E 0; L: 0; 120-198: E 0; L: 0.

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