JOB PROGRESS REPORT
HUMAN ENVIRONMENT DIVISION
Fisheries & Aquatic Biology Section

Submitted To:
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Neur Lake Stocking Report/Amphipods Population Estimation
21-21 Ordibehesht 1353

ABSTRACT

One hundred-ninety two thousand-five hundred rainbow trout were stocked in Neur Lake in East Azarbayjan province. Amphipod population estimations were initiated to monitor the population dynamics of this species since it will be the sole source of food for rainbow trout (Salmo gairdneri).

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Title:Neur Lake Stocking Report/Amphipod Population Estimation
Project Number: L-6-53
Work Projects: WP4, WP5

Period Covered: 21-24 Ordibehesht 1353
Personnel: Jack Boettcher, Fishery Biologist
Mohammed Saadati, Fishery Biologist
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On 22 and 23 Ordibehesht 1353, 192,500 rainbow trout (Salmo gairdneri) were purchased from the Jejrud Fish Hatchery for stocking in Neur Lake in East Azarbayjan province. Two thousand five hundred (2,500) extra fish were provided by the hatchery for mortality losses. The fish averaged 4-5 cm and were transported aboard commercial trucks in three 1800 liter fish tanks. Due to logistical difficulties a mortality of 10,000 to 20,000 trout was suffered. The Jejrud hatchery has admitted full responsibility and has agreed to stock 15,000-20,000 additional trout at no additional cost to the Department. These fish will be stocked at the earliest convenience of the Fisheries section.

The Fishery section has initiated a program to monitor amphipod population levels in Neur Lake following the introduction of these rainbow trout. This species of amphipod (Gammarus fasciatus) will be the sole source of food to these fish; thus, we do not want to over exploit the food resource with a stocking program that is too large.

Appendix I is the raw data collected on this survey. After more collections on amphipod data have been made this summer we will carry out statistical analyses to determine if any significant increase or decrease has occurred in the population.

APPENDIX

NEUR LAKE AMPHIPOD POPULATION ESTIMATIONS

Station	Date	Time	Location	Depth	Sampler Type	Amphipods/meter^2
1	5/14/74	0830	15 m offshore	2 m	bottom	560/m^2
1	5/14/74	0830	15 m offshore	2 m	planktpn net	134/m^2
2	5/14/74	0945	25 m offshore	2 m	bottom	640/m^2
2	5/14/74	0945	25 m offshore	2 m	plankton net	58/m^2
3	5/14/74	1020	20 m offshore	2 m	bottom	680/m^2
3	5/14/74	1020	20 m offshore	2 m	plankton net	83/m^2
4	5/14/74	1100	15 m offshore	1½m	bottom	480/m^2
4	5/14/74	1100	15 m offshore	1½m	plankton net	45/m^2
5	5/14/74	1130	25 m offshore	1½m	bottom	360/m^2
5	5/14/74	1130	25 m offshore	1½m	plankton net	19/m^2
6	5/14/74	1215	20 m offshore	1½m	bottom	320/m^2
6	5/14/74	1315	20 m offshore	1½m	plankton net	50/m^2
7	5/14/74	1430	20 m offshore	2 m	bottom	200/m^2
7	5/14/74	1430	20 m offshore	2 m	insect net	57/m^2
8	5/14/74	1500	middle of lake	3½m	plankton net	614/m^2
9	5/14/74	1520	middle of lake	3½m	plankton net	403/m^2
10	5/14/74	1600	middle of lake	3½m	plankton net	371/m^2
11	5/14/74	1630	middle of lake	3 m	plankton net	186/m^2
12	5/14/74	1715	mid NW end lke	1 m	plankton net	98/m^2
12	5/14/74	1715	mid NW end lke	1 m	bottom	1600/m^2

METHODS OF CALCULATION FOR ESTIMATIONS

Bottom Sampler(circular)

inner diameter = 8 centimeters

circle area = 50.24 cm^2 (pi times radius^2 = 3.14 X$(4)^2$)

1 meter^2 = 10,000 cm^2

10,000/50 = 200

Average sample per station X 200 = Amphipods/meter^2

Plankton net(circular)

Inner diameter = 20 cm

Area of circle = 3.14 X 10^2 = 314 cm^2

10,000 cm^2/ 314 cm^2 = 32

Average sample per station X 32 = Amphipods/ meter^2

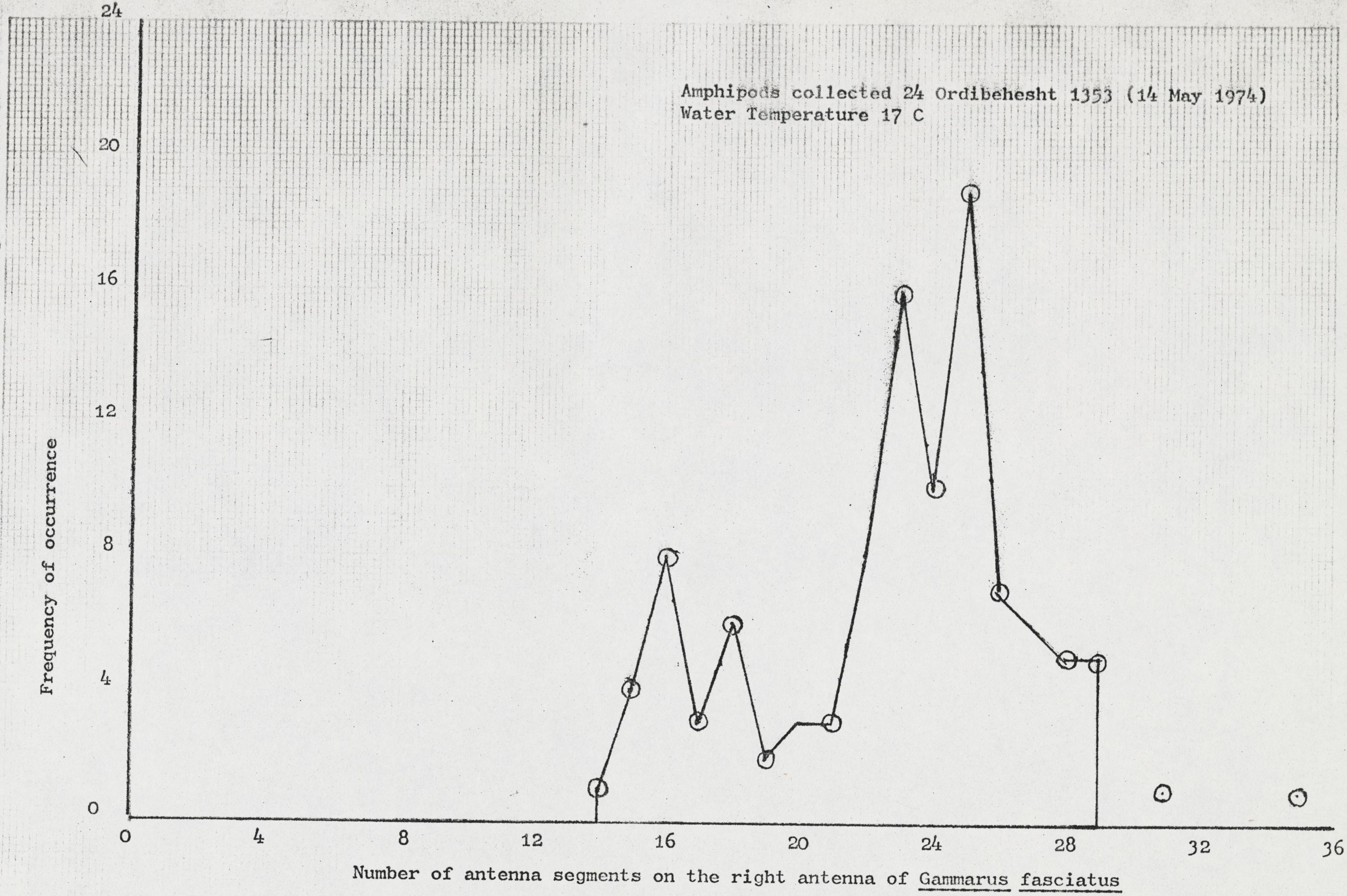
Insect Net (Rectangular)

50 cm X 27 cm = 1350 cm^2

10,000 cm^2/ 1350 cm^2 = 7

Average sample per station X 7 = Amphipods/meter^2

The bottom sample is actually a sample of the water column from the surface to the bottom including the bottom area under the water column and thus represents the most reliable sample. The plankton net only samples the amphipods swimming in the water column ABOVE the substrate and does not include the bottom sample. The insect net collects only the bottom sample and not the amphipods above the substrate in the water column.


Amphipods collected 24 Ordibehesht 1353 (14 May 1974)
Water Temperature 17 C
Frequency of occurrence
0
4
8
12
16
20
24
0
4
8
12
16
20
24
28
32
36
Number of antenna segments on the right antenna of Gammarus fasciatus

APPENDIX II

Neur Lake Amphipod Population Estimation

Estimator of the population mean = μ (mhu)

$\mu - \bar{y} = \; y_i / n = 3240/7 = 462.86$

y_i	$(y_i)^2$
y_1 - 560	313,600
y_2 - 640	409,600
y_3 - 680	462,400
y_4 - 480	230,400
y_5 - 360	129,600
y_6 - 320	102,400
y_7 - 200	40,000
$3240 = \sum y_i$	$1,688,000 = \sum y_i^2$

$(\sum y_i)^2 = (3240)^2 = 10,507,600$

Estimated variance of $\bar{y}$:

$\hat{V}(\bar{y}) = \frac{s^2}{n}(N-n/N)$

(N-n/N) = finite population correction factor. In this case the FPCF is non significant as the sample size is infinitely small compared to the total population.

Thus, $V(\bar{y}) = s^2/n$ where $s^2 = \sum(y_i - \bar{y})^2/n-1 = \sum y_i^2 - (\sum y_i)^2/n/_{n-1}$

$s^2 = 1,688,000 - (10,507,600/7)/6 = 1,688,000 - 1,501,085/6$
$s^2 = 187,015/6 = 31,169$

s= standard deviation = $\pm$ 176.54

$V(\bar{y}) = s^2/n \; 31,169/7 = 4452.71$

95% Confidence Limits = B

$B = T_{alpha/2}^{D.F.} \quad V(\bar{y})$

6 (n-1) degrees of freedom

thus, $T_{alpha/2}$ = 2.447 at 0.975% tile

2.447 ($\pm$ 4452.71) = 2.447 X $\pm$ 66.72 = $\pm$ 163.26

N = number of square meters in Neur Lake = 2,450,000

Thus, the population of amphipods is equal to $N(u) = N(\bar{y})$

$N(\bar{y})$ = 462.85 X 2,450,000 = 1,134,000,000

Finding the sample size required to estimate u with a bound on the error of estimation of B.

We want B = 100

$n = N\ (sigma^2)/(N-1)\ D + sigma^2$ $\qquad$ s^2 is an unbiased estimator of $sigma^2$ and $D = B^2/4 = 100^2/4 = 2500$

$n = (2.45 \times 10^6)\ (3.12 \times 10^4)/(2.45 \times 10^6)(2.5 \times 10^3) + 31{,}169$

$= 7.65 \times 10^{10} / 6.14 \times 10^9 = 1.25 \times 10 = 12.5$

Thus, n = 13

APPENDIX III

Further Notes on Neur Lake

On 28 Ordibehesht 1353, stomach samples were examined from six rainbow trout fingerlings stocked on 22 and 23 Ordibehesht and all stomach contained immature amphipods. This is an excellent indication that the fish began to feed immediately upon being stocked in the lake.

On 5 Khordad 1353 20,000 additional rainbow trout fingerlings were stocked in Neur Lake by the Jejrud fish hatchery as compensation for the mortality suffered on the initial stocking trip on 22-23 Ordibehesht. At this time the area around the lake was subjected to a tremendous infestation of what was believed to be black flies (Simulidae). Hosseini and Saadati say that it was like a plague, almost impossible to breathe without the nasal passages being plugged with the adult insects.

The 20,000 trout stocked on 5 Khordad began to feed immediately on black fly larva as soon as the fish were in the water. The insects are apparently a nuisance to the villagers in the area for about a two week period at this time each year. With 200,000 trout stocked in the lake annually the black fiy population might be somewhat less intense in years to come as the trout should feed quite readily on both the the larva and the adult insects.

JOB PROGRESS REPORT

DEPARTMENT OF THE ENVIRONMENT

Fisheries & Aquatic Ecology Group

Submitted To:

Dr. M.T.Farvar, Chief

Human Environment Division

Submitted By:

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NEUR LAKE LIMNOLOGICAL INVESTIGATION II

6-11 Mordad 1353

L - 6 - 53

ABSTRACT

Forty 1352 stocked rainbow trout averaging 1176 grams in weight and 39.7 cm in length were collected. Also collected were 47-1353 stocked rainbow trout averaging 18.7 cm in length and 125 grams in weight. Two separate amphipod population estimations gave mean population values per square meter of surface area between 1116 amphipods per square meter and 1478 amphipods/m^2. This is 150 - 300 % greater than was observed prior to the introduction of the 200,000 rainbow trout. Preliminary research objectives are outlined for Neur Lake.

Title: Neur Lake Limnological Investigation II, 6-11 Mordad 1353

Project Number: L - 6 - 53

Work Projects Initiated: WP 1 General Survey

WP 2 Fish & Aquatic Invertebrate Collections

WP 4 Population Estimations

WP 5 Stocking and Analysis

Period Coverd: 6-11 Mordad 1353

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INTRODUCTION

A five day survey of Neur Lake was performed to assess the status and growth rates of the introduced rainbow trout. Amphipod population estimations were also determined as part of the fishery group's continuiing monitoring of this species' population trends. Since the amphipods provide the sole source of food for the rainbow trout, investigations of this species' population dynamics are necessary to avoid over-exploitation of the amphipod resource.

METHODS

Water samples were collected with a Kemmerer water sampler at the sampling station indicated on the map of Neur Lake (see appendix, Figure Five). Water quality data were collected and determined with a modified Hach Kit with methods as outlined in Standard Methods(1971).

Plankton samples were collected with a plankton sampler net and fish samples were collected using four horizontal gill nets (3meters X 25-50 meters; 25-50 mm mesh sizes). Plankton population estimates were determined as outlined by Welch(1948). Amphipod population estimates were made using a modified core sampler and statistical calculations were determined as described in Mendenhall,Schaffer, and Ott (1971).

DISCUSSION

Physical and Chemical Data

Water quality data is presented in Table One below. This reflects no significant changes in conditions found on previous surveys in the past two years (Nehring, 1352).

Table One . Water Quality Data - Neur Lake, 8 Mordad 1353, 1200 hours.

Depth (m)	Air T (C)	Water T (C)	D.O. (mg/l)	pH	Alkalinity (as mg/l	Hardness $CaCO_3$)	CO_2 (mg/l)
surface	14.0	15.0	9.6	7.3	165	154	—
2.5	15.0	15.0	8.2	7.1	130	160	—

Biological Data

Forty 1352 stocked Salmo gairdneri averaging 39.7 centimeters in length and 1176 grams in weight and forty-seven 1353 stocked Salmo gairdneri averaging 18.7 cm and weighing 125 grams, were collected on this survey (see Table Two for details). These fish showed phenomenal growth with condition factors of 1.87 and 1.91 respectively. Using the data from this survey and the first Ordibehesht survey (Nehring, 1353) Figures One,Two, and Three were created (see the Appendix). Figure One presents the length-weight data for Neur Lake rainbows. It can readily be seen that once the fish reach approximately 30 cm they begin to gain weight rapidly. This results in a very plump robust fish with very high condition factors.

Table Two. Biometric Data, Salmo gairdneri, Neur Lake, 7-11 Mordad 1353

	N	Length(cm)	Range	Weight(g)	Range	Condition Factor
1352 Trout	40	39.7	36-45	1176	750-1700	1.87
1353 Trout	47	18.7	15.5-22	125	65-170	1.91

Figure Two (appendix) depicts the projected growth rates in the length of the 1353 stocked rainbows, Examination of this graph reveals a projected average length of over 30 cm by the end of Shahrivar when the Fisheries Group intends to install aeration equipment in Neur Lake. Figure Three indicates these 30-32 centimeter trout should average 400 to 500 grams by Mehr 1353. Figure Three is a graph of the projected growth rate of the 1352 stocked rainbows. Between 6 Ordibehesht and 7 Mordad (90 days) these trout displayed an amazing weight gain of 8.7 grams per day! Projecting from this graph the 1352 stocked rainbows should be averaging 45 cm in length and 1600 grams in weight by Mehr 1353.

The raw data and the statistical calculations for the amphipod population estimations are presented in the appendix. The population estimates are separated into two groups. The first estimate includes all samples collected on this survey(see map of Neur Lake for sample stations). This estimate showed 1116.07 amphipods per square meter. The second population estimate resulted in a population of 1478.5 amphipods/m^2 and was based on stations with a sandy substrate.(See the appendix for detailed information). Regardless, both estimates reveal a 150 - 300 % INCREASE in the population per square meter as compared to the 462.85 amphipods/m^2 observed in Ordibehesht (Boettcher, 1353). This is quite natural and is what the Fisheries Research Group expected to find if the trout were not fully exploiting the amphipod resource.

Detailed documentation of the biology and life history of the amphipod population in Neur Lake is an absolute necessity for proper management of the Neur Lake fishery. At present such knowledge is lacking. The following paragraphs are the result of our examination of the amphipod population to date.

Breeding amphipods were observed during the first survey in Ordibehesht. Antenna segment counts from amphipods collected on the second survey in Ordibehesht 1353 indicate the adult (sexually mature) amphipods have 22 to 33 antenna segments The Ordibehesht sampling (2nd survey) consisted of over 90 % adult amphipods. These had over-wintered under the ice and had begun to reproduce when the water conditions became suitable in early Ordibehesht. They produced the generation of immature amphipods present in Neur Lake on the second survey about 25 Ordibehesht. These immatures had 14-19 antenna segments (Boettcher,1353).

On this survey the samples contained more than 99% immature amphipods with 9-13 antenna segments.These amphipods were the young or subsequent generation(s) of the immature amphipods collected during the 2nd Ordibehesht survey.

Stomach analysis revealed that both the 1352 and 1353 stocked rainbows were feeding exclusively on adult amphipods(see Table Three below and Figure Four in the appendix). This selection for adult amphipods is indicative of an under exploited amphipod population. The adult amphipods complete their reproductive cycle and instead of dying and contributing to the detritus in the lake they are usefully channeled into the trout biomass.

Continual monitoring of the amphipod population trends and research into the biology and life history of this population will enable the fisheries research group to determine the optimum trout stocking density without adversely affecting the amphipod population.

TABLE THREE. Amphipod Antenna Segment Data,Neur Lake, 10 Mordad 1353

Number of Antenna segments on the Right Antenna of *Gammarus* sp.

	N	Range	$\bar{X}$
Substrate Amphipod Sample	25	9-13	10.6
Trout Stomach Sample (52)	25	22-31	25.6
Trout Stomach Sample(53)	15	24-29	26.1

A two meter vertical plankton tow indicated a zooplankton population of 1220 cyclopoid copepods/liter and 122 Cladocera/liter (see Appendix II, for calculations). Stomach analyses from over 20 trout from both the 1352 and 1353 populations revealed no predation on the zooplankton.

Nineteen female from the 1352 stocking had granular ovaries and all males from the 1352 stocking had mature testes, indicating these fish will spawn in the spring 1354.

CONCLUSIONS & RECOMMENDATIONS

Neur Lake has more than lived up to the wildest expectations of the Fisheries group (Nehring, 1352a;1352b;1352c,1353)(Boettcher, 1353). The lake is practically a pure trout culture medium. Furthermore, Dr. Behnke believes the trout are displaying world record growth rates. They increased 900 grams in weight in 90 days! Certainly the phenomenal growth rates from a single invertebrate population is unmatched in the temperate regions of ~~ten~~ the world.

Since the trout feed exclusively on a high carotene diet contained within the amphipods, the trout have a very orange colored flesh which is very firm, not unlike Caspian Salmon (*Salmo trutta caspius*). These fish should command a premium price on the market when harvested.

This year the commercial fishery will probably be operated as a concession let by the Department. But we hope in the future (next year) the local villagers can be incorporated into the operation as a fishery cooperative. Loans from the Agricultural Development Bank will have to be arranged to finance the operation. However, the Department must at all times have complete control and authority over the management policy and complete control of the harvest operations.

One of the most important objectives of the Neur Lake research program will be the determination of optimum stocking rates and densities. These stocking rates will be determined by regularly plotting the trout growth curves for different stocking rates. With heavier stocking rates and establishment of intraspecific competition between different age classes of trout the maximum growth rates will eventually fall off.

With all factors considered, such as optimum market size, optimum growth rates, optimum use of the amphipod resource, and optimum stocking densities, we can effectively manipulate the Neur Lake fishery to provide as great a yield per hectare as possible.

Dr. Behnke and Jack Boettcher spent 20 man hours fishing with both flies and lures without getting one strike. This clearly attests to the degree of satiation in the rainbow trout in this lake. Until a greater biomass is present in the lake and intraspecific competition forces the fish to actively forage for food, very few of these trout will enter the sport fisherman's creel in significant numbers.

As productive as Neur Lake is, its production could at least be doubled or even tripled by the introduction of a plankton foraging fish such as Coregonus peled. At present, Neur Lake's zooplankton population is unutilized. To fill this empty niche, it is recommended that the lake whitefish, Coregonus peled, be stocked in Neur Lake. This fish is ideally suited to the warm shallow waters of Neur Lake and should exhibit rapid growth without competing with the rainbow trout. This fish is strictly a zooplankton feeder. It is hoped that arrangements can be made to introduce this fish into Neur Lake in early 1354.

It must be emphasized that to obtain valid scientific information from Neur Lake, no outside influences can be tolerated. Unbiased results and proper management can only be formulated by the Department through research and sound management decisions. Law enforcement officials must strictly enforce the sport fishing and antipoaching regulations.

LITERATURE CITED

American Public Health Association, American Water Works Assoc., and Water Pollution Control Federation. 1971. Standard methods for examination of water and wastewater. 13th edition. Amer. Public Health Assoc. Washington, D.C. 874 p.

Boettcher, J.R. 1353. Neur lake stocking report/amphipod population estimation, 21-22 Ordibehesht 1353. Job Progress Report, Department of the Environment. 5 p.

Mendenhall, W.L., L. Ott, and R.L. Schaffer. 1971. Elementary survey sampling. Wadsworth Publishing Company. Belmont, California. 247 p.

Nehring, R.B. 1352a. Neur lake survey I, 25-26 Ordibehesht 1352. Job Progress Report. Department of Environmental Conservation. 7 p.

Nehring, R.B. 1352b. Neur lake limnological survey, 30-31 Tir 1352. Job Progress Report. Department of Environmental Conservation. 2 p.

Nehring, R.B. 1352c. Neur Lake Winter survey II, 3 Bahman 1352. Job Progress Report. Department of Environmental Conservation. 3 p.

Nehring, R.B. 1353. Neur Lake limnological survey I - 1353, 3-6 Ordibehesht 1353. Job Progress Report. Department of the Environment. 4 p.

Welch, P.S. 1948. Limnological methods. Philadelphia, Penn. 381 p.

APPENDIX I

STATION #	DATE	TIME	LOCATION	DEPTH	SUBSTRATE	AMPHIPODS/M^2
1	8/2/74	1300	40 meters offshore	1.5 m	sand	3280/m^2
2	8/2/74	1330	30 meters offshore	1.5 m	sand	1320/m^2
3	8/2/74	1400	25 meters offshore	1.5 m	mud	680/m^2
4	8/2/74	1430	15 meters offshore	1.5 m	mud	40/m^2
5	8/2/74	1500	15 meters offshore	1.5 m	sand	800/m^2
6	8/2/74	1530	15 meters offshore	1.5 m	sand	2200/m^2
7	8/2/74	1600	20 meters offshore	1.5 m	mud	0/m^2
8	8/2/74	1630	15 meters offshore	1.5 m	detritus	120/m^2
9	8/2/74	1700	15 meters offshore	1.5 m	sand	2225/m^2
10	8/2/74	1730	10 meters offshore	1.5 m	sand	640/m^2
11	8/2/74	1800	15 meters offshore	1.5 m	sand	520/m^2
12	8/2/74	1830	20 meters offshore	1.5 m	sand	1480/m^2
13	8/2/74	1900	15 meters offshore	1.5 m	sand	400/m^2
14	8/2/74	1930	15 meters offshore	1.5	sand	1920/m^2

NEUR LAKE AMPHIPOD POPULATION ESTIMATION

Estimator of the population mean = u (Mhu)

	$(y_i)^2$
y_1 = 3280	10,758,400
y_2= 1320	1,742,400
y_3= 680	462,400
y_4= 40	1,600
y_5= 800	640,000
y_6= 2200	4,840,000
y_7= 0/m^2	0
y_8= 120	14,400
y_9= 2225	4,950,625
y_{10}=640	409,600
y_{11}=520	270,400
y_{12}= 1480	2,190,400
y_{13}= 400	160,000
y_{14}= 1920	3,686,400

APPENDIX I

NEUR LAKE AMPHIPOD POPULATION ESTIMATION

First the population estimate will be based on the total sample size of 14 subsamples around the lake. Thus;

$u = \bar{y} = \Sigma y_i/n$ (when $n = 14$) $= 15{,}625/14 = 1116.07$ amphipods/m^2

$\Sigma y_i^2 = 30{,}126{,}625$

$(\Sigma y_i)^2 = 244{,}140{,}625$

$(\Sigma y_i)^2/n = 17{,}438{,}616$

The estimated variance of $\bar{y}$:

$\hat{V}(\bar{y}) = \frac{s^2}{n}(N-n)/N$*

*NOTE: The Finite Population Correction Factor (FPCF) is equal to one in this case as the total area of the lake is infinitely large in comparison to the 14 m^2 samples taken for the population estimate.

Thus, $V(\bar{y}) = s^2/n$ where $s^2 = \Sigma(y_i - \bar{y})^2/n-1 = \Sigma y_i^2 - (\Sigma y_i)^2/n \,/\, n-1$

$s^2 = 30{,}126{,}625 - 17{,}438{,}616 = 12{,}688{,}009/13 = 976{,}000.6 = s^2$

$s =$ standard deviation $= \pm 988$

$V(y) = s^2/n \; 976{,}000.6/14 = 69{,}714.3$

95% confidence limits for the population are as follows:

$B = T_{alpha/2\ D.F.}(\pm\sqrt{V(\bar{y})}$ and $T_{alpha/2\ D.F.} = 2.16$ for n-1 (13) D.F.

$B = 2.16(\pm\sqrt{69{,}714.3}) = 2.16\ (\pm 264.034) = \pm 570.268$

APPENDIX I

NEUR LAKE AMPHIPOD POPULATION ESTIMATION

The second population estimate is based on a sample size of ten subsamples around the lake where all ten samples were taken over a sandy substrate. The areas of sandy substrate had a significantly higher population density than areas where the substrate was either mud or detritus or both. Thus:

$u = \bar{y} = \Sigma y_i/n$ (when $n = 10$) $= 14{,}785/10 = 1478.5$ amphipods / m^2

$\Sigma y_i = 14{,}785$

$\Sigma y_i^2 = 29{,}648{,}225$

$(\Sigma y_i)^2 = 218{,}596{,}225$

$(\Sigma y_i)^2/n = 218{,}596{,}225/10 = 21{,}859{,}622.5$

*NOTE: The finite population correction factor is equal to one in this case as the area of the lake is infinitely large in comparison to the sample size of 10 m^2.

The estimated variance of $\bar{y}$:

$$\hat{V}(\bar{y}) = \frac{s^2}{n}(N-n/N)^*$$

Thus, $V(\bar{y}) = s^2/n$ where $s^2 = \Sigma(y_i - \bar{y})^2/n-1 = \Sigma y_i^2 - (\Sigma y_i)^2/n \,/\, n-1$

$s^2 = 29{,}648{,}225 - 21{,}859{,}622.5/9 = 869{,}400.3$

s = standard deviation $= \pm 932.42$

$\hat{V}(\bar{y}) == s^2/n = 869{,}400.6/\ 10 = 86{,}940.03$

95 % confidence limits for the population mean based on 10 samples are as follows:

$B = T_{alpha/2D.F.}\ (\pm\sqrt{V(\bar{y})}$ and $T_{alpha/2\ D.F.} = 2.26$ for n-1 (9) D.F.

$B = 2.26\ (\pm\sqrt{86{,}940.03}\ ) = 2.26\ (\pm 295) = \pm 666.7$

APPENDIX II
ZOOPLANKTON POPULATION CALCULATIONS FROM TWO METER PLANKTON TOW

Plankton net (circular) inner radius . = 7.25 cm

Circular area = 164 cm^2 = (pi)(r^2) = 3.14 X($7.25)^2$

Volume of water column sampled = 0.0164 m^2 X 2 m = 0.0328 m^3

0.0328 m^3 = 32.8 liters in the column.

2.0 copepods/drop water X 20 drops/ml = 40 copepods/ml =40,000 copepods/l

40,000 copepods/liter! 32.8 liters = 1220 copepods/liter of lake water

0.2 _Daphnia_/drop X 20 drops/ml = 4 _Daphnia_ / ml = 4,000 Daphnia/liter

4,000 _Daphnia_/liter / 32.8 liters = 122 _Daphnia_/ liter lake water.

NEUR LAKE AMPHIPOD BIOMASS/M^2 CALCULATIONS (DRY WEIGHT)

Collected 22 Ordibehesht 1353 - 16-31 amphipods antenna segments(rt.antenna)

0.7~~24~~ 624 grams/97 amphipods = 0.0078 grams/ amphipod

0.0078 grams/amphipod X 462.86 amphipods/m^2 = 3.61 grams/m^2

3.61 grams/m^2 = 3610 milligrams /m^2 = 3,610,000 micrograms/ m^2

Collected 10 Mordad 1353 = 9-13 antenna segments

0.0343 grams/ 99 amphipods = 0.000346 grams/amphipod

A) All stations -(14)

0.000346 grams/amphipod X 1116.07 amphipods/m^2 = 0.38616 grams/m^2

0.38616 grams/m^2 = 386.16 milligrams/m^2 = 386,160 micrograms/m^2

B) Sandy substrate sampling stations (10)

0.000346 grams/ amphipod X 1478.5 amphipods/ m^2 = 0.511561 grams/ m^2

0.511561 grams/ m^2= 511.561 milligrams/m^2 = 511,561 micrograms/m^2

FIGURE ONE. LENGTH-WEIGHT RELATIONSHIP OF NEUR LAKE RAINBOW TROUT

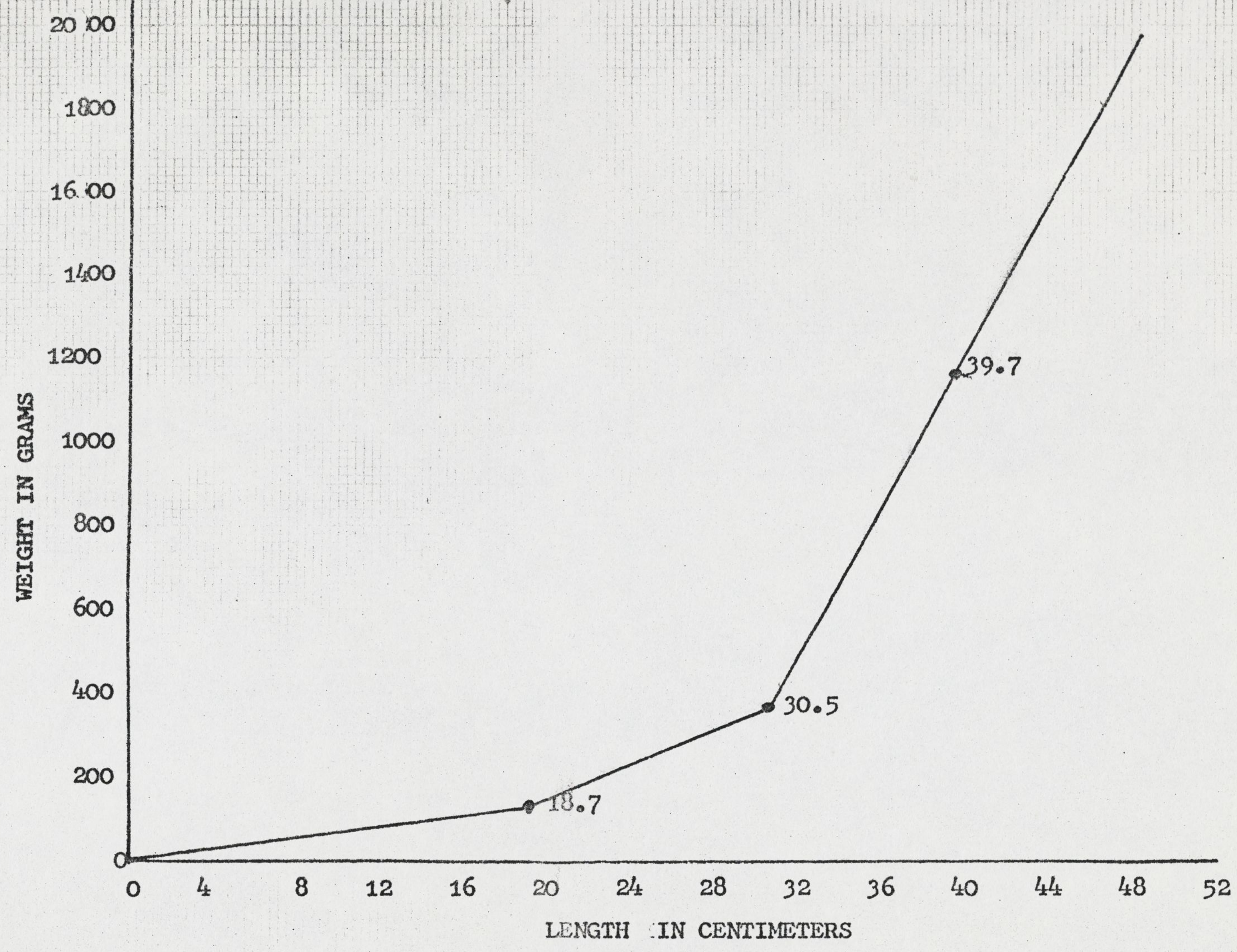


FIGURE TWO. PROJECTED GROWTH RATE OF NEUR LAKE RAINBOW TROUT IN LENGTH 1353 (1353 Stocked)

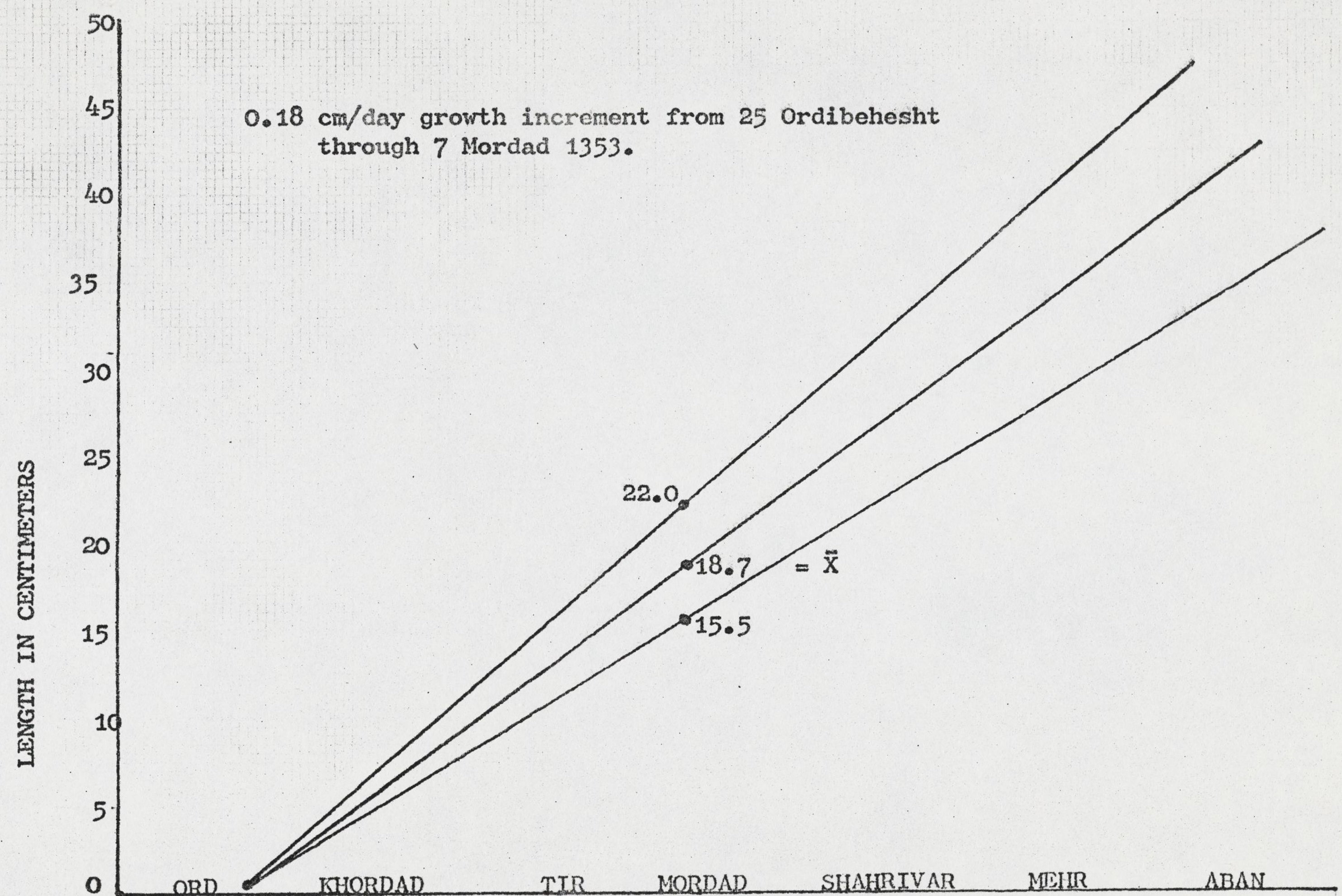


FIGURE THREE. PROJECTED GROWTH RATE OF 1352 STOCKED NEUR LAKE RAINBOW TROUT IN LENGTH AND WEIGHT (Average)

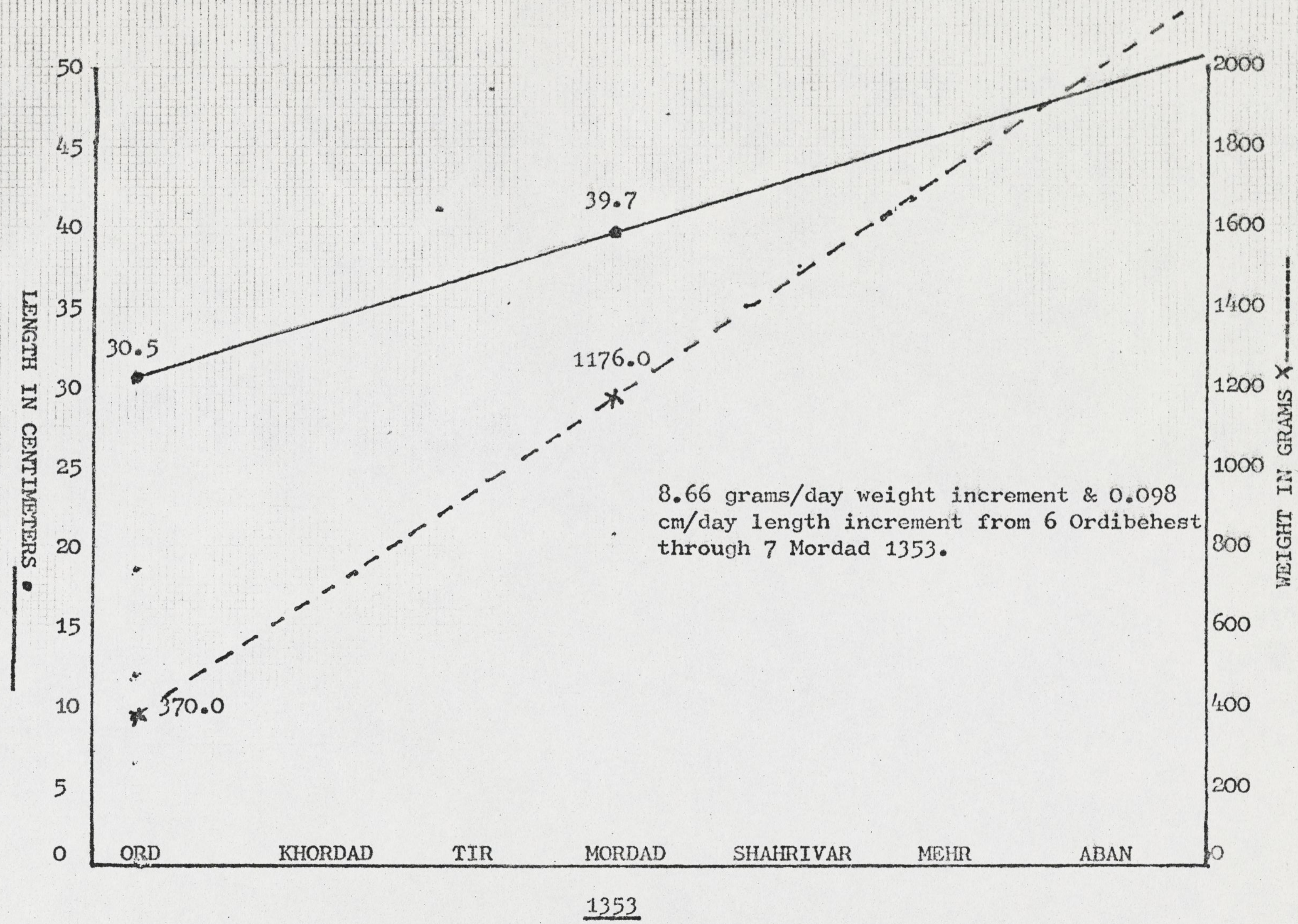
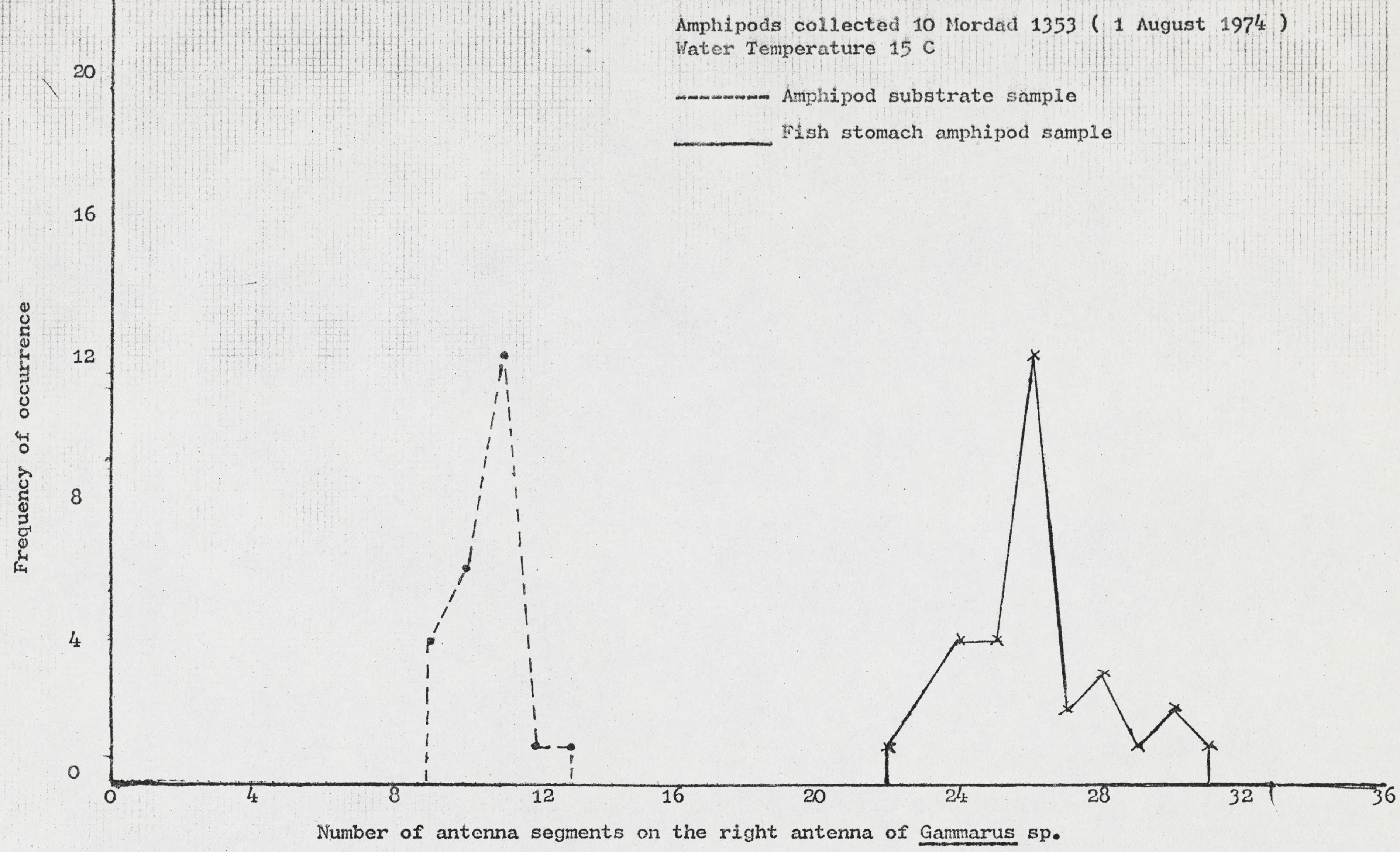


Figure four. AMPHIPOD ANTENNA SEGMENT FREQUENCY DATA INDICATING SELECTIVE PREDATION BY NEUR LAKE RAINBOWS



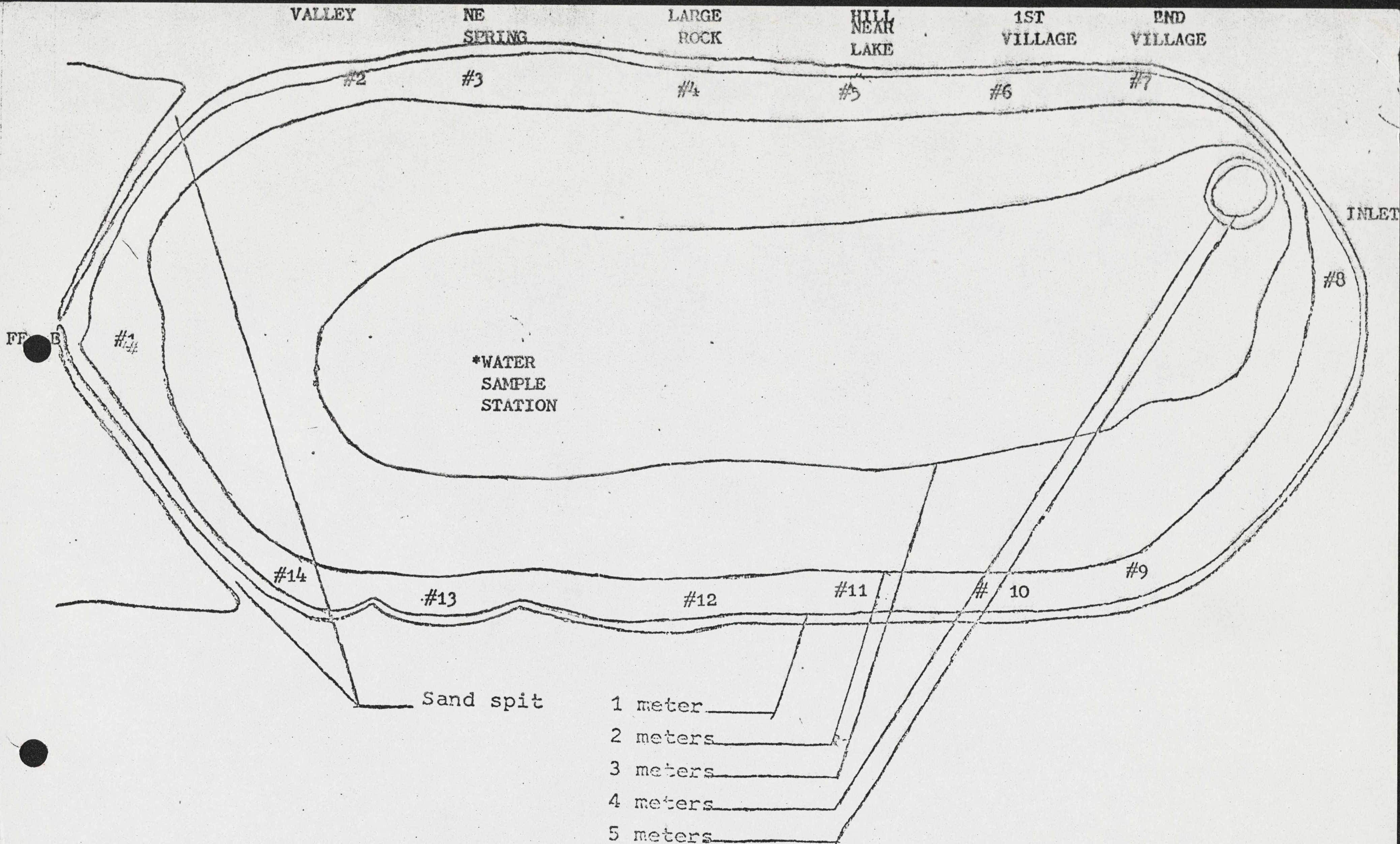


FIGURE FIVE.
AMPHIPOD SAMPLING STATIONS- 10 Mordad 1353
1 August 1974

Neur Lake
1 cm= 100 meters
approximate area 245 ha.

JOB PROGRESS REPORT

DEPARTMENT OF THE ENVIRONMENT

Fisheries & Aquatic Ecology Section

Submitted To:

Dr. M.T. Farvar, Chief

Human Environment Division

Submitted By:

Barry Nehring, Advisor

Fisheries & Aquatic Ecology

The Ecology and Population Dynamics of the Neur Lake Amphipod Population and Aban Amphipod Population Estimation

ABSTRACT

Our amphipod population estimation on the second and third of Aban revealed an average population per square meter of substrate of 308 amphipods with 95% confidence limits of $\pm$ 296 amphipods. This is about a forty percent decrease since our last estimate on 2 & 3 Mehr 1353. This decrease is to be expected as no amphipod reproduction has taken place in the lake since Mordad 1353. The ecology and population dynamics of the Neur Lake amphipod population is discussed in the light of studies completed by William Cooper on Sugarloaf Lake in Michigan. We find no evidence to date that even suggests that any damage has been done to the amphipod population in the lake as a result of predation by rainbow trout. Assuming proper fish management, none is expected to occur in the future.

JOB PROGRESS REPORT

DEPARTMENT OF THE ENVIRONMENT

FISHERIES & AQUATIC ECOLOGY SECTION

Submitted To:

Dr. F.A. Harrington, Chief

Parks & Wildlife Division

Submitted By:

Hooshang Abbasi, Aquatic Biologist

NEUR LAKE COMMERCIAL FISHERY

29 Mehr - 19 Aban 1354

ABSTRACT

A 14 day commercial fishery was conducted at Neur Lake from 2 Aban through 15 Aban 1354. During that period 5236-2 year old trout weighing 8308.5 kg were caught. Eight large trout from the 1352 stock were also caught of which two were females. The average length of the 2 year old trout was 47.5 cm and the average weight was 1700 grams. The length of the three year old trout varied from 56 to 62 cm and the weight from 3700 to 4200 grams. Some of the 2 year old trout were also over 3000 grams.

A nylon beach seine of 308 meters length and 5,5 meters width with a mesh size of 33 mm with 400 meters of rope on each end was made in Bandar Pahlavi and used in the program. The two largest catches (at the north and south ends of the lake) netted 274 trout and 172 trout,respectively. Water temperature on the first day of the fishery was 6.0 C and it decreased to 2.7 C on the last day. Also, assorted gill nets and beach seines (up to 60 meters length) were used in the commercial fishery to supplement the catch with the hand operated beach seine.

Title: Neur Lake Amphipod Population Estimation IV - 1353

Project Number: L-6-53

Work Projects Initiated: WP 4 Population Estimation

Period Covered: 2-3 Aban 1353

Personnel: Barry Nehring, Fisheries & Aquatic Ecology Advisor
Jack Boettcher, Aquatic Ecologist
Ali Soltanpour, Algalogist

INTRODUCTION

During our commercial fishing expedition to Neur Lake (27 Mehr - 17 Aban 1353) the fourth amphipod population estimation was carried out on Neur Lake's amphipod population. It was performed on 2 and 3 Aban, exactly one month after our Mehr population estimation.

METHODS

The estimation was carried out by taking from five to ten core samples with our modified aquatic weed core sampler. This sampler is designed to capture all amphipods swimming in the water column as well as those occurring on the substrate in the column of water through which the sampler passes. Each sample covers an area of 50 cm^2 over the lake surface. Thus, when ten subsamples are collected an area of 500 square centi-meters is sampled. Each sample is filtered over a fine mesh screen to allow fine silt to pass through yet capture all amphipods down to the earliest instar. Samples were taken at each of the fourteen sampling stations as outlined by Boettcher (1353).

RESULTS

Our population estimate on 2 & 3 Aban indicated a population size of 308 amphipods/m^2 of substrate. This estimate is based on a sample size of fourteen stations. The range of population levels per square meter ran from 0/m^2 at stations 7,10, and 11 to 1540/m^2 at station 2. The 95% confidence limits for this estimate were $\pm$ 296 amphipod/m^2. If the stations with no amphipods are discarded from the population estimate we arrive at an estimate of 392 amphipods/m^2 with 95% confidence limits of $\pm$ 371 amphipods/m^2.

The amphipods collected during the population estimation were subjected to examination for recording the number of right antenna segments, upon our return to Tehran. The amphipods collected from the substrate averaged 17 segments on the right antenna (primary antenna). (See Table Three in the Appendix). These amphipods were all from the second generation produced in Neur Lake in 1353. Stomach content analysis revealed that a few amphipods could be found in about 10-20 percent of the fish collected during the commercial fishing operation from 30 Mehr through 15 Aban 1353. The amphipods taken from fish stomachs averaged 23.7 segments on the right antenna as compared to an average of 17 antenna segments from those amphipods collected from the substrate.

Figure One in the Appendix presents a graphic analysis of the antenna segment data to present pictorially what portion of the amphipod population the trout are preying upon. This graph shows that a 20% overlap occurs between the amphipod population found in Neur Lake and those amphipods occurring in the stomachs of trout examined. This shows that the trout are feeding only upon the larger, older segment of the amphipod population. These results are exactly what was found by Cooper (1965), in his classic study of the amphipod population occurring in a Michigan lake in North America.

DISCUSSION

With one year's data now collected on the Neur Lake amphipod population, we are now in a position to assess and predict the effects of the trout population in Neur Lake on this population of forage organisms. This is an especially important process as the amphipod is the mainstay and the preferred food of the trout diet in Neur Lake. Thus, although Neur Lake has a very considerable biomass of alternative food resources available to the trout, the quality and quantity of trout that has been produced in Neur Lake in 1353 could conceivably be drastically cut should irreversible damage be inflicted on the amphipod population as a result of excessive predation by the rainbow trout. Thus, assessments and predictions concerning the past, present, and future status of the Neur Lake amphipod population will be extensively discussed below, mainly in light of the impressive study done by Cooper (1965).

Our observations and collection of data from 1352 and 1353 indicate that all amphipods in Neur Lake over the winter months are progeny of the second generation of amphipods produced in Neur Lake each year around the 1st of Mordad (late July). These amphipods are either adults (sexually mature) or sub-adults (approaching sexual maturity) that will breed with the melting of the ice in the spring and warming of the waters of the lake. Referring to the population of the amphipod population, Hyalella azteca, in Sugarloaf Lake, Michigan, Mr. Cooper says,"The spring populations consist entirely of adults and subadults overwintering from the previous fall. These large adults decline rapidly in abundance and are essentially absent from the population by the first of July." Continuing," Young animals make up roughly one-half of the population during the summer months.The adult half of the population during the summer consists of newly recruited adults which mature and begin reproducing by the latter part of June. The number of young animals in the population declines rapidly in September due to the cessation of reproduction and the continuing growth of the young individuals into adults."

Except for a time lag of approximately (due primarily to the colder water temperatures and high elevation of Neur Lake) one month, the population dynamics of the Neur Lake amphipod are virtually identical to the Hyalella azteca population of Sugarloaf lake. Figure Three in the appendix is a graphic representation of the probable population dynamics of the Neur Lake amphipod population. Reproduction occurs for the first time each year around late Farvardin through the end of Ordibehesht or early Khordad, depending primarily upon the water temperature. The onset of breeding and reproduction was definitely determined to be temperature controlled by Cooper. This is undoubtedly the case in Neur Lake as well. In 1352, reproduction had not yet occurred, although copulation was observed on 25-26 Ordibehesht 1352. At that time the water temperature was 7.0 C. This year breeding was observed as early as 3-6 Ordibehesht although the water temperature was only 2-3 C. However, on 25 Ordibehesht 1353, the water temperature was already 14-15 C and the first generation had already been produced and was in the third or fourth molt after hatching.

Our population estimate on 25 Ordibehesht 1353 revealed 462 amphipods per square meter of substrate. However, this population was made up of two generations, those remaining adults left over from the overwintering adult population and the new generation of young. Unfortunately, we have no data on the precentage composition of the population broken down by generation. The population data from Ordibehesht 1353 was taken from Boettcher (1353a).

In our survey on 10 Mordad 1353, a population of 1116 to 1478 amphipods/m^2 was found, depending upon whether or not the zero data points are included in the population estimation (Boettcher, 1353b). Also see Table One in the Appendix). Our data showed that 99.99% of the population in Neur Lake consisted of 1st and 2nd instar juvenile amphipods, yet the analysis of trout stomach contents revealed 99.99% adult amphipods (1st generation 1353). This indicated a highly selective predation factor on the amphipod population with only the large adult amphipods being subjected to predation.

Our population estimate in Mehr 1353 revealed 537 amphipods/m^2 based on a sample size of 14 with two zero amphipod/m^2 data points(Nehring1353). If we discard the two zero data points the population estimate is raised to 627 amphipods/m^2. The average number of segments on the right antenna at this time was 16.0 as compared to 17.8 on the antenna of amphipods consumed by the trout on that date. Although this would tend to indicate that the trout were beginning to exert a serious pressure on the amphipod population, the facts are that the pressure exerted by the trout on the amphipod population at this time was actually probably at its lowest impact since Ordibehesht this year. Less than 1% of the trout collected on this survey (over 400) had any amphipods in their stomach contents at all. This indicates again the fact that the trout are only effectively grazing on the largest amphipods that are present in the population at any point in time. Trout are very inefficient predators on benthic invertebrates and have not been shown to effect irreparable damage on any forage population in any scientific study ever completed.

Our Aban 1353 population estimate revealed the presence of 308 to 392 amphipods/m^2 depending upon whether or not the three zero data points are eliminated from the estimation process or not. The downward trend in the numbers of amphipods/m^2 with the approach of fall and winter is unmistakable. But this is not a serious problem. This same phenomenon was also documented by Cooper in his paper. The reason is that once the reproductive process has ceased for the year, the population cannot do anything but decrease. Without any recruitment of young amphipods to the population, the population cannot possibly increase.

Concerning the annual production of amphipods in Sugerloaf lake (both in numbers of amphipods and biomass of amphipods) Cooper says the following:"Slightly more than 50% of the numerical yield is attributed to the adult amphipods over the course of the summer. Measured as dry weight biomass, the difference in yield between adults and young is even more striking since the adults (roughly 150 ug) average about 6 times heavier than the young (roughly 25 ug). The adult amphipods are responsible for a majority of the annual productivity."

Although we have no definite data to support our hypothesis at this time, our general observations on the Neur Lake amphipod population would tend to indicate that the adult amphipod population in Neur lake makes up at least 50% of the total amphipod production in Neur Lake over the summer. Coopers data in Sugarloaf lake indicated that the adult amphipods contributed to from 50.2% to 57.5% of the total amphipod production over the summer in that lake. Comparison of Boettcher's biomass data on the Neur Lake amphipods (Boettcher, 1353b) with Cooper's biomass data shows that juvenile amphipods in Neur Lake are 12 times bigger than the juveniles in Sugarloaf lake and that the adult amphipods in Neur Lake are more than 50 times larger than Cooper's amphipods. Thus, although the numerical production of amphipods in Sugarloaf lake is an order of magnitude larger than Neur Lake (4000 to 6000/m^2 in Sugarlaof lake as compared to 300 to 600/m^2 in Neur Lake), Neur Lake is virtually an order of magnitude higher (10 times) in production on a biomass basis as compared to Sugarloaf lake. The mean population size in Sugarloaf lake was 4.07 kg/ha as compared to 36.1 kg/ha for Neur Lake on 22 Ordibehesht 1353. No further explanation concerning the production possibilities of Neur Lake should be necessary, the data speaks for itself.

Finally, Cooper showed that the yellow perch (*Perca flavescens*) and to a lesser extent the bluegill (*Lepomis macrochirus*) were selectively preying upon only the largest 2-5% of the total amphipod population. Further, he showed that the population dynamics of the amphipod, *Hyalella azteca*, were very stable in the face of predation from these fish. Such would be our conclusions concerning the rainbow trout predation and population dynamics of the Neur Lake amphipod, temporarily identified as *Gammarus fasciatus*.

Boettcher (1353a) found amphipods occurring in the open water pelagic areas of the lake in Ordibehesht of this year, over the muddy substrate of the lake's center. This was at the time of stocking 200,000 rainbow trout fingerlings, and prior to the time when the trout would have begun to prey on the amphipod population in any significant numbers. At the time of this fish stocking, only a maximum of 5000 thirty centimeter trout were in the lake. That is a stocking rate of about 25 trout per hectare and could not have had any measurable effect on the amphipod population as far as predation is concerned up to 25 Ordibehesht. However, by 3 Mehr 1353, all amphipods had completely disappeared from the pelagic zones of the lake of three meters depth or greater. This indicates that either the trout had completely eliminated all amphipods from this region of the lake, or that the amphipods found in this area of the lake in Ordibehesht were accidental immigrants to this area of the lake during and immediately following the reproductive process. There is little doubt that these amphipods were in fact consumed by wide ranging trout, but this is a natural process. Our observations on the habitat preferences of the Neur Lake amphipod indicate that these amphipods could not possibly survive over a long period of time in the areas of Neur Lake over three meters in depth. These areas have a muddy, anaerobic muck substrate with absolutely no production of aquatic macrophytes upon which the food base of the amphipod is borne. Thus, the only possible explanation is that these amphipods were wayward migrants into the deeper zones of the lake during the reproductive process when the amphipods become very active and swim about the lake constantly.

Cooper concludes that the amphipods in Sugarloaf lake depend upon aquatic macrophytes for both a source of food and shelter from predation by fish. These are our conclusions regarding the ecology of the Neur Lake amphipod population as well. The density of the Neur Lake amphipod is defintely directly linked to the intensity of the aquatic macrophyte growth. Although we have to date collected no data to support our conclusions, casual observation of the mordab at the north end of Neur

quite obviously supports an amphipod population that may be five to ten times as large numerically and on a biomass basis as the main part of Neur Lake. The reason is that the mordab has a much greater production of aquatic macrophytes over its entire area than the large lake which only supports aquatic macrophytes around the edge of the lake out to about 50 meters from the edge of the lake.

RECOMMENDATIONS AND CONCLUSIONS

Our data collected this year on the Neur Lake amphipod population indicates no departures from the norms of the population dynamics of other amphipod populations faced with predation pressures from fish. All of our data support the exact same observations and conclusions reached by Cooper (1965) in his assessments of the amphipod population, Hyalella azteca, in Sugarloaf Lake, Michigan.

With proper stocking rates of rainbow trout and adequate removal of a large portion of the biomass of fish each year there is absolutely no danger of irreversible ecological damage to the amphipod population of this lake. As the cold water temperatures of winter set in, the rate of predation on the amphipod population by the trout will decrease to virtually nothing. With the onset of warmer water temperatures in the spring, breeding will commense and the two new generations will be produced as the spring gives way to summer. The trout is simply a not predator of great efficiency, and cannot possibly eliminate the amphipod from this lake.

Our investigations of the Neur Lake amphipod population will be intensified in 1354 and 1355 to give us a complete picture of the intense ecological relationships and population dynamics of this invertebrate population in the face of trout predation. Studies will be implemented to document the number and sizes of brood produced by the female amphipods, studies to document the increase in predation efficiency by the trout with the various types of amphipod habitat, and studies to document whether or not the predation by the trout has had an effect on decreasing the average brood size of the amphipods as a result of selective predation by the trout for the larger amphipods.

LITERATURE CITED

Boettcher, J. 1974 (1353a). Neur lake stocking report/amphipod population estimation; 21-25 Ordibehesht 1353. 6 p. Department Environment. Job Progress Report.

Boettcher, J. 1974 (1353b). Neur lake limnologcial investigation II; 6 - 11 Mordad 1353. 17 p. Department of Environment. Job Progress Report.

Cooper, W.E. 1965. Dynamics and production of a natural population of a fresh-water amphipod, Hyalella azteca. Ecological Monographs. 35:377-394.

Mendenhall, W.L., L. Ott, and R.L. Schaeffer. 1971. Elementary survey sampling. Wadsworth Publishing Company. Belmont, California, 247 p.

Nehring, R.B. 1974 (1353). Neur lake limnological survey III 1353 and installation of Neur lake aeration equipment. 30 Shahrivar-12 Mehr 1353. Job Progress Report to Department of the Environment. 21 p.

APPENDIX I

NEUR LAKE AMPHIPOD POPULATION ESTIMATION

3 Aban 1353

The population estimation on 3 Aban 1353, based on a sample size of 14 was 308.57 amphipods/meters^2. This estimate included three data points of zero amphipods/square meter. The 95% confidence limits for this estimate (based on a sample size of 14) was $\pm$ 296.15.

Many statisticians throw out all zero data points. Thus, if we discard the three zero data points and use a sample size of 11, the estimatte is raised to 392.73 amphipods/square meter of substrate with 95% confidence limits of $\pm$ 371.28 amphipods/square meter. Outlined below are the mathematical manipulations for obtaining the standard deviation (s), the variance of the mean ($V(\bar{y})$), and the 95% confidence limits(B) based on a sample size of 14. The population mean and all other parameters cited above can be determined for a sample size of 11 simply by substituting 11 for 14 where the equations have an "n" and 10 for 13 where the equations have an "n-1". These statistical formulas are taken according to Mendenhall, Schaeffer, and Ott(1971).

Note*: The Finite Population Correction Factor (FPCF) is equal to one in this case as the total area of the lake is infinitely large in comparison to our 14 m^2 samples. Thus, $V(\bar{y}) = s^2/n$.

$y_i = 4320$

$\sum(y_i)^2 = 4,751,200$

$(\sum y_i)^2 = 18,662,400$

$(\sum y_i)^2/n = 18,662,400/14 = 1,330,028.57$

The estimated variance of $\bar{y}$: $= V(\bar{y}) = s^2/n$ XX $(N-n/N)^* = s^2/n$.

$s^2 = \sum(y_i - \bar{y})^2/n-1 = \sum y_i^2 - (\sum y_i)^2/n // n-1$

$s^2 = 4,751,200 - 1,330,028.57/13 = 263,167.03$

$s = \pm 513$

$V(\bar{y}) = s^2/n = 263,167.03/14 = 18,797.65$

95% Confidence limits (B) $T_{alpha/2\ D.F.}$ $(\pm\sqrt{V(\bar{y})}$ and $T_{alpha/2\ D.F.}$ for $n-1 = 2.16$

Thus, $B = 2.16\ (\pm\sqrt{V(\bar{y})} = 2.16\ (\pm\sqrt{18,797.65}) = 2.16\ (\pm 137.10) = \pm 296.15$

For N = 11 $s^2 = 305461.82$; $s = \pm 552.69$; $V(\bar{y}) = 27,769.26$; $B = \pm 371.28$;

and the population mean (mhu) $= \bar{y} = 392.73$

APPENDIX I

Table One. Neur Lake 1353 Amphipod Population Data/ meter ^{2} by station

Station #	10 Mordad	3 Mehr	3 Aban
1	3280	400	1440
2	1320	940	1540
3	680	500	340
4	40	0	40
5	800	80	80
6	2200	120	160
7	0	320	0
8	120	3000	40
9	2225	40	40
10	640	0	0
11	520	360	0
12	1480	240	160
13	400	200	320
14	1920	1320	160

Table Two. Neur Lake 1353 Amphipod Population Estimations/meter^2

Date of Estimate	Sample Size	Amphipods/m^2
25 Ordibehesht 1353	7	462/m^2
10 Mordad 1353	14	1116/m^2
10 Mordad 1353	10	1478/m^2
3 Mehr 1353	14	537/m^2
3 Aban 1353	14	308/m^2

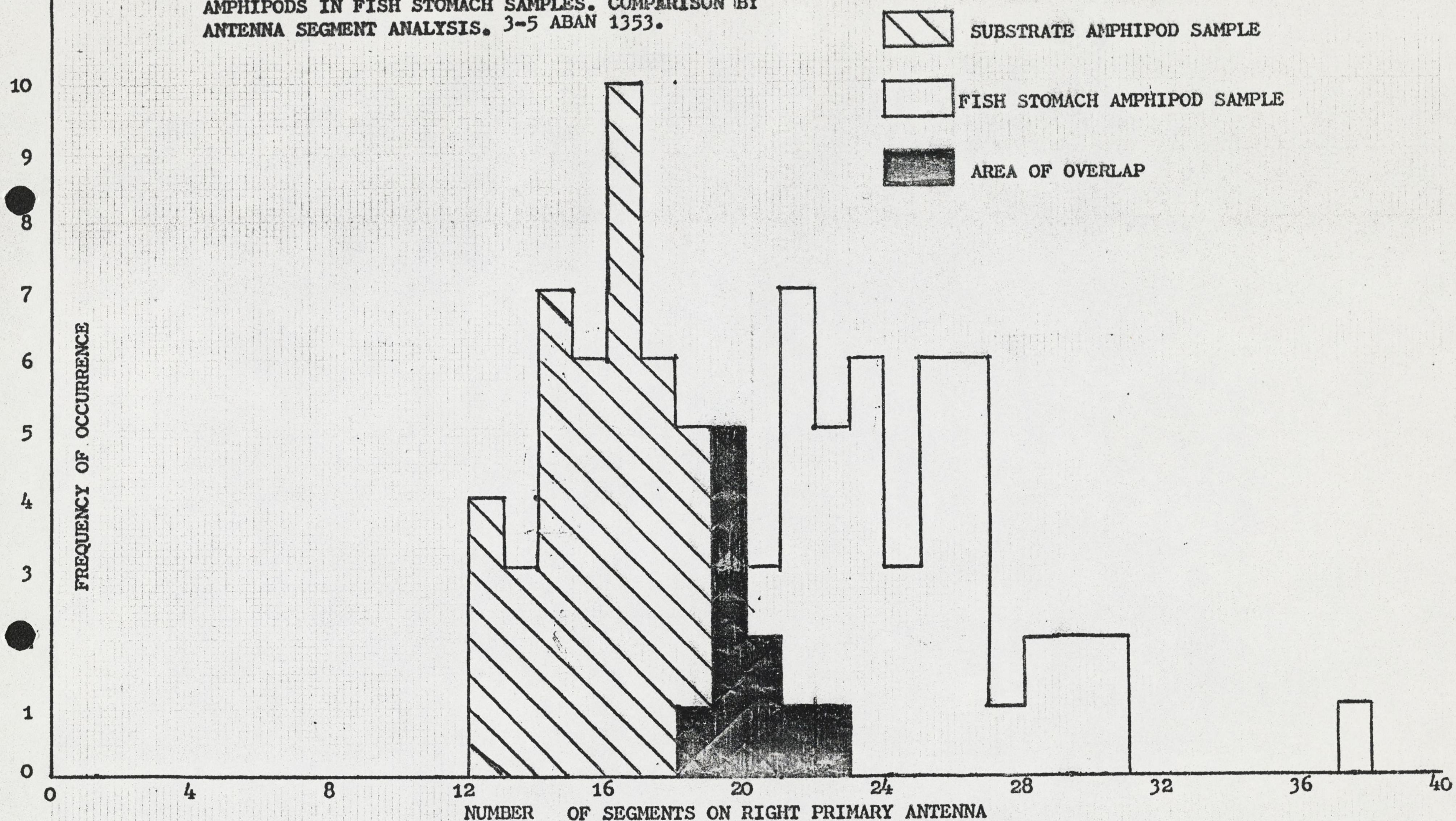
Table Three. Neur Lake Amphipod Antenna Segment Data from 1353.

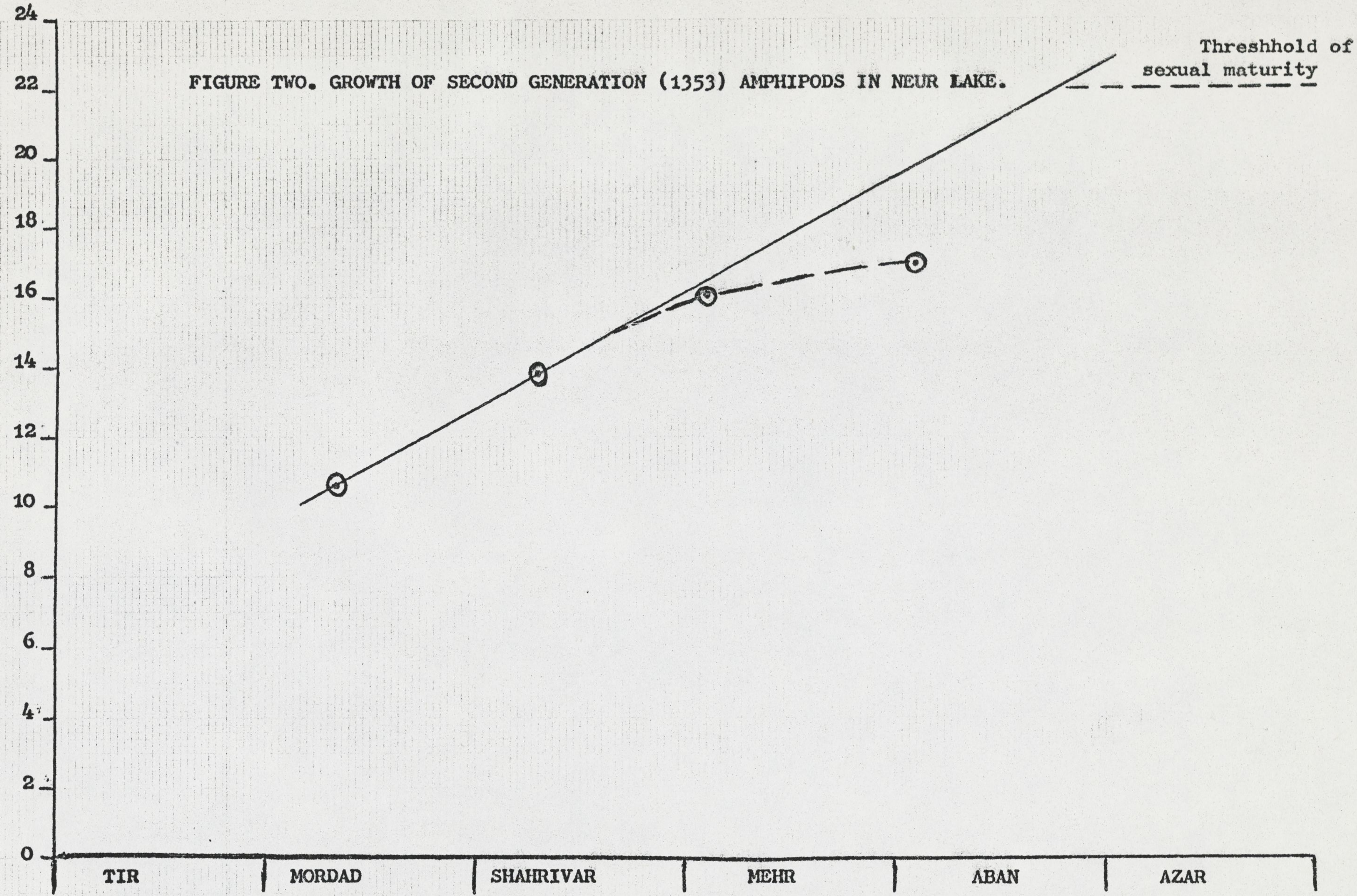
Date of Sample	Stomach Sample			Substrate Sample		
	N	$\bar{X}$	Range	N	$\bar{X}$	Range
10 Mordad 1353	25	25.6	22-31	25	10.6	9-13*
8 Shahrivar 1353	30(53 fish)	22.3	17-32	35	13.8	11-18*
8 Shahrivar 1353	40(52 ")	19.1	11-29	35	13.8	11-18*
3 Mehr 1353	35	17.8	14-28	50	16.0	13-21*
11 Mehr 1353	—	—	—	35	18.2	15-22**
3-5 Aban 1353	50	23.7	18-37	50	17.0	13-22*

Note*: Amphipods collected from all over the lake on population estimate

Note**: Collected 2 meters from shore in 40 cm of water as compared to a 1.5 meter average depth on all other amphipod substrate samples.

FIGURE ONE. COMPARISON OF AMPHIPOD SIZE IN THE LAKE WITH AMPHIPODS IN FISH STOMACH SAMPLES. COMPARISON BY ANTENNA SEGMENT ANALYSIS. 3-5 ABAN 1353.





24
22
20
18
16
14
12
10
8
6
4
2
0
FIGURE TWO. GROWTH OF SECOND GENERATION (1353) AMPHIPODS IN NEUR LAKE.
Threshhold of sexual maturity
TIR
MORDAD
SHAHRIVAR
MEHR
ABAN
AZAR

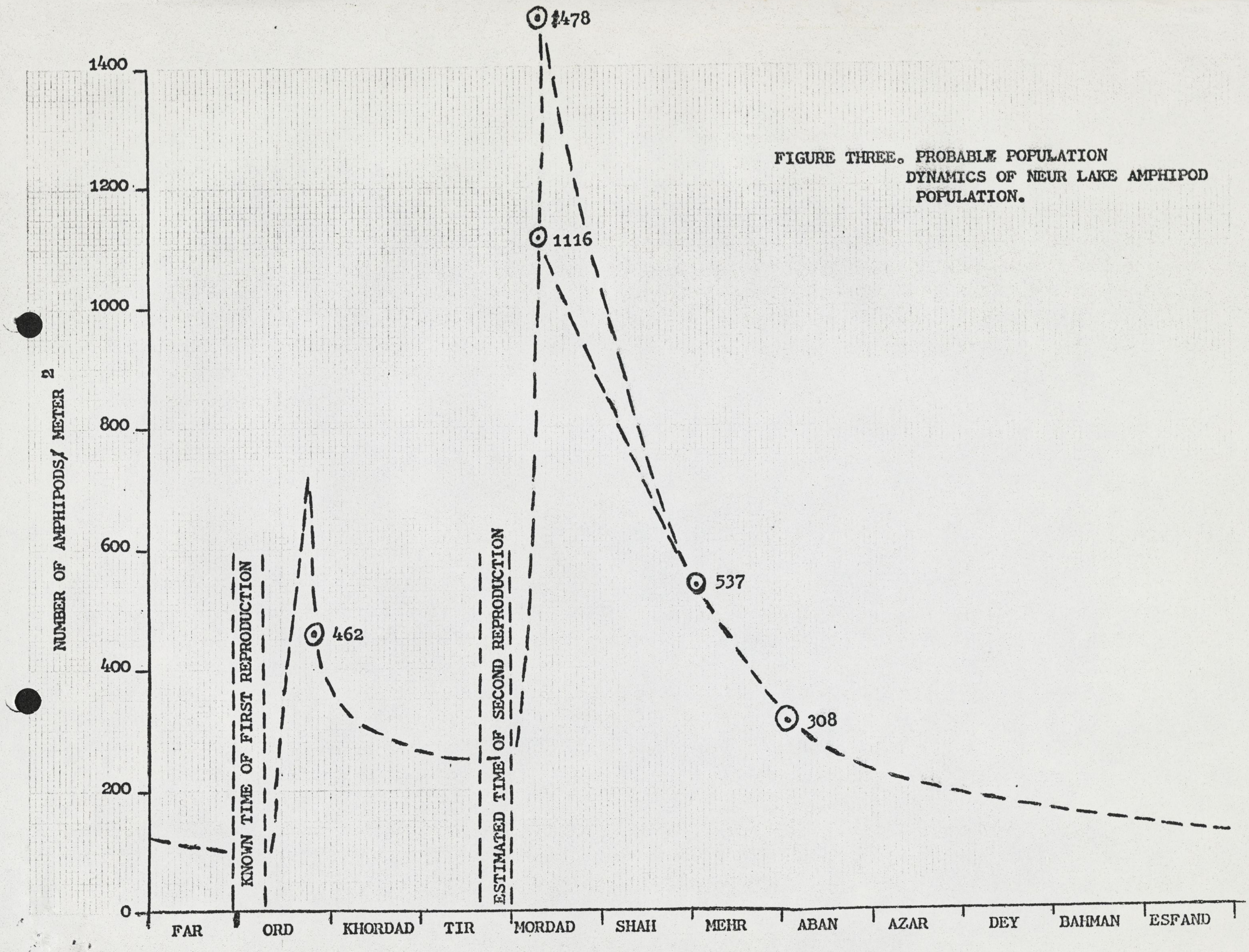


FIGURE THREE. PROBABLE POPULATION DYNAMICS OF NEUR LAKE AMPHIPOD POPULATION.

JOB PROGRESS REPORT

DEPARTMENT OF THE ENVIRONMENT

Fisheries & Aquatic Ecology Section

Submitted To:

Dr. M.T. Farvar, Chief

Human Environment Division

Submitted By:

Barry Nehring, Advisor

Fisheries & Aquatic Ecology

NEUR LAKE LIMNOLOGICAL SURVEY III 1353
AND
INSTALLATION OF NEUR LAKE AERATION EQUIPMENT

30 Shahrivar - 12 Mehr 1353

L - 6 - 53

ABSTRACT

The Neur Lake helixor aeration system was installed between 4 - 10 Mehr 1353 with some technical difficulties described in this report. The amphipod population averages 537 amphipods/meter^2. This 50 % decrease in the population level since 10 Mordad is believed to be due to natural phenomena (natural mortality) and not due to predation by rainbow trout. Gill net catch per unit effort data give a CPUE (catch per unit effort) of 0.35 kg/ meter/12 hours. To catch 300 kg/day it is necessary to fish 1000 meters of net, or 3000 meters of net to catch one metric ton/day. The 1352 stock trout now average 48 cm and 1623 grams, while the 53 stock average 27.5 cm and 310 grams. The purchase of an Atlas Copco UT-85 portable compressor is recommended for the aeration system.

Title: Neur Lake Limnological Survey III 1353 and Installation
of Neur Lake Aeration Equipment.

Project Number: L-6-53

Work Projects Initated: WP 1 General Survey
WP 2 Fish & Aquatic Invertebrate Collections
WP 4 Population Estimations
WP 5 Stocking & Analysis
SP - Special Project:Installation of Helixor Aeration System

Period Covered: 30 Shahrivar 1363 - 12 Mehr 1353

Personnel: Barry Nehring, Fisheries Advisor
Jack Boettcher, Aquatic Ecologist
Saied Hosseini Emami, Fisheries Biologist
Mohammad Saadati, Fisheries Biologist
Ali Soltanpour, Algalogist
Ramazan Yahyavi, Fisheries Technician

INTRODUCTION

A fourteen day survey was conducted on Neur Lake to further analyze the growth rates of the rainbow trout stocked in this lake in 1352 and 1353, complete a population estimation on the amphipods, collect water quality data, analyze the phytoplankton and zooplankton populations, and install the aeration equipment.

METHODS

The water quality data was analyzed on a modified Hach Kit and the water samples were collected using a Kemmerer Water Sampler. Fish specimens were collected using gill nets with mesh sizes ranging from 40 mm to 60 mm. The amphipods were collected using a modified aquatic weed core sampler. Zooplankton and phytoplankton samples were collected using a plankton net. The piping for the aeration system and the helixors were installed using three boats with outboard motors. The piping was stretched with a fourteen foot fiberglass boat and 40 hp motor. The piping was laid using the 13 foot aluminum boat and the Zodiac 9 foot rubber raft, both equipped with 6 hp outboard motors.

RESULTS

Physical Data

Water quality data was measured at the south end of the lake in the deepest part with a depth of over 5 meters. No significant changes were noticed in any of the parameters measured. For details, see Table One below.

Table One. Water Quality Data, Neur Lake, 3 Mehr 1353, 1000-1200 hours

Depth (m)	D.O. (mg/l)	Alkalinity (as	Hardness mg/l $CaCO_3$)	pH	Water Temp (C)	Air Temp (C)
Surface	7.4	150	135	7.3	12	18
1	7.6	136	150	7.2	11	18
2	7.4	120	120	7.0	11	18
3	7.0	130	150	7.2	11	18
4	7.2	130	150	7.3	11	18
5	6.4	120	150	7.1	10.5	18
NE Spring	4.6	55	77	6.8	8.5	18

The area of Neur Lake was previously calculated to be 245 hectares. This was a very crude estimation made by pacing off half the perimeter of the lake and estimating the distance across the lake. This measurement was made on our Ordibehesht survey this year (Nehrong, 1353). This was an overestimate of about 26%. The new estimate of the area of the lake is 181 hectares and this is believed to be accurate to $\pm 10\%$. This is the main body of the lake and does not include the mordabs at the north and south ends of the lake. The new area was calculated by measuring off one kilometer on the shoreline and measuring this distance in the time required to travel one kilometer with the 13 foot aluminum boat and 6 hp motor. Knowing this time to travel one kilometer, the entire length and breadth of the lake was traversed with the aluminum boat and the time recorded to travel this distance. From this data it was possible to calculate the length and width of the lake quite accurately. These measurements were made during calm (no wind factor) weather. The total north south length of the lake was calculated to be 2236 meters and the east-west width 812 meters. Neur Lake is almost a perfect rectangle and by multiplying these two measurements, an area of 181.6 hectares is obtained.

The helixors were all installed at an approximate depth of three meters. The main air line from the compressors is about 400 to 420 meters long and runs 300 meters into the water from the east bank of the lake. At the 300 meter point from shore, a 4-way pipe divider branches out radially with each helixor installed on the end of 180-200 meters of piping. A total of 19 (50-60 meters) rolls of polyethylene tubing were used in the installation of the system. A total of 30 rolls were purchased for the project. The piping was 1.5 inches in diameter and was sunk to the bottom of the lake using 15-16 kg concrete anchors clamped onto the pipe with 2 inch hose clamps. A total of 500 concrete block were made for anchors and only 300 were used. After the first season of operation of the aeration system, modifications will undoubtedly be necessary to improve the overall efficiency of the system. This will require the laying of additional piping and anchors. With the extra piping and left over concrete anchors, no additional cash outlays will be required. For details on the installation and layout of the aeration system, see Figure Five in the Appendix. This is a schematic representation of the aeration system as it is now installed in Neur Lake.

Biological Data

The Neur Lake rainbow trout stocked in 1352 and 1353 continue to exhibit good growth. The 1353 stocked trout are just beginning to exhibit an acceleration in their growth rate and will probably almost average 400 grams before ice cover this winter. The biometric data collected from the fish caught on this trip is presented in Table Two below.

Table Two. Biometric Data, Rainbow trout, Neur Lake, 30 Shahrivar-12 Mehr 53

1353 Stock	N	$\bar{X}$	Range
Length (cm)	353	27.5	21-32
Weight (g)	399	309.6	125-550
1352 Stock	N	$\bar{X}$	Range
Length (cm)	20	47.9	42-54
Weight (g)	20	1623	1250-2050

Figure One in the Appendix is a plot of the length weight relationship derived from the biometric data on the growth of rainbow trout stocked in Neur Lake. It clearly indicates the fantastic increase in weight of the trout between 30 cm and 40 cm. The growth curve has an angle of 75 degrees with the horizontal once the fish reach 30 cm in length.

Figure Two is a plot of the length-weight biometric data from the fish stocked in Neur Lake in 1353. This growth curve is much less steep than the curve in Figure One, indicating the trout stocked this year have not yet reached the point where they put on maximum weight for a unit increase in length. This curve may begin to shoot upwards in mid to late Aban 1353, but will probably not occur until Ordibehesht 1354.

The standing crop or biomass of fish in Neur Lake at the present time is conservatively estimated at 58 metric tons or 58,000 kg. Fifty metric tons is comprised of the fish stocked in 1353 and the other 8 tons of the 1352 stock (5000 trout averaging 1600 grams each).

A standing crop of 58 metric tons is a production of 320 kg/hectare. However, this cannot all be harvested efficiently. Assuming that 50% of the standing crop can be easily harvested, that would be a yield of 160 kg/ha. This production figure is based on the total standing crop.

Using an average weight of 333 grams for the fish stocked this year and assuming a survival of 150,000 fish of the 200,000 fish that were stocked we get a standing crop of 50,000 kg or a yield of 138 kg per hectare. The standing crop in kg/ha for this years stock is 276. In actuality the survival of the 200,000 fish stocked in Ordibehesht was probably better than 90% or 180,000 trout. If this were the case. the standing crop would be 332 kg/ha with a yield of 166 kg/ha on a five month growing season.

The rainbow trout were not consuming amphipods in any measurable numbers during this survey. The amphipods are too small at present to be readily detected and preyed upon by the trout. Thus, the trout were turning to alternative sources of food in the lake. This included fingernail clams, snails, blood worms, and leeches. The latter food item was apparently breeding at the time of the survey and swimming about the lake in a pelagic manner seeking a mate. Probably 95-98% of the food items found in the trout stomachs were leeches during this survey. Many of the trout were so gorged on the leeches that they were found disgorging masses of leeches once entangled in the gill nets. It is good to know that the trout will feed on the other abundant food items in the lake when the amphipods (preferred forage) are unavailable to the trout. Our bottom sampling for amphipods revealed the leeches to be at least as abundant as the amphipods on a square meter basis, if not more so. Blood worms were also equally abundant. The amphipods averaged 537/m^2 on this survey. Snails were estimated at more than 100/m^2 and the fingernail clams(Pelecypoda), probably <u>Psidium</u>, are undoubtedly the most abundant invertebrate in the lake. In some areas they are found as abundant as 10,000 to 100,000/m^2.

The Neur Lake amphipod estimate this time was 537 amphipods/m^2. This is down significantly from the 1116 amphipods/m^2 estimate in early Mordad (Boettcher, 1353). However, I believe that this reduction in the population is a natural phenomenon that would occur regardless of whether or not the fish were present in the lake. Boettcher (1353) found that no amphipods with less than 20 antenna segments could be found in the fish stomachs in Mordad, despite population levels of greater that 1100/m^2. Our Mehr survey again supported this conclusion. The amphipods in the fish stomachs average 17.8 antenna segments. Although this does indicate some predation on the amphipod population at this time it must be realized that the amphipods have only reached an average of 16 antenna segments since late Shahrivar. This means that the trout have just begun to feed on the largest amphipods available in the population. Thus, it must be concluded that the 50 % decrease in the population is due to natural phenomena and NOT due in any measurable amount to fish predation.

Table three below lists the biometric data on the Neur Lake amphipod population as of 2-3 Mehr 1353.

Table Three. Neur Lake Amphipod Biometric Data, 2-3 Mehr 1353

Sample Type	N	$\bar{X}$	Range	
Substrate Sample (1.5 m)	50	16.04	13-21	
Substrate Sample(40cm)	35	18.20	15-22	(11 Mehr 53)
Stomach Sample	35	17.77	14-28	

DISCUSSION

Amphipod Population Dynamics & Ecology

Amphipods are preyed upon by trout on a size selective basis with the largest amphipods being taken first. Our data indicates that trout do not prey on amphipods with fewer than 17-18 antenna segments on the average for two reasons. First, the amphipods smaller than the 17-18 antenna segment stage are too small to be easily detected by the trout on a large scale basis. Second, the amphipods lead a benthic, sedentary existence prior to attaining sexual maturity and thus go undetected by the trout. Upon attaining sexual maturity the amphipodsbecome pelagic in habit, ranging throughout the lake in search of a suitable mate. At this stage the amphipods are readily available to the trout.

The amphipods definitely produce two generations each year, possibly three. Figure Three in the Appendix depicts a hypothetical population producing three generations a year.Projected antenna segment development of the second generation from this year indicates sexual maturity is possible in late Aban-early Azar this year. That would mean the third generation would develop under ice cover this winter.

Figure Four in the Appendix indicates a population producing two generations per year. This is the most probable case for several reasons. First, as the water temperature drops in Aban-Azar, the development of the amphipods will slow proportionally.Also, Pennak (1953) indicates breeding in amphipods is temperature dependent and below a certain temperature breeding is inhibited. This would indicate that a third generation being produced in Aban-Azar is highly unlikely prior to ice cover.

Amphipods collected in the inshore area on 10 or 11 Mehr 1353 average two more antenna segments than those amphipods collected in the pelagic zone of the lake on 2-3 Mehr 1353. This indicates that the trout are probably cropping off the larger amphipods in the open water areas of the lake, but not in the shallow water areas. This indicates our antenna segment counts are probably biased on the low side and that our data indicates a two to three week lag in the development of the amphipods. This is not the real case. The population in general is probably at the same stage of development as those amphipods collected on 10 Mehr in the inshore areas of the lake.

According to Figures Three and Four in the Appendix, the first generation of amphipods this year probably bred around the first of Mordad. The presence of amphipods in the trout stomachs on 10 Mordad averaging 25-26 antenna segments and 22-23 antenna segments on 8 Shahrivar indicates that the adult amphipods may live three to five weeks or longer after successful copulation and reproduction. A few adults of extreme longevity even turned up in the stomach samples on 2-3 Mehr 1353.

The time of first breeding each spring is definitely dependent on water temperature in Neur Lake amphipods. Last year (1352) the amphipods were first observed breeding on 25-26 Ordibehesht and the water temperature was 7-8 C. This year the amphipods were observed in copulation on 3-6 Ordibehesht when the water temperature was 2-3 C. (Nehring, 1352, 1353). By 25 Ordibehesht these amphipods had already produced this year's first generation and these amphipods were already at the 16-17 antenna segment stage. However, it must be noted that the water temperature on 25 Ordibehesht this year was 17 C as compared to 7 C one year before on the same day. This would indicate that the amphipods were developing very rapidly after hatching from the eggs and discharge from the marsupium of the female.

Rainbow trout fecundity

All of the female trout stocked in 1352 are sexually mature now, as are all of the male trout stocked both in 1352 and 1353. This is not an unusual phenomenon. Male trout often mature one year ahead of the females of the same age, especially under the ideal food conditions found in Neur Lake. No female trout stocked this year were found to be sexually mature. Only one female even had a granular ovary. The fecundity of the 1352 stocked females is very high with a 1600g female producing 4400 eggs. This is an exceptionally high fecundity. Hatchery brood fish normally produce about 2000 eggs per kilogram of body weight. These fish produce 3000 eggs/kg body weight. In the spring of 1355 if it were possible to seine out 5000 to 10,000 female (2 kg each) the Department would be able to market 30,000,000 to 60,000,000 high quality rainbow trout eggs. At a price of several tomans per 1000 eggs a very large additional revenue could be easily generated for the Department in addition to the revenues derived from the commercial marketing of the trout.

Technical Requiremnts for Commercial Fishery

On this survey efforts were made to obtain accurate estimates of the possible gill net catch of trout and to calculate catch per unit effort indicators in order to plan on the amount of gill net needed for various catch rates.

On 2-3 Mehr we fished 140 meters of gill net for 24 hours and caught 35.4 kg during that period. However, only 100 meters of net were effective in catching the trout as forty meters of net was 6 cm mesh and did not catch any fish. Thus, our catch per unit effort (kg/meter of net) was .354 kg in 12 hours. The fish avoid the gill nets during day light hours; thus, the catch per unit effort is calculated on a 12 hour basis. From 3 Mehr through 10 Mehr we fished only forty meters of net and except for one or two days the catch per unit effort was constant at about 0.3 kg/ meter. On one day it was 30-40% below the average and one day it was 20-30% about the average of 0.3 kg/meter.

The gill net mesh size must be between 25 and 40 mm for the most efficient catch per unit effort. Gill nets any larger than this will have a very low efficiency. Furthermore, it is axiomatic that as the fish's body temperature goes down with decreasing water temperature the movement of the fish decreases. Thus, it can be assumed that as the water temperature decreases the net efficiency will decrease also. Therefore, to maintain a constant catch rate it will probably be necessary to increase the amount of net fished each day.

With a catch per unit effort of 0.35 kg/ meter net/12 hours, 1000 meters of net are required to catch 300 kg trout/day. To catch one metric ton/day 3000 meters of net will be required. The net can be in any length up to 500 meters with a width of 2-3 meters.

Technical Difficulties with Helixor System.

Although the requirements (100 cubic feet/minute at 2 atmospheres pressure) were spelled out to the engineer at Pneumatic Company where the Bernard compressor and 10 hp MWM deisel motor were purchased, we have found this motor-compressor system to be totally inadequate on a full time basis to prevent winter-kill. It will work as a standy by unit in case of an emergency for several weeks, but cannot be depended upon to deliver the air needed for the entire aeration season (1 Azar- 1 Ordibehesht). This set up only delivers about 30 cubic feet/minute, not 100 cfm as promised by the engineer. Due to the insufficient capacity of this unit it was necessary to pull out 500 meters of pipe that had been installed in the lake to even make the helixors work at all. As the system is installed now, all four helixors work, but only at about 10-20% efficiency until such time as an adequate compressor unit is installed on the line.

Such a compressor unit has been located and is available in Tehran. The unit delivers 88 cfm at an operating pressure of 100 pounds per square inch (PSIG). As we need only 100 CFM at 30 PSIG, this unit delivers about 300% of the capacity required by the system. By installing a bypass valve for venting the excess capacity we will be able to use this unit very well. In addition, this unit has several features that make it extremely desirable for our operation. It is air cooled, starts electrically, and is completely self contained and totally portable, being mounted on a two wheel trailer that can be pulled behind a landrover. It is small, very compact, and for use in heavy industry (air hammer for heavy construction work). If major overhaul is required, the unit can easily be pulled to Tehran for refitting and service. We feel this unit is more than adequate for our purposes and should give trouble-free service for a long time. The electric starter motor is a very desirable feature that will save alot of hard work and wrist wrenching cranking as is necessary with the MWM-Bernard unit that we have now.

RECOMMENDATIONS AND CONCLUSIONS

Assuming the commercial fishery is initiated within the next two weeks, every effort will be made to collect catch per unit effort data from all of the gill netting operations and with this data attempt to make a population estimation on the rainbow trout stocks of the lake. Data will also be gathered on the water temperature to compare the catch data with decreasing water temperatures and document any decrease in catch due to decreases in temperature.

Additional data will be gathered on the amphipod population to see whether or not a third generation will develop this winter under the ice or not. If time and weather permit, another amphipod population estimation will be attempted as well.

Every effort must be made to insure the installation and proper operation of the compressor system prior to the first of Azar to insure no chance of winterkill during the last three months of 1353. The purchase and installation of the UT-85 Atlas Copco Compressor should insure that winterkill will not occur.

Monthly surveys will be made on Neur Lake during Aban,Azar, Dey, Bahman, and Esfand to document the decrease in dissolved oxygen in the lake. From last year's data we anticipate the helixor aeration system will have to be turned on about 10 Dey 1353 and operate until about 15 Esfand. Whenever the dissolved oxygen levels in the lake fall below 6 mg/l (ppm) the compressor system will be turned on.

At a water temperature of 10-12 C 1000 meters of gill nets (25-40 mm mesh) are needed to catch 300 kg/day. For a catch rate of one metric ton per day 3000 meters of gill net will be needed.

To date, the 200,000 rainbow trout stocked in Neur Lake have in no way caused a decrease in the amphipod population of the lake. The trout feed only upon the largest amphipods present in the population at any one time. Furthermore, they are not an efficient predator upon the amphipods until the amphipods are sexually mature and change from a sedentary benthic existence to a highly mobile, pelagic habit as they search out prospective mates to complete the life cycle. Once the amphipods reach the pelagic, mobile stage of their life cycle they become extremely susceptible to predation by the trout in the open water areas of Neur Lake. However, those adults that restrict themselves to the inshore areas of the lake (where most of the amphipods remain) are never susceptible to predation by the trout on a large scale basis. These conclusions are supported by the extensive study carried out on the amphipod <u>Hyalella azteca</u> by Cooper (1965).

The Neur Lake amphipod will probably not breed again this Iranian calendar year and produce a third generation before Esfand. Although the second generation will probably be sexually mature in late Aban or early Azar, they should be prevented from breeding by the cold water temperatures.

LITERATURE CITED

Boettcher, J. 1974 (1353). Neur lake limnological investigation II, 6 - 11 Mordad, 1353. L-6-53 . Job Progress Report. Department of the Environment. 17 p.

Cooper, W.E. 1965. Dynamics and production of a natural population of a fresh-water amphipod, Hyalella azteca. Ecological Monographs. 35:377-394.

Nehring, R.B. 1973 (1352). Neur lake survey I (Lisar Protected Region). 25-26 Ordibehesht 1352. Job Progress Report. Department of Environmental Conservation. 7 p.

Nehring, R.B. 1974 (1353). Neur lake limnological survey I - 1353, 3-6 Ordibehesht 1353. Job Progress Report. Department of the Environment. 5 p.

APPENDIX

STATION #	DATE	TIME	LOCATION	DEPTH	SUBSTRATE	AMPHIPODS/M^2
1	9/24/74	1500	40 meters offshore	1.5m	sand	400/m^2
2	9/24/74	1530	30 meters offshore	1.5m	sand	940/m^2
3	9/24/74	1600	25 meters offshore	1.5m	mud	500/m^2
4	9/24/74	1630	15 meters offshore	1.5m	mud	0/m^2
5	9/24/74	1645	15 meters offshore	1.5m	sand	80/m^2
6	9/24/74	1700	15 meters offshore	1.5m	sand	120/m^2
7	9/24/74	1730	20 meters offshore	1.5m	mud	320/m^2
8	9/24/74	1800	15 meters offshore	1.5m	detritus	3000/m^2
9	9/25/74	0900	15 meters offshore	1.6m	sand	40/m^2
10	9/25/74	0930	10 meters offshore	1.5m	sand	o/m^2
11	9/25/74	1000	15 meters offshore	1.5m	sand	360/m^2
12	9/25/74	1030	20 meters offshore	1.5m	sand	240/m^2
13	9/25/74	1100	15 meters offshore	1.5m	sand	200/m^2
14	9/25/74	1130	15 meters offshore	1.5m	sand	1320/m^2

NEUR LAKE AMPHIPOD POPULATION ESTIMATION

Estimator of the population mean = u(Mhu)

y_i	$(y_i)^2$
y_1= 400	$(y_1)^2$ = 16,000
y_2= 940	$(y_2)^2$ = 883,600
y_3= 500	$(y_3)^2$= 25,000
y_4=0	$(y_4)^2$= 0
y_5= 80	$(y_5)^2$ = 6,400
y_6= 120	$(y_6)^2$ = 14,400
y_7= 320	$(y_7)^2$ = 102,400
y_8= 3000	$(y_8)^2$ = 9,000,000
y_9= 40	$(y_9)^2$= 1,600
y_{10}= 0	$(y_{10})^2$ = 0
y_{11}=360	$(y_{11})^2$ = 129,600
y_{12}= 240	$(y_{12})^2$ = 57,600
y_{13}= 200	$(y_{13})^2$ = 40,000
y_{14}= 1320	$(y_{14})^2$ = 1,742,400

Population Mean = u = $\sum y_i/n$ = 7520/14 = 537/m^2

APPENDIX

NEUR LAKE AMPHIPOD POPULATION ESTIMATION

The population estimation this time (based on a sample size of 14) is 537 amphipods/m^2. The procedure for calculation of the variance, standard deviation, and 95% confidence limits is outlined below.

$\Sigma y_i^2 = 12,019,000$

$(\Sigma y_i)^2 = 56,,550,400$

$(\Sigma y_i)^2/n = 56,550,400/14 =$

The estimated variance of $\bar{y}$:

$V(\bar{y}) = \frac{s^2}{n}(N-n)/N$ *

*NOTE: The finite population correction factor (FPCF = N-n/N) is equal to one in this case as the total area of the lake is infinitely large compared to the 14 m^2 samples taken to get the population estimate.

Thus, $V(\bar{y}) = s^2/n$ where $s^2 = \Sigma(y_i - \bar{y})^2/n-1 = \Sigma y_i^2 - (\Sigma y_i)^2/n \,/\, n-1$

$s^2 = 12,109,000 - 56,550,400/14 = 12,019,000 - 4,039,314 = 7,979,686/13$

$s^2 = 7,979,686/13 = 613,822$

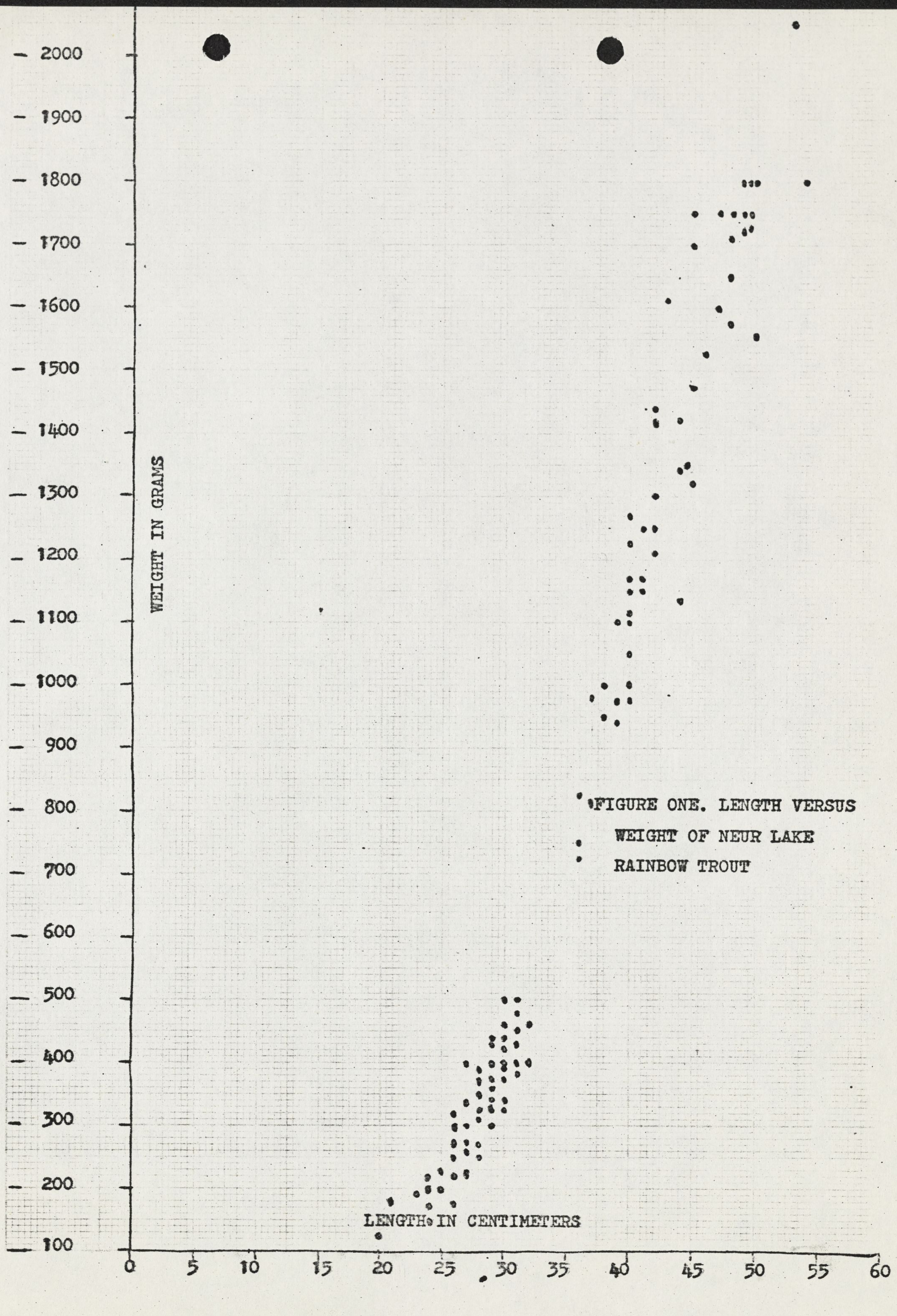
$s = \pm\ 783.5$

$V(\bar{y}) = s^2/n = 613,822/14 = 43,844$

95% confidence limits for the population mean are as follows:

$B = T_{alpha/2\ D.F.}\ (\pm\sqrt{V(\bar{y})}\ )$ and $T_{alpha/2\ d.f} = 2.16$ for n-1 (13) D.F.

$B = 2.16\ (\pm\sqrt{V(\bar{y})}\ ) = 2.16\ (\pm\sqrt{43,844}\ ) = 2.16\ X \pm 209 = \pm\ 451.44$


WEIGHT IN GRAMS
LENGTH IN CENTIMETERS
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
5
10
15
20
25
30
35
40
45
50
55
60
FIGURE ONE. LENGTH VERSUS
WEIGHT OF NEUR LAKE
RAINBOW TROUT

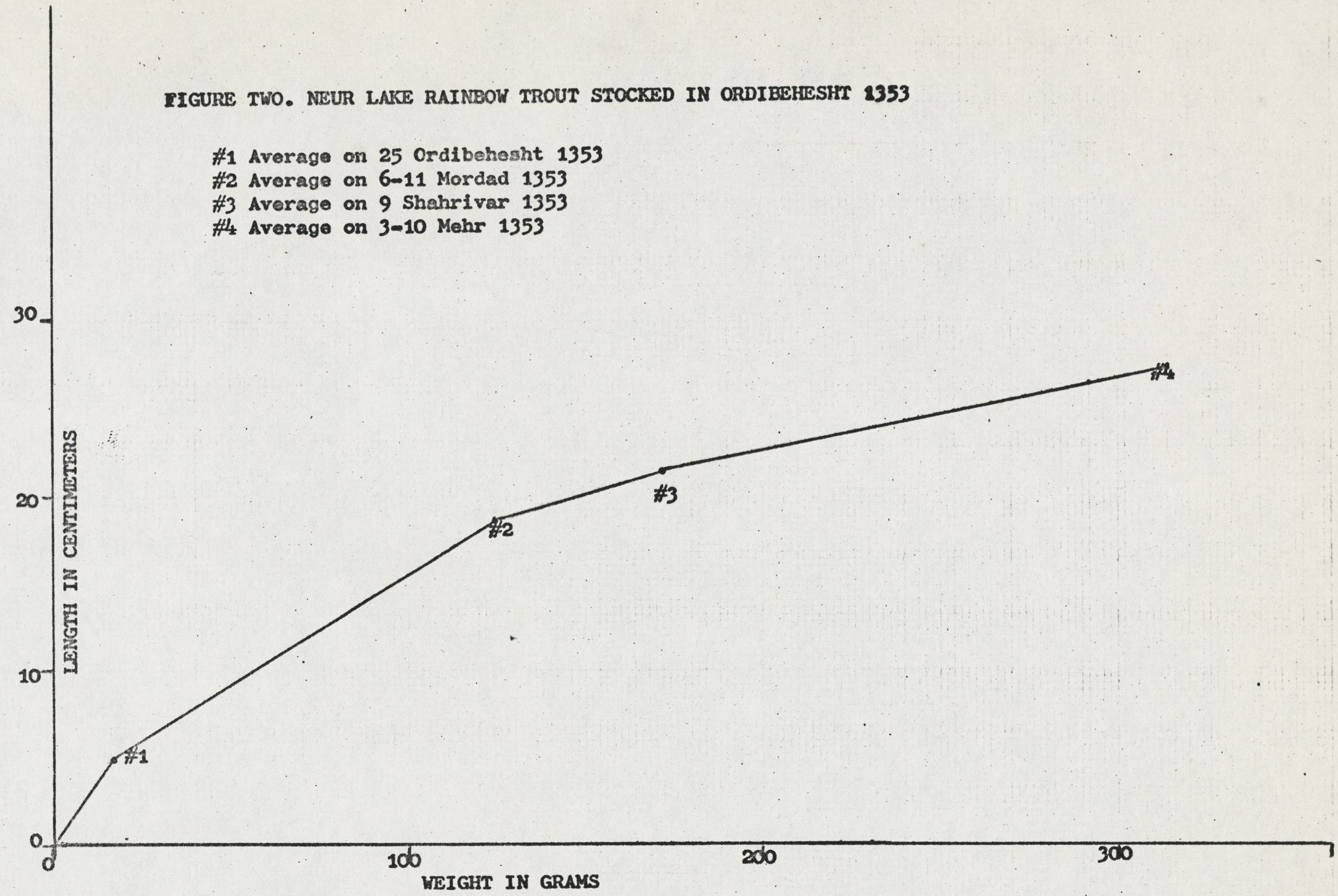


FIGURE TWO. NEUR LAKE RAINBOW TROUT STOCKED IN ORDIBEHESHT 1353
#1 Average on 25 Ordibehesht 1353
#2 Average on 6-11 Mordad 1353
#3 Average on 9 Shahrivar 1353
#4 Average on 3-10 Mehr 1353
LENGTH IN CENTIMETERS
WEIGHT IN GRAMS
0
10
20
30
0
100
200
300
#1
#2
#3
#4

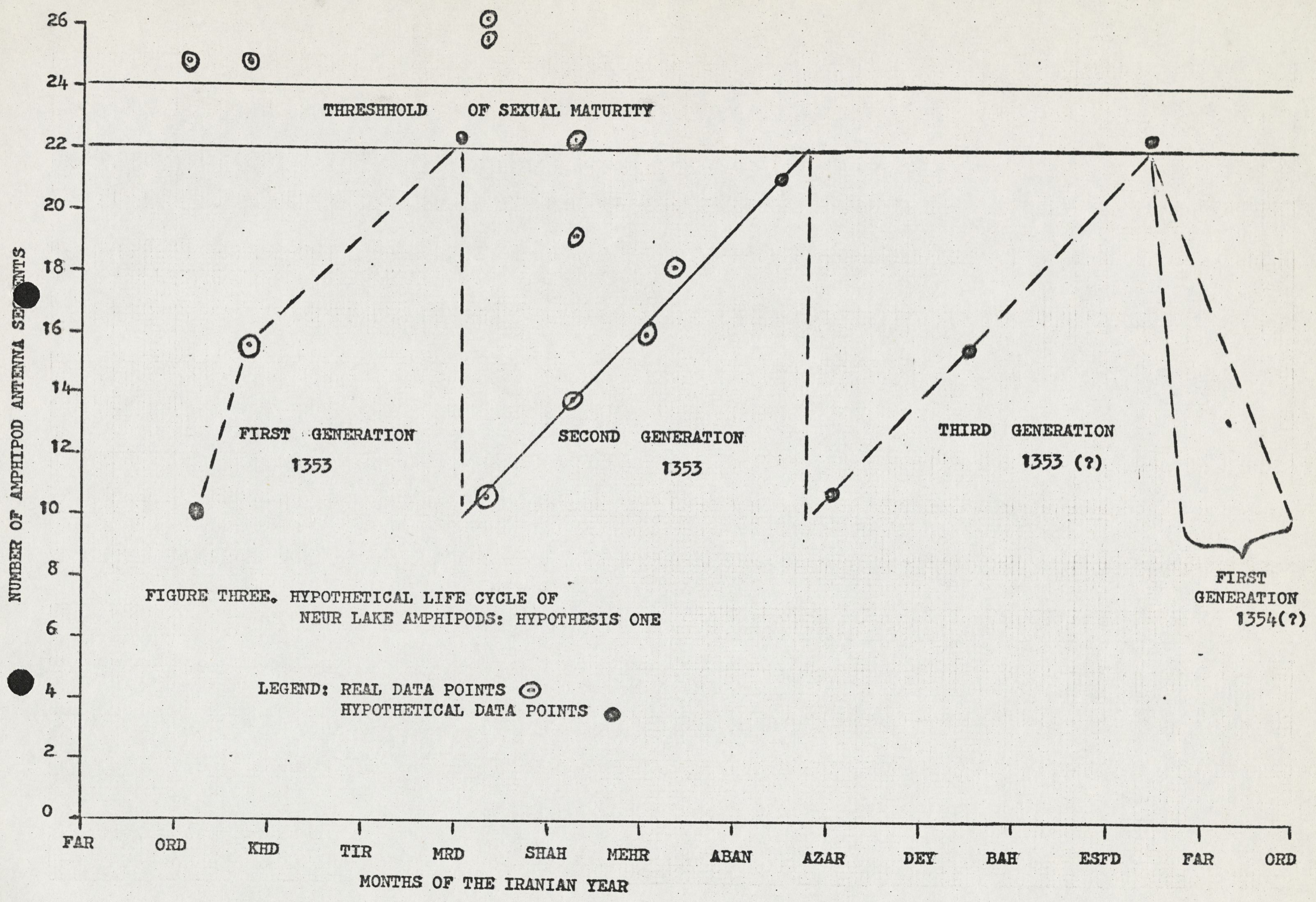
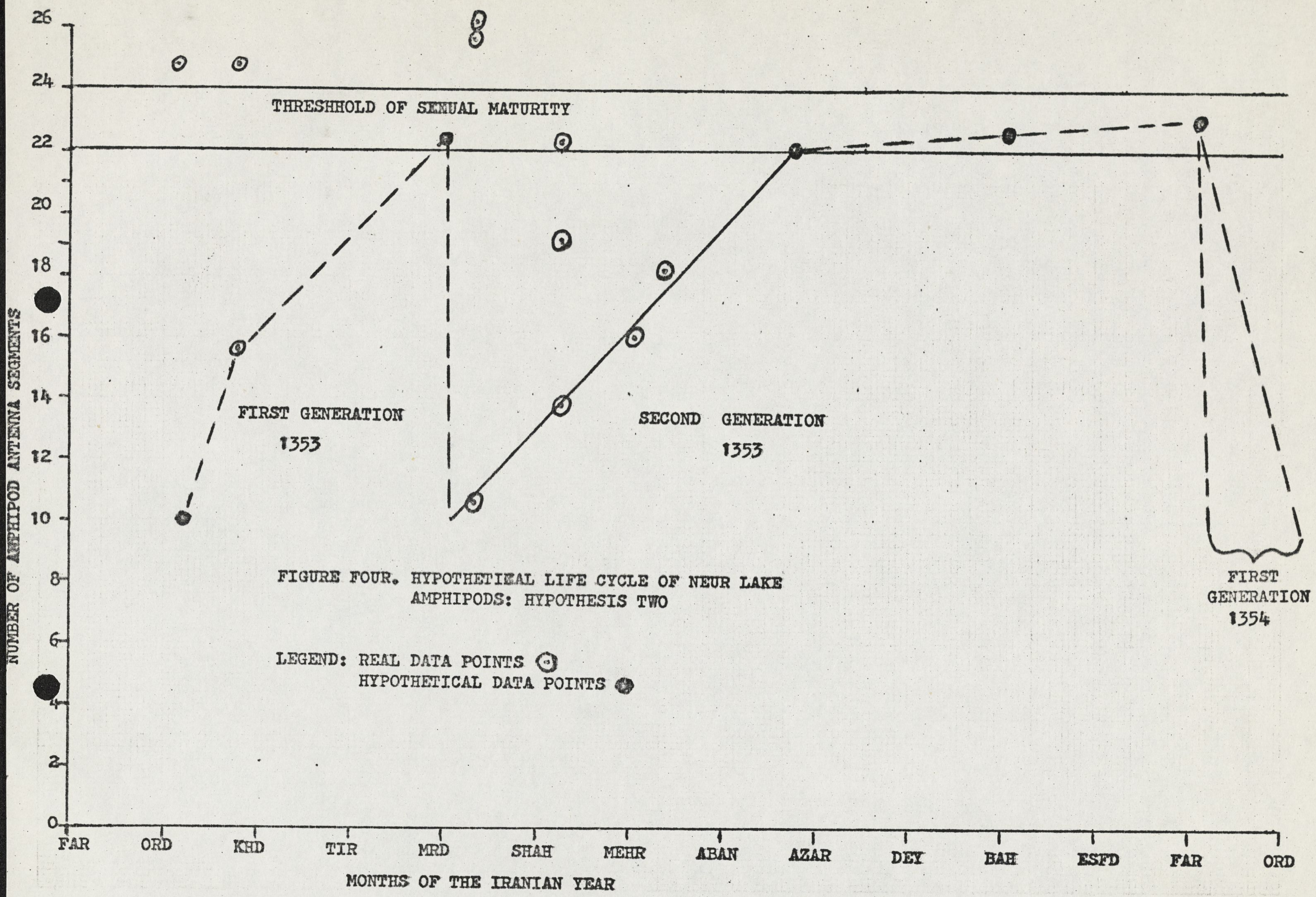


FIGURE THREE. HYPOTHETICAL LIFE CYCLE OF
NEUR LAKE AMPHIPODS: HYPOTHESIS ONE



26
24
22
20
18
16
14
12
10
8
6
4
2
0
NUMBER OF AMPHIPOD ANTENNA SEGMENTS
THRESHHOLD OF SEXUAL MATURITY
FIRST GENERATION
1353
SECOND GENERATION
1353
FIRST
GENERATION
1354
FIGURE FOUR. HYPOTHETICAL LIFE CYCLE OF NEUR LAKE
AMPHIPODS: HYPOTHESIS TWO
LEGEND: REAL DATA POINTS
HYPOTHETICAL DATA POINTS
FAR
ORD
KHD
TIR
MRD
SHAH
MEHR
ABAN
AZAR
DEY
BAH
ESFD
FAR
ORD
MONTHS OF THE IRANIAN YEAR

FIGURE FIVE. BETHYMETRIC MAP. NEUR LAKE, EAST AZARBAYJAN PROVINCE, IRAN
SURFACE AREA - 181 HECTARES (WITHIN 10 %)
1 CENTIMETER EQUALS 100 METERS

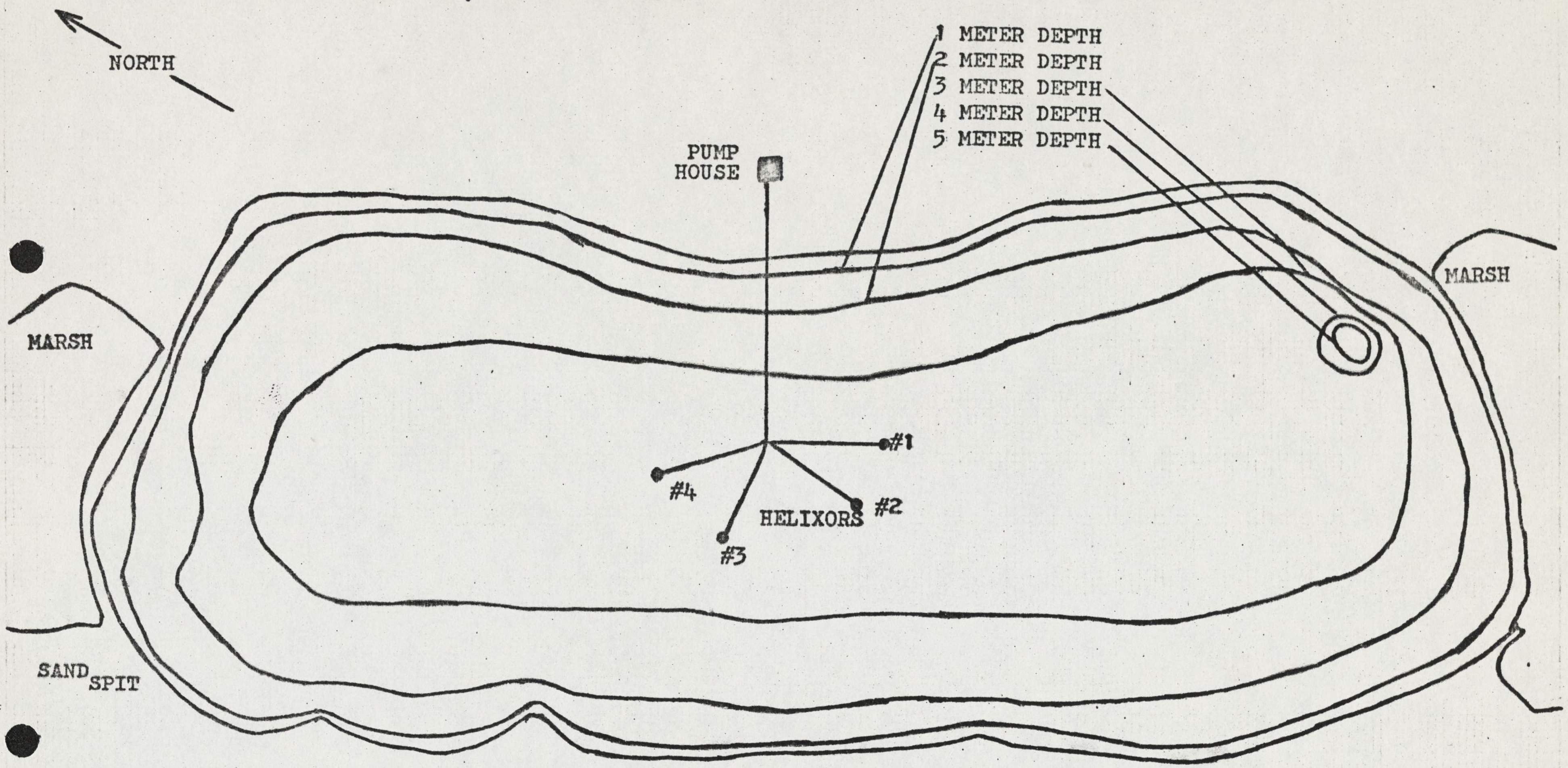
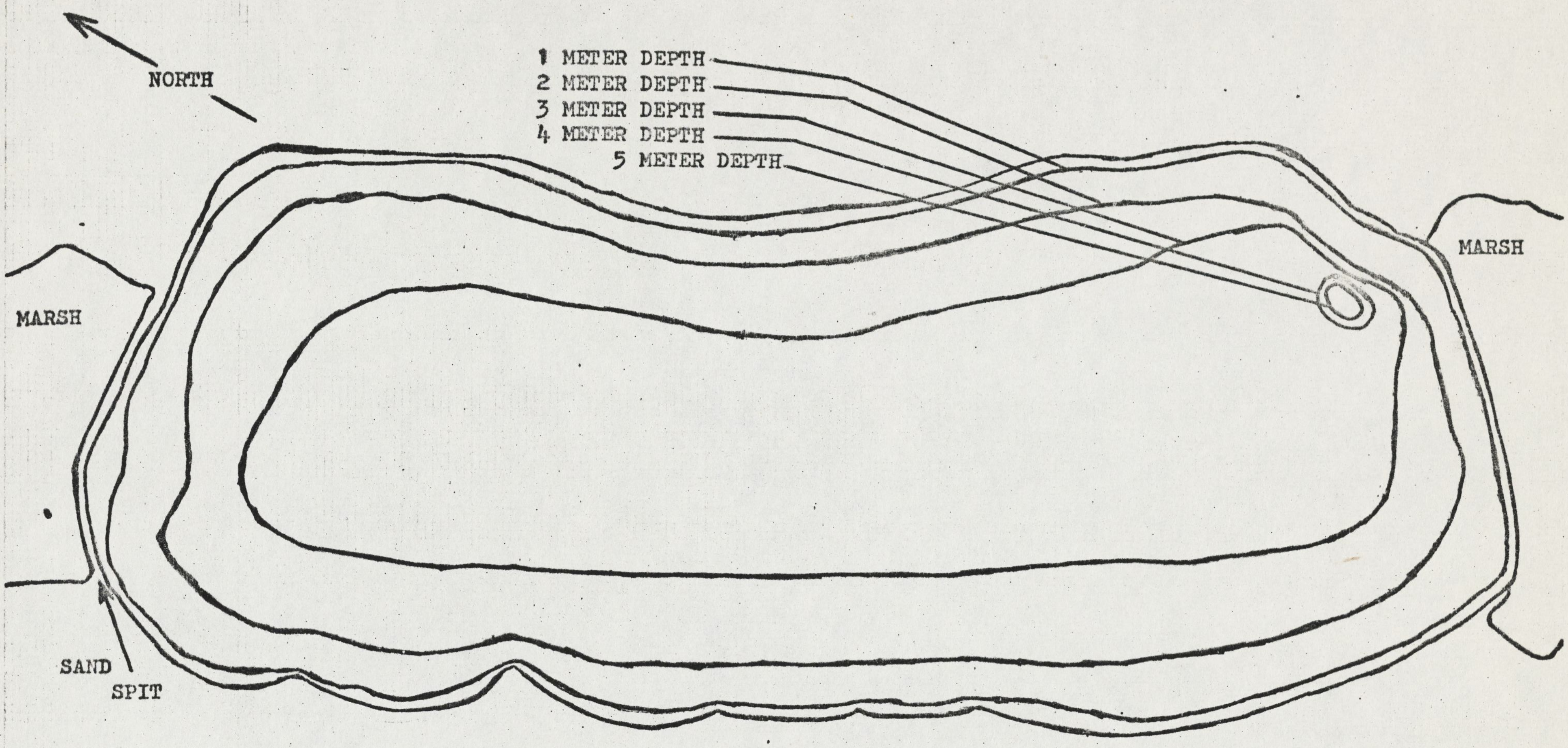


FIGURE FIVE. BATHYMETRIC MAP - NEUR LAKE, EAST AZARBAYJAN, IRAN
SURFACE AREA - 181 HECTARES (WITHIN 10 %)
1 CENTIMETER EQUALS 100 METERS



JOB PROGRESS REPORT
DEPARTMENT OF THE ENVIRONMENT

Fisheries & Aquatic Ecology Group

Submitted To:

Dr. M.T. Farvar, Chief

Human Environment Division

Submitted By:

Hooshang Abbasi, Aquatic Biologist

NEUR LAKE EXPERIMENTAL COMMERCIAL FISHERY

27 Mehr - 16 Aban 1353

ABSTRACT

A 16 day experimental commercial fishery was conducted at Neur Lake from 30 Mehr through 16 Aban 1353. During that period 14098 trout weighing 4630 kilograms were caught. The total weight of the fish marketed by the Jejrud Trout Farm was 3838 kg. Ninety-four large trout from the 1352 stock were also caught, of which 70% were female. In the mordab at the north end of the lake 1083 kg were caught. Temperature of the water on the first day of the fishery was 9.0 C and it decreased to 6.5 C on the last day. Average weight and catch per unit effort (CPUE) data are presented in the report on a daily basis. Recommendations are set forth as to the type of commercial fishery that should be implemented next year, both in regard to time and the type of nets to be used.

Title: Neur Lake Experimental Commercial Fishery

Job Project Number: L-6-53

Work Projects: WP 4 Population Estimation

WP 5 Stocking & Analysis

Period Covered: 27 Mehr - 16 Aban 1353

Personnel: Barry Nehring, Fisheries Advisor (27 Mehr - 6 Aban)

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Ali Soltanpour, Algalogist (27 Mehr - 6 Aban)

Mohammad Saadati, Fisheries Biologist (5-10 Aban)

Hooshang Abbasi, Fisheries Biologist (5-16 Aban)

Ali Ghalamsiah, Accountant (27 Mehr - 16 Aban)

Ramezan Yahyavi, Fisheries Technician (27 Mehr- 16 Aban)

INTRODUCTION

A sixteen day experimental commercial fishery was conducted on Neur Lake. The fish were caught by the Fisheries Unit and delivered to personnel from the Jejrud Fish Farm at the lake, according to the agreement with this company and our department. Fish were collected twice each day (weather permitting) at 6AM and again at 4 PM.

METHODS

Five hundred meters of gill net with mesh sizes varying from 25 mm to 70 mm were set at nine different locations in the main lake and the mordab at the north end of the lake. Neur Lake is naturally divided into two sections as the result of a sand spit across the northern two-thirds of the lake. The nets were set at the locations designated in Figure One of the Appendix. Figure One also provides a list of the length of each net set by alphabetical designation.

Twice each day (at 6 AM and 4 PM) the nets were checked, fish reomoved, weighed, measured, and the biometric data recorded. The fish stocked in 1353 were counted and weighed in 10 kg lots for rapid processing while the large fish from 1352 were handled individually and a sex determination was made at the same time.

Some of the fish had deteriorated in the nets and were not marketable by the Jejrud Trout Company. These fish were set aside and divided among the local workers hired to clean the fish, the local game guards, and the Fisheries personnel.

Biological Data

Biometric data collected from the large trout stocked in 1352 is recorded in Table One in the Appendix. The average length of these trout was 47.3cm; the average weight was 1602 g; and the average condition factor was 1.52 . These fish ranged in size from 40 cm and 900 g (female) to 55 cm and 3025 g (male). All of these fish could readily be distinguished by sex and all were sexually mature with the exception of two females that had granular ovaries but would not be ready for spawning until late spring 1354 or late fall or winter of 1354. All of the other large trout were within one or two months of being ready to spawn.

Catch per unit effort (CPUE) per meter of net and the average weight of the 1353 stocked fish was calculated on a daily basis and recorded in Table Two in the Appendix. The temperature of the air and water was measured and recorded daily to determine the relationship (if any) between the total daily catch and the ambient water temperature. Over the 17 day period of the commercial fishery, the water temperature decreased from a high of 10.5 C to 6.5 C on the last day, or about a 40% decrease in water temperature over the 17 day period. The catch per unit effort decreased about 60% over the same time period from the first day's CPUE of 0.81 kg. As the water temperature decreases the trout experiences a proportional decrease in metabolic activity and this means that the fish does not move about as actively. Thus, the catch rate drops proportionally with decreasing water temperature. However, the decreasing catch is not due to the decrease in temperature alone, but also because our nets were in poor condition and deteriorated significantly over the 17 day period when the nets were in the water. This also caused the catch to decrease.

RESULTS AND DISCUSSION

During the commercial fishery 14098 trout weighing 4630 kg were caught of which 3838 kg were considered marketable and sold to the Jejrud Trout Company. Each day about 10-15% of the trout were damaged in the gill nets to the point where they could not be transported and marketed in Tehran without considerable spoilage resulting. This was the reason for the 16% difference between the total catch and the total received by the Jejrud Fish Company.

The average catch per day was about 900 fish weighing 300 kg. Daily catch statistics are presented in Table Three of the Appendix.

Air and water temperature data are recorded in Table Four in the Appendix. Figure two in the Appendix presents temperature vs CPUE data.

RECOMMENDATIONS AND CONCLUSIONS

A catch of 14098 trout is very small in relation to the 200,000 trout stocked in late Ordibehesht this year. There is still a large population of fish in the lake. For the commercial harvest in 1354 we recommend the use of a 400 meter beach seine 3 meters in width with a 30 mm mesh size on the wings and 20 mm in the bag. This method of harvesting will be much more efficient than gill nets. With a beach seine and the existing population of trout in the lake it should be possible to catch 1500 kg per day; thus, the harvest can be completed in a very short period of time if necessary. Using a beach seine will require a 5 meter wooden boat to operate the seine efficiently. In those portions of the lake where submerged vegetation and shallow water hinder the operation of a seine, gill nets can be employed for the harvest. Apart from taking a long time to catch the fish with gill nets and an exhorbitant amount of labor, the gill nets have the added disadvantage of rendering 10-15% of the catch per day unmarketable. In contrast, the beach seine insures that the trout are absolutely fresh, no physical damage is done to the trout, and it is much more efficient. If gill nets are used in the commercial fishery in the coming year they should be of the 35-40 mm mesh size.

Inasmuch as the greatest portion of the biomass of trout remains in the lake, we recommend that another commercial fishery be implemented in Ordibehesht 1354 just as soon as the weather conditions permit. This commercial fishery should continue until it becomes economically unprofitable to catch any more fish. It should be possible to catch between 60-70% of the biomass in the lake before the point of unprofitability is reached.

If the commercial fishery cannot be implemented in Ordibehesht next year, then it will not be possible to stock the lake until such time as the commercial fishery has been completed. This is to insure that excessive cropping of the amphipod population does not occur. A biomass of 150,000 large trout and an additional 200,000 fingerlings could put undue ecological pressure on the amphipod population.

If the commercial fishery is completed by the end of Ordibehesht or early Khordad then it will be possible to stock 10-12 cm fingerling trout and possibly harvest 400-500 gram trout by the end of Shahrivar 1354. With a commercial fishery in the fall 1354, it is recommended that it be implemented early, probably by the 10-15 Mehr 1354 to insure completion of the commercial fishery prior to the onset of winter.

APPENDIX

Table One. Biometric Data, 1352 Stocked Rainbow Trout, Neur lake 27 Mehr - 16 Aban 1353.

	$\bar{X}$	N	Range
Length (cm)	47.3	80	40 - 55
Weight (g)	1602	80	900-3025
Condition Factor	1.52	80	————

Sex ratio(Males/Females) = 30%/70%

Table Two. Catch Statistics, Neur Lake Commercial Fishery, 27 Mehr-16 Aban 53.

Date	CPUE (kg/m/da)	Effort (meters/da)	Ave. Wt. (g)	Date	CPUE (kg/m/da)	Effort (meters/da)	Ave. Wt. (g)
30 Mehr	0.81	470	316	8 Aban	0.39	560	310
1 Aban	0.78	400	321	9 Aban	0.36	560	339
2 Aban	0.71	400	314	10 Aban	0.41	560	348
3 Aban	0.74	500	325	11 Aban	0.45	560	331
4 Aban	0.72	560	299	12 Aban	0.41	560	318
5 Aban	0.65	560	319	13 Aban	0.46	560	324
6 Aban	0.57	575	324	14 Aban	0.35	560	320
7 Aban	0.56	575	338	15 Aban	0.38	560	328

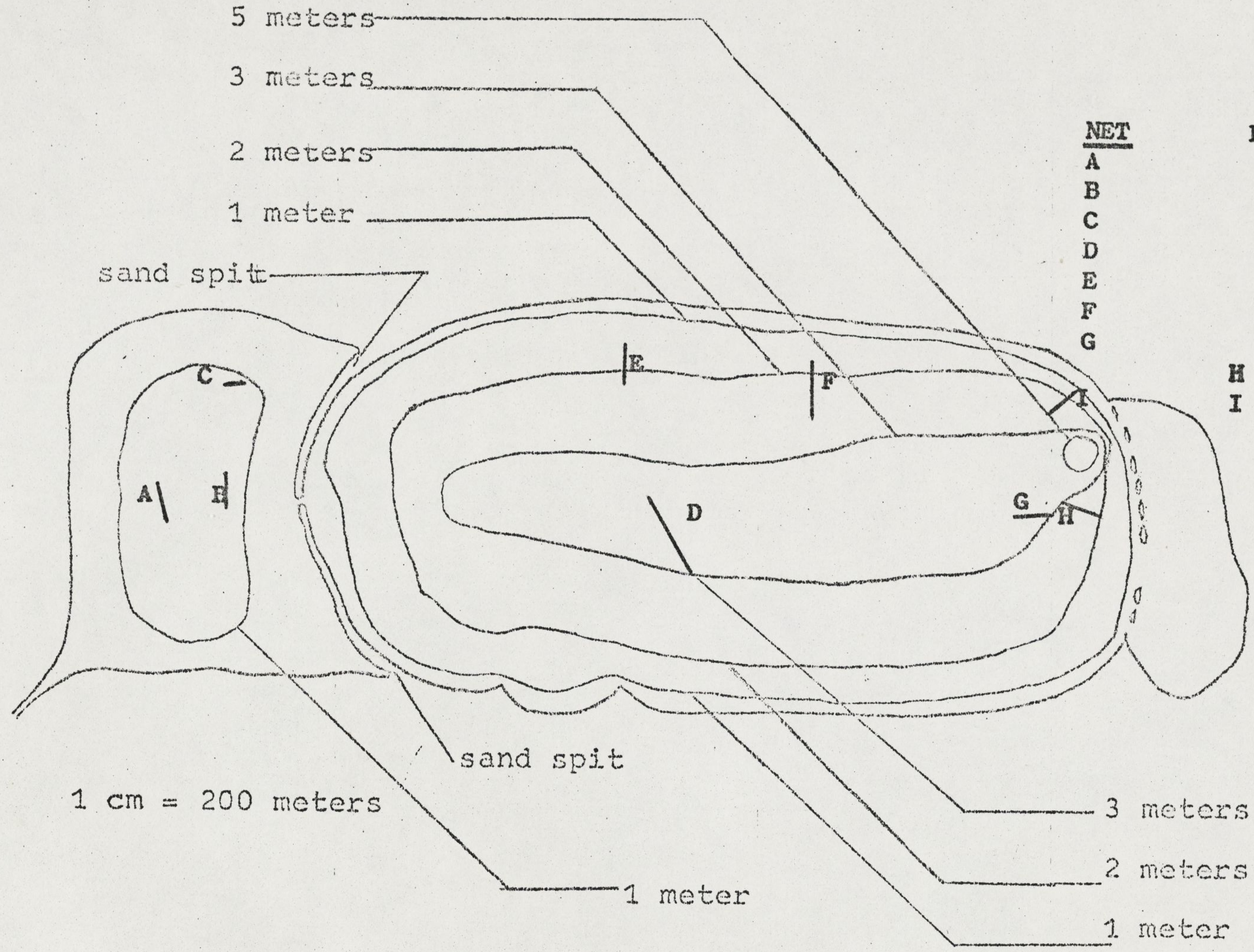
Table Three. Additional Catch Statistics, Commercial Fishery. Total Catch.

Date	small fish		large fish			small fish		large fish	
	Number	wt(kg)	No.	wt(kg)	Date	No.	wt(kg)	No.	wt(kg)
30 Mehr	1151	366	11	15.875	8 Aban	722	224	3	5.150
1 Aban	932	299	9	13.650	9 Aban	589	189	3	4.290
2 Aban	903	284	3	4.325	10 Aban	697	232	4	6.400
3 Aban	1076	349	12	20.288	11 Aban	755	250	5	8.900
4 Aban	1309	391	8	13.015	12 Aban	727	230	4	6.650
5 Aban	1146	366	10	14.725	13 Aban	799	250	2	3.325
6 Aban	993	322	9	14.390	14 Aban	619	198	1	1.450
7 Aban	934	318	9	14.525	15 Aban	652	214	1	1.700
TOTALS*	14004	4482	94	148.658	* Totaled from both columns.				

APPENDIX

Table Four. Water Temperature of Neur Lake from 30 Mehr - 16 Aban 1353

Date	Water Temperature(C)	Air Temperature(C)	Time (hrs)
30 Mehr	9.3	15.8	1300
1 Aban	10.0	15.5	1300
2 Aban	9.5	15.0	1300
3 Aban	9.3	13.0	1300
4 Aban	9.0	13.0	1300
5 Aban	8.5	12.0	1300
6 Aban	8.5	10.0	1300
7 Aban	8.0	10.0	1300
8 Aban	8.0	10.5	1300
9 Aban	8.0	12.0	1300
10 Aban	8.0	12.0	1300
11 Aban	8.0	13.5	1300
12 Aban	8.0	10.0	1300
13 Aban	8.0	9.5	1300
14 Aban	7.5	9.0	1300
15 Aban	6.5	7.5	1300



NET	LENGTH (METERS)
A	50
B	50
C	30
D	130
E	55
F	85
G	50
H	60
I	50

Figure One. Bathymetric Map- Neur Lake,
Showing Placement of Gill Nets During the Commercial Fishery.

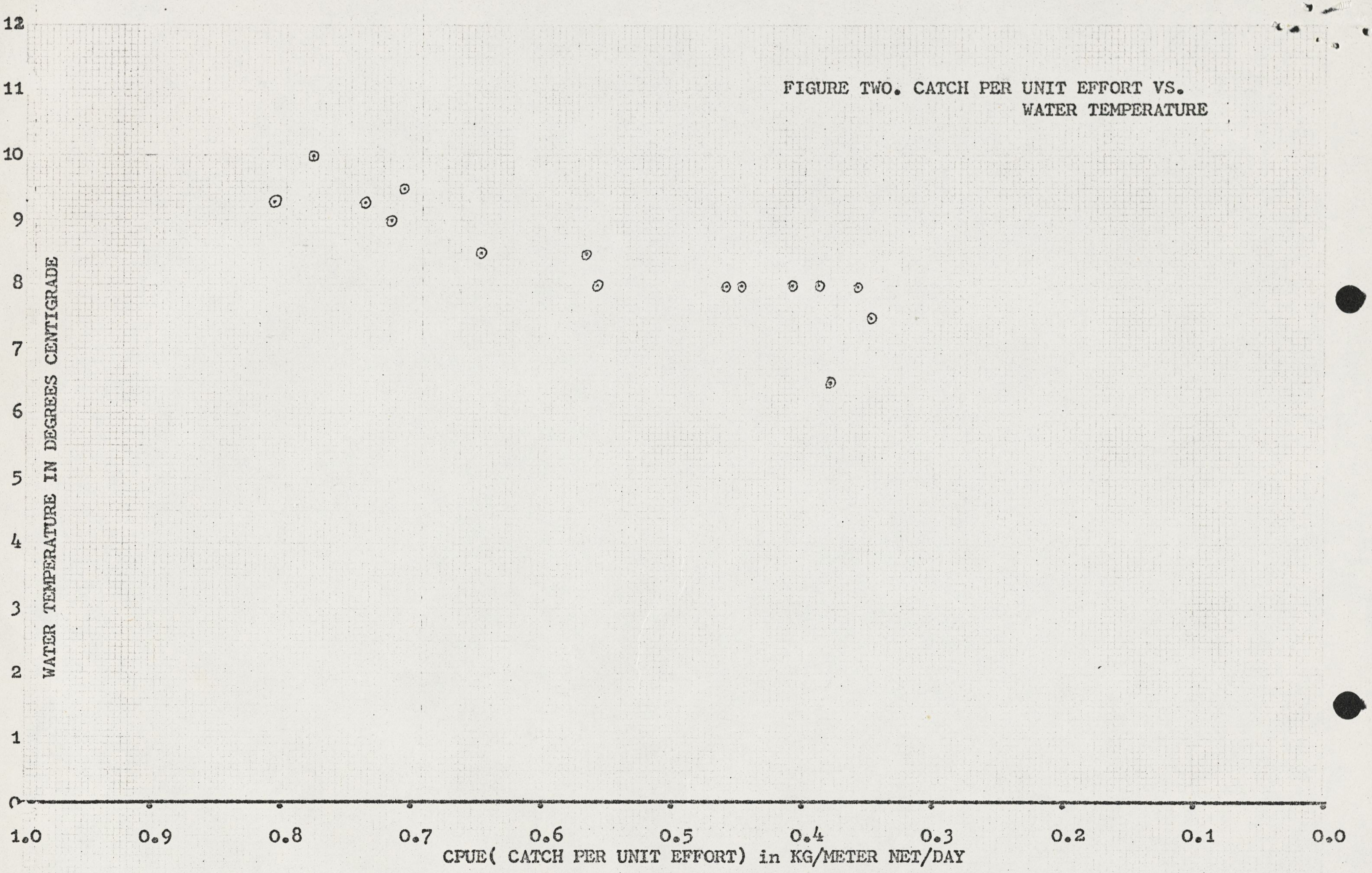


FIGURE TWO. CATCH PER UNIT EFFORT VS.
WATER TEMPERATURE
WATER TEMPERATURE IN DEGREES CENTIGRADE
12
11
10
9
8
7
6
5
4
3
2
1
0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
CPUE(CATCH PER UNIT EFFORT) in KG/METER NET/DAY

JOB PROGRESS REPORT
DEPARTMENT OF THE ENVIRONMENT

FISHERIES & AQUATIC ECOLOGY SECTION

Submitted To:
Dr. F.A. Harrington, Chief
Parks & Wildlife Division

Submitted By:
Barry Nehring, Advisor
Fisheries & Aquatic Ecology

NEUR LAKE LIMNOLOGICAL SURVEY I - 1354

13 - 20 Ordibehesht 1354

L - 7 - 54

ABSTRACT

Eight days were spent in completing the first limnological survey of Neur Lake during the ~~field~~ season of 1975 (1354). An evaluation of the extent of trout mortality was made and estimated at 7 - 10% of the total population in the lake last Aban 1353. An amphipod population estimation was completed and found to be 321 amphipods/ square meter of substrate in the shallow areas of the large lake. The average in the small mordab was estimated at 832 amphipods/ square meter. Analysis of the ecology of Neur Lake by engineers from Polcon Corporation in Canada has supported our conclusions from this winters data and they recommend the installation of another compressor and 4 additional helixors. It is recommended that an additional UT - 85 Atlas Copco Compressor be ordered as soon as possible and that a letter of credit be opened for the purchase of four additional helixors and air freight charges from Montreal to Tehran.

A commercial fishery should be implemented at the earliest possible date to harvest as large a biomass of the trout population as is economically feasible. The harvest should be done with a 500 meter beach seine of 25 mm mesh size. All efforts should be taken to insure proper removal, distribution and dispersal of the fish taken in the commercial fishery to insure that no spoilage occurs.

Title: Neur Lake Limnological Survey I - 1354
Job Project Number: L-7-54
Work Programs Initiated: WP 1 General Survey
WP 2 Fish & Aquatic Invertebrate Collections
WP 4 Population Estimations
WP 5 Fish Stocking & Analysis

Period Covered: 13 - 20 Ordibehesht 1354
Personnel: Barry Nehring, Advisor, Fisheries & Aquatic Ecology
Bruce Sanford, Peace Corps Aquatic Ecologist
Hashemi Nezhad, Afsar Shikarbon II
Ramezan Yahyavi, Game Guard II, Fisheries Technician

INTRODUCTION

Our fisheries management program has been going on an intensive basis for two years now. The fish have been stocked and the aeration equipment has been installed through one winter season. The purpose of this survey was manyfold: 1) To evaluate the extent of the mortality of rainbow trout in the lake this past winter; 2) To collect water quality and limnological data on the lake; 3) To evaluate the increase/decrease in growth of the trout in the lake over the winter months; 4) To install a "fish fence" in the outlet of the upper larger lake to prevent trout from moving out of the upper lake into the lower lake and out the irrigation outlet; and 5) To carry out a population estimation of the amphipod population in the upper lake and orient Game Guard II Ramezan Yahyavi in the techniques of completing an amphipod population estimation so that this data can be collected every two weeks all summer long in the absence of fisheries personnel.

RESULTS

Water Quality Data

Physical and chemical limnological parameters were measured and recorded as presented in Table One in the Appendix. No unusual data was obtained and conditions were as expected. The water temperature was about 9 C throughout the period of the survey which was exactly the temperature during our commercial fishing efforts in Mehr- Aban 1353 (Abbasi, 1974). This fact allowed us to make a more effective evaluation of the extent of the mortality this winter as compared to the general population levels of trout present in the lake last Mehr and Aban. Water quality data was measured in the deepest part of the lake, a pocket of water at the southeasternmost corner of the lake. The lake is 5.5 meters deep at this point. As can be seen from the data in Table One, no stratification exists in the lake and none is expected throughout the entire summer.

Trout Population Analysis

Five days were spent in gill netting to determine how great a decrease in the trout population had occurred due to winterkill this past winter. Four different gill nets were used with three different mesh sizes. The mesh sizes ranged from a minimum of 20 mm to a maximum of 50 mm. The nets were fished all around the perimeter of the lake in an attempt to evaluate the distribution and/or concentration of fish in a particular area of the lake.

Our catch statistics for the five days of gill netting show an average catch of 0.56 kg trout/ meter gill net/day. This compares almost exactly with our commercial fishing statistics for Mehr- Aban 1353. During the 16 day commercial fishery we averaged 0.55 kg trout/ meter net/day (Abbasi, ibid.). The data from the gill netting on this survey is presented in Table Two of the Appendix.

Biometric data on the Neur Lake trout population are presented in Table Three of the Appendix. These data are somewhat biased for small trout as they were all caught in gill nets with a very small mesh size. The optimum mesh size for the trout of Neur Lake at this time would be 40 mm. Thus, the data presented in Table three reflect that segment of the population that is smaller than normal. The 20 mm mesh gill nets were so small that even the smallest fish were only caught by their teeth or tangling their mandibles or maxillary bones in the gill nets. Had the mesh size on these 20 mm mesh gill nets been 35 - 40 mm the catch (as presented in Table Two) with these gill nets would probably have been at least double. Accordingly, our catch statistics might also be biased on the low side.

The biometric data presented in Table Three of the Appendix readily reflect a significant difference in the growth rate of male and female trout, especially those fish stocked in 1353. This is to be expected as all of the male trout were sexually mature last fall, and many still possess ripe gonads (extruding milt) yet. Whenever a fish becomes sexually mature the growth rate slows greatly. However, once the period of sexual activity passes for this year, the male trout will once again begin to grow rapidly as the food resource in Neur Lake is copious to say the least.

The two year old trout (1352 stock) appear to have lost no weight on the basis of the three large trout taken on this survey. We expect these fish to average in excess of 2.5 - 3 kg by the end of this growing season. After the 1st of Shahrivar when the food supply in the lake becomes more restricted and less available to the trout, these fish should provide excellent sport fishing for any anglers present to take advantage to the opportunity.

Figure Three in the Appendix illustrates the approximate location and density of dead trout in Neur Lake as we found them during the week of 13 - 20 Ordibehesht 1354. Although the trout were undoubtedly evenly distributed over the northern half of the lake and frozen in the ice after they died, the wind blew them into the concentrations as shown after the ice melted from the lake. The 13,000 dead fish were counted (estimated) in 100 unit lots by Barry Nehring and Bruce Sanford. It is quite remarkable that only 13,000 trout died during this past winter when one considers that the trout were subjected to dissolved oxygen levels of less than 1 mg/l for over a thirty day period (Tables Nine and Ten, Appendix). Trout tolerance to dissolved oxygen levels this low has never been documented previously. The apparent "acclimation" to 2 mg/l for the 45 day period prior to being exposed to less than 1 mg/l was undoubtedly the reason for the good survival of the trout. Nehring (1975) hypothesized that this acclimation period might be enough to bring the trout through the winter in good condition.

Installation of "Fish Fence" Between the Lakes

During the week of the survey Mr.s Sanford, Nehring, and [illegible] installed a sixty meter long fish fence between the upper and lower parts of Neur Lake in order to prevent migration of fish from the upper lake into the lower lake and then out the irrigation outlet. This fence was to have been installed as soon as possible after ice out, but severe weather conditions prevented its installation prior to our arrival. However, it has been installed now and further migration and loss of fish from the main lake is now prevented. A one day setting of a 50 meter by 2 meter gill net with 20 mm mesh size resulted in a catch of only 15 trout, indicating that very few trout had migrated from the large lake into the small lake.

Amphipod Population Analysis

The amphipod sampling program was intensified this year in an attempt to document any differences or preferences in habitat of the amphipods regarding deeper versus shallow water. Thus, at each of the 14 stations set up in the upper lake (Boettcher, 1974) two substations or samples are drawn, one in water 1 - 1.5 meters in depth, the other in water 2 - 2.5 meters in depth. This will allow us to see if any preferences can be detected in habitat selection by the amphipods. Furthermore, 5 additional stations were set up in the lower lake, which is more productive and shallower than the upper lake. Since the lower lake contains very few fish, the lower lake will serve as a "control" by which to evaluate the amphipod population in the upper lake as it responds to predation by the rainbow trout.

Table Four in the Appendix presents the amphipod population of Neur Lake on a station by station basis with the first 14 stations broken down by substations "A" & "B" . As can readily be seen from the data, the amphipod population appears to concentrate in the area around the "A" substations or the shallow water. The average population data, presented in Table Five of the Appendix shows that we averaged 321 amphipods per square meter. This is somewhat less than the 537 amphipods per square meter found last year by Boettcher(ibid). However, the sample this year was taken a week earlier and it is quite possible that the population level could increase in the next few weeks to equal or surpass the levels of last year. However, if the decrease is real and is due to predation by trout, the amphipod population is still in no great danger. Figure One in the Appendix is a graphic representation of the relation of the amphipod population in the lake to the predation on amphipods by the trout. The "hatched" portion of the graph show that portion of the amphipod population consumed by the trout and the clear portion the amphipod population as it occurs in the lake. The black portion of the graph indicates the areas or percentage of overlap between the amphipod population in the lake and the predation by the trout. The majority of the amphipods consumed by the trout have from 24 to 28 antenna segments which indicates that the trout are grazing upon the oldest 10 % of the amphipod population. Over the summer they may graze down to that level of the population having 20 antenna segments but not much lower. Our data from last year (Nehring, 1974, Boettcher, 1974 b) shows that the majority of the amphipod population in the lake is made up of young immature amphipods at all times. As long as there is no intense predation by trout on the immature stocks of amphipods, no danger exists for the amphipod population.

Table Seven in the Appendix contains data on the fecundity of the female amphipods. The range of egg production is from 16 to 30 with an average of 24. eggs per female produced during a single mating. Pennak (1953) indicates that amphipods often breed continually throughout much of the summer.

The ice on the smaller lake melted off a week or ten days sooner than the ice on the large lake. Thus, it is to be expected that the amphipod population in the small lake is more farther along in the development of the first generation of amphipods for 1354. Such is the case. Figure Two in the Appendix shows that the amphipod population in the mordab is composed of older individuals. The mean antenna development in the large lake is about 17-18 segments while in the smaller lake the mean antenna development is about 22-23 segments.

DISCUSSION

Condition of the Trout Population

How extensive was the trout mortality in Neur Lake this past winter? We estimated 13,000 dead trout along the shores around the northern half of the lake. If there were 130,000 fish in the lake last Aban after completion of the commercial fishery then the total loss would be 10%. If 150,000 fish remained after 17 Aban 1353, the mortality would have been 8.7%; if 180,000 trout remained the total mortality would be 7.2%. Of course, all this assumes our tally of 13,000 was accurate and accounted for all of the loss. This is not necessarily true. Nonetheless, we feel safe in saying that 90% of the population or more survived the winter as our gill net catch would have been significantly lower if a greater percentage of the population had died. If the total loss had been between 25 and 50 percent then our gill net catch would have been correspondingly lower. Murphy (1966) shows that as the fish population decreases, the catch per unit effort also decreases proportionally.

With less than 10% mortality of the trout population in the lake, it is quite necessary that a commercial fishery be implemented as soon as possible. Proper arrangement for both catching of the fish and an efficient system of dispersal and distribution must be provided for. It is also must important that the commercial harvest begin no later than 1 Tir 1354 in order to give adequate time for harvesting of the fish and also to allow for restocking of the lake by Mordad or at the latest 1 Shahrivar 1354. It would be best if the lake could be restocked in Khordad or Tir to allow the newly stocked fish to take maximum advantage of the maximum abundance of the amphipods in the lake during Tir and Mordad; however, without first removing a large portion of the trout population in the lake at present, we would probably suffer excessive mortality of the newly introduced small trout to predaceous large trout.

Although our amphipod population estimate this year ($321/m^2$) is somewhat less than that obtained by Boettcher (1974) last year, no conclusions can be drawn that the decrease is indeed due to intense predation by the trout and that the amphipod population in the lake is in danger of extinction. This will not happen. As can readily be discerned from the graphic analysis presented in Figure One of the Appendix, the trout are feeding <u>only</u> upon the largest 10% of the amphipod population. This was our recurring observation last year. As such there is absolutely no danger of eliminating the amphipod population through excessive predation by the trout.

Examination of the data presented in Tables Nine and Ten (summary of the dissolved oxygen data from Neur Lake this past winter) reveal just how close we actually came to losing all of the fish. The period of acclimation to near lethal dissolved oxygen levels that began on or about the 30th of Dey and continued through the 1st of Esfand 1353 was all important as it allowed to fish to adapt to these near lethal oxygen levels and when the major breakdown of the compressors occurred on the 3rd of Esfand and the oxygen levels dropped to less than 1 mg/l the fish were still able to survive. All this leads one to conclude that drastic redesign of the aeration system needs to be implemented this summer and fall to insure that we are not relying on "Lady Luck" to carry us through again this year.

A detailed evaluation of the aeration system for Neur Lake was requested from Polcon Corporation in Montreal (supplier of the helixors) and has just recently been received. They definitely recommend another four helixors to augment the systems as they are installed now, in addition another compressor or positive pressure blower. Analysis has shown that: 1) four more helixors are necessary to open up a critical area of ice which will allow for additional aeration of the lake water through wind action and wave action. The helixors can only transfer 9% of the actual oxygen pumped into the water when installed at 5 meters depth. When installed at three meters depth this efficiency drops to 6% ! Our evaluation of the oxygen demand of Neur Lake set at 1050 kg per day was substantiated by Polcon Engineers. They supplied further data that indicates the Helixors were putting in only a bit more than 100 kg per day. Even with four more helixors the system will only put in 200 kg per day. Their analysis also showed that: 2) the helixors must be activated earlier in the year to prevent large build ups in ice thickness, and 3) to open up a large enough hole to allow for reaeration of the water through wave and wind action. To accomplsih these last two objectives, it will be necessary to install another UT - 85 Atlas Copco Compressor , install a total of 8 helixors, and locate the helixors all very close together to insure that one large hole of about one hectare in size is kept ice free all winter .

Thus, it is imperative that another Atlas Copco Compressor (UT - 85) be installed this year. Budgetary allotments have been made for the purchase of this unit. Also a letter of credit should be opened immediately for the purchase of four more helixors and their shipment to Iran from Montreal, Canada by air freight as soon as possible.

RECOMMENDATIONS AND CONCLUSIONS

1) It is recommended that another Atlas Copco UT - 85 compressor unit be purchased for Neur Lake for installation late this summer. This unit is absolutely necessary to insure that no fish mortality occurs this winter.

2) It is recommended that an additional four helixors be ordered from Polcon Corporation as soon as possible for installation in Neur Lake this summer. These four helixor units are necessary to insure that a sufficiently large aeration hole is opened in the lake so that additional reoxygenation of the lake's waters occurs through wind and wave action as even eight helixors by themselves can supply only 20-25 % of the total oxygen consumed by biological decomposition during a 24 hour period.

3) It is recommended that a commercial fishery be implemented at the earliest possible date to remove as large a biomass of the trout in Neur Lake as possible to allow for early restocking with more 2-4" fingerlings. This commercial fishery should be implemented with a very efficient system for distribution and dispersal to eliminate any wastage as occurred last year. The harvest itself should be accomplished with beach seines of up to 500 meters in length with 25 mm mesh in the bag of the net. This will be the most efficient method of fish capture and eliminate any unnecessary losses due to spoilage.

4) Our analysis shows that approximately 7 - 10 % of the fish population in the lake was lost due to winterkill in 1353.

5) Our amphipod population surveys show that the amphipod population is not in danger of significant decrease due to excessive predation by rainbow trout. We expect that the amphipod population will continue to expand throughout the summer until mid-Mordad when it will begin to decrease due to cessation of natural reproduction of the amphipod population.

LITERATURE CITED

Abbasi, Hooshang, 1974 (1353). Neur lake experimental commercial fishery, 27 Mehr - 16 Aban 1353. L - 6 - 53. Job Progress Report. Department of the Environment. 9 p.

Boettcher, J. 1974a (1353). Neur lake stocking report/ amphipod population estimation. L - 6 - 53. Job Progress Report. Department of the Environment. 9 p.

Boettcher, J. 1974b (1353). Neur lake limnological investigation II, 6 - 11 Mordad 1353. L - 6 - 53. Job Progress Report. Department of the Environment. 18 p.

Nehring, R.B. 1974a (1353). The ecology and population dynamics of the Neur lake amphipod population and Aban amphipod population estimation. L - 6 - 53. Job Progress Report. Department of the Environment. 14 p.

Nehring, R.B. 1974b (1353). Neur lake winter survey III - 1353, 20 - 25 Esfand 1353. L - 6 - 53. Job Progress Report. Department of the Environment. 7 p.

Murphy, G.I. 1966. Population dynamics and population estimation, p.1 - 18. IN A. Calhoun (editor), Inland fisheries management. California Department of Fish & Game. Sacremento, California.

Pennak, R.W. 1953. Amphipoda (scuds, sideswimmers). p. 435 -446. IN. R.W. Pennak, Freshwater invertebrates of the United States. Ronald Press Company, New York.

APPENDIX I

TABLE ONE. WATER QUALITY DATA, NEUR LAKE, 14 - 20 ORDIBEHESHT 1354

Date	Time (HRS)	Air T (C)	H_2O T (C)	D.O. (mg/1)	Alkalinity (as mg/1	Hardness $CaCO_3$)	Phth Alk.	Depth (m)
14/2/54	1700	12.0	12.3	—	—	—	—	surface
15/2/54	0700	4.0	9.4	—	—	—	—	surface
15/2/54	1100	13.0	9.8	12.0	167	52	0	surface
15/2/54	1130	13.0	9.3	11.0	169	120	0	5 meters
15/2/54	1200	12.0	9.8	12.0	175	29	0	3 meters
15/2/54	1215	11.0	9.8	11.6	176	30	0	2 meters
15/2/54	1230	10.0	9.8	12.0	173	55	0	4 meters
16/2/54	1900	3.0	9.2	—	—	—	—	surface
17/2/54	1900	3.5	9.0	—	—	—	—	surface
18/2/54	1900	4.1	9.2	—	—	—	—	surface
19/2/54	0800	-0.8	7.0	—	—	—	—	surface
19/2/54	1900	5.8	10.2	—	—	—	—	surface

TABLE TWO. NEUR LAKE CATCH PER UNIT EFFORT (CPUE= KG/METER NET/DAY); 15 - 19 ORDIBEHESHT 1354

DATE	NET SPECIFICATIONS	LOCATION OF SET	CPUE (KG/M/DAY)
15/2/54	13 m X 2 m X 35 mm	south end of lake	1.3 kg
16/2/54	13 m X 2 m X 35 mm	south end of lake	1.2 kg
17/2/54	13 m X 2 m X 35 mm	north end of lake	0.33 kg
17/2/54	40 m X 3 m X 50 mm	south end of lake	0.40 kg
17/2/54	50 m X 2 m X 20 mm	east side spring	0.50 kg*
18/2/54	40 m X 3 m X 50 mm	south end of lake	0.42 kg
18/2/54	13 m X 2 m X 35 mm	north end of lake	0.30 kg
18/2/54	50 m X 2 m X 20 mm	west side of lake	0.27 kg*
19/2/54	50 m X 2 m X 20 mm	west side of lake	0.27 kg*
19/2/54	50 m X 2 m X 20 mm	east side of lake	0.46 kg*
19/2/54	40 m X 3 m X 50 mm	south end of lake	0.49 kg
19/2/54	13 m X 2 m X 35 mm	east side spring	o.85 kg

AVERAGE CPUE FOR ENTIRE SURVEY = 0.56 kg/ meter net / day

* NOTE: The CPUE data here is heavily biased on the low side as the fish were only caught in the nets by their teeth and mandibles. Larger fish (over 300 g) were unable to get their heads into the net.

TABLE NINE. SUMMATION OF NEUR LAKE DISSOLVED OXYGEN DATA, WINTER 1353.

NEUR LAKE DISSOLVED OXYGEN DATA WINTER OF 1974-75 (1353)

Date	Helixor 1 (mg/l)	Helixor 2 (mg/l)	Helixor 3 (mg/l)	Helixor 4 (mg/l)	1-2 (mg/l)	2-3 (mg/l)	Average (mg/l)
5/9/53	——	——	——	——	——	——	10.3
19/9/53	——	——	——	——	——	——	10.8
1/10/53	——	——	——	——	——	——	9.0
10/10/53	——	——	——	——	——	——	6.6
17/10/53	——	——	——	——	——	——	3.7
25/10/53	4.4	5.0	4.0	——	4.5	4.3	4.4
30/10/53	3.7	2.0	2.5	——	——	——	2.7
5/11/53	2.0	2.0	2.5	——	——	——	2.3
12/11/53	2.2	2.0	2.1	2.0	3.0	2.5	2.3
17/11/53	2.1	2.0	2.0	——	3.0	2.8	2.4
23/11/53	2.8(3.8)	2.0	2.4	——	2.1	2.1	2.3
26/11/53	2.1	1.6	2.0	1.5	1.4	2.2	1.8
1/12/53	1.2	1.2	1.4	1.5	2.5	2.0	1.7
5/12/53	0.5	0.5	0.5	0.5	0.7	0.8	0.6
15/12/53	0.5	0.5	0.5	0.5	1.0	1.5	0.8
22/12/53	0.8	0.6	0.5	0.5	1.4	0.6	0.7
1/1/54	0.4	0.4	0.5	——	0.7	0.8	0.6
5/1/54	1.0	0.9	1.1	0.9	1.4	1.5	1.1
9/1/54	0.9	1.0	1.0	0.8	1.2	1.3	1.0
16/1/54	6.5	6.0	6.8	5.0	8.0	7.8	6.6
20/1/54	12.0	9.0	7.0	7.0	13.0	12.0	10.0

Neur Lake froze over on the 6th of Azar 1353 and began to break up on the 20th of Farvardin 1354. The ice began to break up from the northern shore of the large lake along the sandspit.

TABLE TEN.

NEUR LAKE MISCELLANEOUS DISSOLVED OXYGEN DATA, WINTER 1974-1975 (1353)

LOCATION OF SAMPLE (APPROXIMATE)	MG/LITER	DATE
South end of the lake (near shore)	0.1	22/12/53
South end of lake-200 meters from shore	0.9	22/12/53
Pressure ridge hole (east side of lake)	0.8	22/12/53
Large auxiliary hole near house	0.8	22/12/53
Big Cheshmeh NE corner of lake	6.6	23/12/53
Big Cheshmeh, edge of ice	2.6	23/12/53
40 meters N of big cheshmeh	1.6	23/12/53
Creek inlet at NE corner of lake	10.0	23/12/53
5 meters from creek mouth	5.0	23/12/53
North end lake, 100 meters from shore/	0.8	23/12/53
mid lake, 500 meters from North shore	0.5	23/12/53
40 meters from west bank	0.3	23/12/53

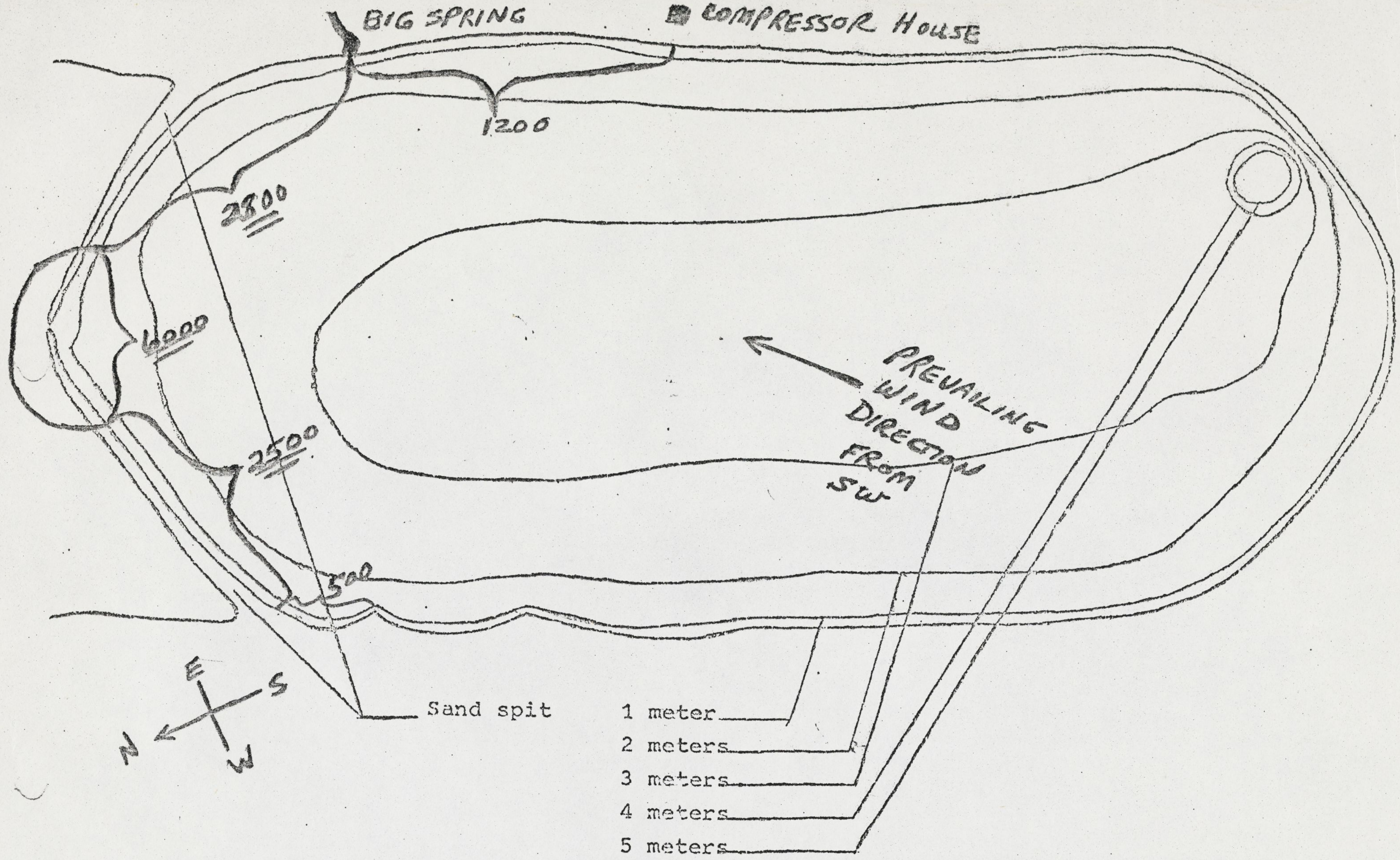


FIGURE THREE. LOCATION OF DEAD FISH AROUND NEUR LAKE.

Neur Lake
1 cm= 100 meters
approximate area 245 ha.

JOB PROGRESS REPORT

DEPARTMENT OF THE ENVIRONMENT

FISHERIES & AQUATIC ECOLOGY SECTION

Submitted To:

Dr. F.A. Harrington, Chief

Parks & Wildlife Division

Submitted By:

Barry Nehring, Advisor

Fisheries & Aquatic Ecology

LAR, KARADJ, & LIGVANCHAI BROWN TROUT POPULATION ESTIMATIONS - 1354

9 - 19 Shahrivar 1354

ABSTRACT

Ten days were spent carrying out population estimations on the brown trout populations of the Lar, Karadj, and Ligvanchai streams. No unusual differences were observed between this year and last in population densities with the exception of the Cheshmeh Do Barare population where we observed 11,380 trout/km over 2 years of age. At the spring, the trout were suffering from gas embolism and it is feared this problem could lead to secondary infections from bacterial gill disease and/or fungal infestations from Saprolegnia sp. It is recommended that the entire Lar river system be opened up to trout fishing next year, all the way from Kamardasht to Cheshmeh Do Barare. Statistically significant differences in average length of the trout were observed in the Lar river this year as compared to last year. All age classes of trout two years and over were 2 - 3 cm shorter than last year. This is believed to be due to a shortened growing season this year. Fishing regulations for 1355 are discussed in the recommendations and conclusions.

Title: Lar, Karadj, & Ligvanchai Brown Trout Population Estimations-1354

Period Covered: 9 - 19 Shahrivar 1354

Job Project Numbers: S - 11 - 54 Karadj River

S - 12 - 54 Lar River

S- 13 - 54 Ligvanchai River

Work Programs Initiated: WP 1 General Survey

WP 2 Fish & Aquatic Invertebrate Collections

WP 4 Population Estimations

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INTRODUCTION

The purpose of this survey was to obtain accurate population estimations on the brown trout populations of the Lar, Karadj, and Ligvanchai rivers in order to effectively evaluate and manage these trout populations in the coming year.

RESULTS

Table One in the Appendix presents growth data by age class, broken down by sex and includes data on weights and lengths for both the Lar river and the Ligvanchai river. This data was not collected on the Karadj river this year or any of its tributaries. Table Two in the Appendix presents the population estimations completed in 1354 on all tributaries of the Lar and Karadj systems, as well as the Ligvanchai river in East Azarbayjan.

Table Three in the Appendix presents biometric data on all trout populations that were subjected to population estimations this fall. The data is based on age class breakdown by length-frequency distribution as well as age classification by scale growth ring analysis. Table Four in the appendix presents the overall age class structure with 95% confidence limits. This data is compared to age class composition between the first shocking and second shocking as well as the percent recapture by age class. The table also presents the average rate of recapture for all age classes in each population and compares it to the percent recapture in each age class.

Table Five in the Appendix presents a statistical evaluation of the Lar river brown trout by age class between 1354 and 1353. Table Six presents a statistical evaluation of the Lar populations by age class between 1353 and 1352. And Table Seven, presents a statistical evaluation of the Lar populations by age class between 1354 and 1352.

Table Eight presents a comparison of the population estimations from the Lar and its tributaries, the Karadj tributaries, and the Ligvanchai river for 1352, 1353, & 1354.

Table Nine presents a comparison of the population age class structure within individual populations for the years 1352, 1353, and 1354. This data helps give the biologist a better idea of what state of flux the population in question is in, i.e., is it in a steady state, on the increase, or decreasing?

AB KHARSANG

Our investigations this year showed a population of 1310 trout/km in the Ab Kharsang. This is almost a 100% increase over our estimate from last year. Virtually all of this increase was due to a large cohort of two year old fish entering the population (49.42% of this years population is two year old trout) comprising about 650 trout per kilometer. In addition, good survival of the 3 year old age class from last year to this year also contributed to the increase. The survival was better than 50% with 400 three year olds (1353) becoming 230 four year olds this year.

It is most significant to point out that the population in the Ab Kharsang this year was the lowest in the Lar valley except for the Alarm, and last year (1353) it was the lowest of all estimates in the Lar river, yet the trout habitat is the best to be found in the Lar valley. This readily points out that population density does not necessarily equate with a healthy trout population,. This subject will be elaborated upon in the discussion section.

but on a kg/hectare basis.

AB - E - SEFID

No estimate was possible on the Ab-e-Sefid tributary this year. However, our attempts to get an estimate on this stream over the past three years (we were successful in 1352) leads us to the conclusion that the population is at about the same level as we found it in 1352, as far as total numbers of trout are concerned. However, this year 85% of the population was 2 year old trout, similar to last year, and very much unlike 1352 when the population was composed primarily of large three and four year old trout.

ALARM

This year the overall population age class structure in the Alarm river was virtually identical with last year in all age classes. However, the population estimate has decreased from 2334/km last year to 751/km this year. However, NEHRING (1974) pointed out that the population density last year was quite unnatural and probably resulted from immigration into the Alarm from the main Lar during the floods of Tir and Mordad 1353. This year, with normal water levels, the trout again retreated into the main Lar river at Gozzeldareh and the population level fell back to normal. It is significant to note that no decrease in the population below levels of two years ago occurred even though fishing was allowed in the Alarm for one month this year, Next year (1355) this stream should be completely opened up to trout fishing.

CHESHMEH DO BARARE

Our population estimate at Cheshmeh Do Barare this year revealed and increase of about 50% over last year and almost a 500% increase over 1352! We found a population of 11,380 trout/km with 95% confidence limits of ± 1576 trout/km. The population is building to the point where it may soon crash from disease or other causes, something that is virtually unheard of in fish populations. Indeed, possible signs of a disease are already manifest in the Cheshmeh Do Barare population. Virtually 100% of all trout living in the immediate vicinity of the big spring have very serious erosion of the mouth and gill tissues with large bubbles under the skin. The bubbles are also present on the gill covers, exterior of the mouth, dorsal and caudal fins in extreme cases. Although this disease may be simple gas embolism (gas bubbles under the epithelial tissues due to supersaturation of the water with some gas, probably nitrogen) it is still very serious as this disease could soon run to other secondary infections that could wipe out the trout population at Cheshmeh Do Barare for several kilometers downstream. Most likely to strike will be fungal diseases caused by the bacteria Saprolegnia sp., commonly known as "fin rot" (the fins of the trout turn "furry"white with fungus and rot away) or bacterial gill disease which rots away the respiratory tissues on the gills. These bacterial diseases are world wide in distribution and strike quickly in cases of overcrowding, stress due to spawning, and malnutrition (all three conditions flagrantly present at Cheshmeh Do Barare) and can wipe out entire populations in a matter of weeks. The problems are most readily present in hatchery situations,however, when the conditions are right (as they most assuredly are at Cheshmeh Do Barare) they can strike any fish population in the wild as well.

The large increase in the CDB population this year is undoubtedly due to the severe drought in the Lar river valley this past summer. The drought has dried up most of the Lar from CDB to Kamardasht. To avoid death by dessication, the trout have no alternative but to swim upstream as the water recedes, in this case to Cheshmeh Do Barare.

It is imperative that public fishing in the Lar river all the way from Kamardasht to Cheshmeh Do Barare be permitted next year to restore some balance in the trout population there before Mother Nature does it for us. There is no such thing as stockpiling fish for VIPs or anyone else. If man does not exact his toll on the population , then Nature will.

CHESHMEH SIAH

Our population estimate this year at Cheshmeh Siah revealed 1705 trout/km two years old and over. This is the lowest estimate taken here in three years and it readily points up many interesting facts. First of all, since no fishing is allowed at this point, it is obvious that increases and decreases in the trout population occur regardless of what our management objectives are and furthermore, these fluctuations will continue regardless of whether or not sport fishing is allowed here. Also, the trout will continue to die of old age, regardless of our protection to "stockpile"trout for VIP fishing. If we examine the data presented in Tables Eight and Nine in the Appendix, the numbers will readily reveal the futility of this "protection" program. In 1352 20% of the population was two year old trout or 440 trout. In 1353, 19% of the population was three year old trout, or 480 trout. And in 1354, 7% of the population was four year old trout, or 130 trout. This 1352 cohort, which made up a small part of the population in 1352 maintained its level in 1353 and then decreased by over 60% by 1354 to only 130 trout. In contrast let us consider the three year old age class from 1352 which made up 43% of the population at that time, or 950 trout. In 1353, four year old trout made up 5.4% of the population or 136 trout. In 1354, the five year old age class (1352 three year old cohort) made up only 0.66% of the population, or 11 trout. Likewise, the 1353 two year old age class made up 74% of the total population or or 1660 trout. In 1354, the three year old age class made up 49% of the population or 830 trout. These three little examples reveal a very important biological principle of fish management, ie, mortality from natural causes operates in direct proportion to population density and the carrying capacity of the stream. In other words, when the population density is too high for the carrying capacity of the stream, natural mortality will bring the population into balance through intraspecific competition among the trout. On the other hand, when population densities are at a low ebb as they were for the two year old cohort of 1352 then natural mortality over the two succeeding years was much less. What this really says is that the rigors of life in the Lar at Cheshmeh Siah automatically cut the population of four year old trout down to about 130 trout/km, [regardless of what the total number of trout per kilometer is from year to year.] Would it not be better that the fishermen get a crack at this surplus of trout than have them all lost due to natural mortality. That surplus was over 800 trout from 16 - 24 cm during the 1353 fishing season, and 120 trout over 24 cm during the 1354 fishing season.

- hard to equate this sentence with density dependence

SIAHPALAS

The population estimation in the Siahpalas this year revealed 2436 trout/km over two years of age. This was very similar with the estimate of 2542 trout/km last year. Also the percentage composition of each age class changed very little from this year to last, with the exception that no four and five year old trout were observed at all this year. Two year old trout still comprise the largest portion of the Siahpalas population, 83.5% both in 1353 and 1354. It is quite obvious that fishing in the Siahpalas this year had no effect on the trout population whatsoever, considering that the population in 1352 was only 726/km when fishing was not permitted in the stream. Next year the Siahpalas should be opened to public fishing all year round, from Khordad through Shahrivar at any rate.

LIGVANCHAI

Our population estimate on the Ligvanchai this year was 1246/km with 95 % confidence limits of $\pm$ 216 trout/km. The estimate this year is not directly comparable with last year as it was completed 4-5 km above Ligvan village, whereas in the two preceding years the estimate was completed in the stream just below the village. However, we collected trout for the Ab Bazuft stocking at the same place in the stream where the estimate was completed two years preceding this, and we found the population to be in the same condition as two years previously, or about 500 trout/km. The habitat at this point in the stream is not as good as several kilometers above the village and the water is mildly polluted from excessive washing of human garments and carpets in the stream, somewhat to the detriment of the trout population.

It is interesting to note that the trout in the Ligvanchai are no larger in length or weight at a given age than the Lar river brown trout. However, biologically speaking, the Ligvanchai population is undoubtedly in better condition. Where in the Lar river 100% of all male and female trout are sexually mature in their second year, in the Ligvanchai only 50% of the males are sexually mature and no females are mature until their third year. This indicates that the Ligvanchai population in under very little stress, biologically speaking as the Ligvanchai trout population exhibited the normal life span prior to reaching sexual maturity. In contrast, in the Lar where the population is under severe stress of intra-specific competition for food and living space, the population has become "stunted" in the sense that natural selection has pressured the population into natural reproduction at 1+ years of age. Reproduction at such an early age is generally a sign that the population is under severe competition from some source and successful natural reproduction is favored (selected for) at 1+ years of age rather than 2+ years of age. If the chances are much less for survival to 2+ years of age prior to natural reproduction, then the natural selection is for trout that spawn at 1+ years of age, and the growth is stunted as all energy is channeled into sex products rather than large gains in length and weight.

GAJEREH

Our estimate on the Gajereh this year was 488 trout/km over two years of age, with 95% confidence limits of ± 503 trout/km. The wide confidence limits were due to the poor rate of racapture of marked fish on the second shocking. However, from our estimates in this stream and others both from this year and past years, we feel the estimate is fairly reliable. Fifty-three percent of the population in the Gajereh this year was three and four year old trout. The Gajereh stream is a very swift cold running stream with very little good cover for trout which undoubtedly is one reason for the low population density.

VARANG-E-RUD

Our estimate on the Varang-e-rud this year was completed at the same location as two years ago (immediately above Varange-e - rud village). It is significant that the population this year was almost 250% greater than at the same location two years ago, and even higher than our estimate in the closed section of the stream several kilometers above the village. The obvious reason is that this year was the first year in the past five years that Iran Safaris did not operate a fishing camp at the village. With this drastic decrease in fishing pressure, the stream bounced back to the same population density observed in the virgin, unfished waters examined far above the village last year. The estimate this year was 1182 trout/km over two years of age with 95 % confidence limits of ± 558 trout/km.

Then the VIP's would have better fishing if you left it alone for their occasional use?

LOWER SHAHRASTANAK RIVER

Our population estimate this year on the lower Shahrastanak was 420/km with 95% confidence limits of ± 399 trout/km. This estimate is similar to those from the two previous years. However, this year the 0+ age class made up 43% of the population. If this age class were not included in the estimate, the population would probably be more on the order of 250/km with the two and three year old age classes comprising about 50% and 35% of the populations respectively. This indicates that the population is at lower densities than any time in the past three years; however, we believe this is due primarily to the severe flooding of the Shahrastanak river in Ordibehesht andd Khordad this past spring. The population in the upper Shahrastanak is about 40% lower than the past two years as well and the fishing pressure there was virtually nonexistent this past summer.

UPPER SHAHRASTANAK RIVER

The population estimate here this year was 605 trout/km over two years of age with 95 % confidence limits of ± 359 trout/km, or about a 40% decrease over the past two years. As stated above, we believe this decrease was due entirely to severe flooding of the Shahrastanak river this past spring, and not due to excessive fishing pressure. License sales on the Karadj river above the dam this year have not increased at all. If anything they have decreased, and our game guards report that there was almost no fishing pressure on the Shahrastanak river this year.

DISCUSSION

The discussion section of the report this year will be much less in depth than last year. Most points made last year in the discussion section are every bit as valid now as they were then. A brief analysis of the data is presented in the Tables and Figures of the Appendix , while major points will be emphasized. Many recommendations concerning trout management made over the past three years have still gone unheeded, despite OVERWHELMING evidence that these recommendations should be immediately implemented. We hope that the recommendations made in this report will be implemented in total in the 1355 fishing season.

As discussed previously, Tables One and Three in the Appendix show that for a given year, male and female brown trout are approximately the same lengths and weights for a given age class. This holds for all areas investigated to date. Examination of the data presented by NEHRING (1352, 1353) also show the same relationship in past years. However, examination of NEHRING'S (IBID) data from past years reveal statistically significant differences in growth rates for the same age class of trout between years. This data is presented in Tables Five, Six, and Seven in the Appendix.

In Table Five, data is presented showing that 2,3, and 4 year old age classes of brown trout from the Lar river populations are statistically significantly smaller than those same age classes from 1353 at P = 0.01. Two year old trout are 2.1 cm shorter than last year, three year old trout are 3.2 cm shorter than last year, and four year old trout are 3 cm shorter than last year.This means that for some reason, the trout in the Lar valley this year did not grow as well as last year. Why? The only explanation to offer is that the very cold late spring with heavy rains and snows in the Elborz mountains delayed the warming of the waters in the Lar river by about 30 to 45 days in comparison with a "normal" or average year. This colder water in turn cut 30 - 45 days off the normal growing season of the trout in the Lar river, resulting in a much shorter trout in all age classes of the population.

Table Six reveals that three and four year old trout from 1352 were also statistically significantly shorter than the same year classes from 1353. Thus, it might be proper to assume that 1353 was an unusually GOOD year for trout in the Lar river valley. However, comparison of 1354 age classes with 1352 age classes shows that two and three year old trout from this year's population were also statistically significantly smaller than the same age classes of trout from 1352. Thus, finally, we can assume that 1354 was indeed the poorest growing season for trout in the Lar valley during the past three years this study has been going on.

What then are the real causes for drastic fluctuations in both growth rates and population densities of the trout populations in the Lar river system? The reasons are many and very complex and we can only hypothesize as to what the true situation is. Nonetheless, analysis of the Lar situation, together with and in the light of research findings on trout populations all across North America, begin to give us some indication as to what the problem is. NEHRING (IBID) alluded to some of these answers in his report on the Lar river last year.

SHETTER and ALEXANDER (1970) found no drastic fluctuations in either population levels or growth rates in their seven year study of the brook and brown trout populations of the Ausable river that could be contributed to natural causes. KLEIN (1974) in his eleven year study of rainbow and brown trout populations found no significant differences in either population densities or growth rates of either rainbow or brown trout in the Poudre River of Colorado, despite management attempts to increase the growth rate and survival of rainbow trout through special harvest regulations. In contrast, the trout population in the Lar exhibits wild fluctuations in both growth rates and population densities from one year to the next. The reasons can be best explained by the catch-all phrase , "differences in habitat".

Six or seven items readily come to mind when the trout manager hears the words "<u>proper habitat</u>". First , <u>ALL</u> age classes of trout must have an adequate food supply. Thus, the stream must contain both small and large food items in abundance for both small and large trout. Second, all trout streams should have adequate spawning and nursery areas to sustain natural reproduction. All trout streams must have adequate living space, feeding areas- holding areas, with good instream shelter devices such as large stones, boulders, tree stumps, and deep pools. Fourth, the stream banks and stream bed should be stable. Fifth, good vegetative cover of the stream bank is an absolute necessity to supplement any lack in instream primary productivity. Sixth, the physical and chemical water quality parameters must be acceptable to allow for normal trout growth. Seventh, the presence of predators (large fish, fish-eating raptors, mergansers, water shrews, and the like) as controls on excessive natural reproduction by the trout is also a integral part of healthy trout habitat. If the better trout streams in western Europe and North America were given a rating of 1 when any one of the above items was present and 0 when not present over most of the stream, I submit that the better trout streams would have at least 5 to 7 points. Poorer trout streams would rank lower. The Lar river would rate a dismal 1 on this rating scale, possessing only adequate spawning habitat and nursery areas. And this factor it has in GREAT ABUNDANCE, which in the final analysis actually exacerbates the situation. With all of the other factors flagrantly missing, excellent recruitment of young of the year cohorts year after year only intensifies intra-specific competition, resulting in earlier sexual maturity in the population and stunting from grossly inadequate food supplies.

I think it appropriate to include some of Dr. Robert Behnke's (a former and I hope future foreign advisor with this Department in Fisheries) comments in a recent letter from him. The remarks fit the Lar situation very well, and he has more than 20 years experience in the field of fishery management.

Dr. Behnke's comments:" ---- a report detailing and documenting the biological basis for fishery regulations - when, where, and why they will or will not produce the desired results. The gist seems to be essentially how the production and biomass is distributed among the age classes and if the entire population is exploiting a common food resource (intraspecific competition among all age groups). In such situations , the overwhelming majority of the production is tied up in the 0 and I age groups (Sub catchables) and any manipulation of the older age groups has virtually no influence on the overall population dynamics in producing more or fewer large trout- stockpiling is not possible.

"Yet, protective regulations do indeed seem to work with cut-throat trout in Yellowstone River and in large rivers in Idaho. Here, I believe the early life history of the populations are geographically removed from the adults (in small tributaries) and intraspecific competition among age groups is lessened. Also the age structure includes many IV - VII fish, which combined with good growth rates and high angler vulnerability allows a build up of protected size groups and a high quality trophy fishery- high catch-per-man-hour."

I heartily endorse Dr. Behnke's comments. The situation he describes in the first paragraph fits the condition of the population in the Lar river exactly.

Extraction of a few facts and figures from the Cheshmeh Do Barare and Cheshmeh Siah population estimations over the past three years and synthesis into an organized table will serve to illuminate what happens to the trout populations in the Lar river, IRREGARDLESS of whether fishing is permitted or not!! This data will be presented below in context as it is too important to be buried in the appendix where the administrative officials responsible for regulation setting cannot find it or understand the data, if it can be found.

TABLE I. LOSSES TO NATURAL MORTALITY IN LAR RIVER TROUT POPULATIONS

LOCATION	AGE	YEAR	NUMBER OF TROUT	PERCENT LOSS/GAIN
CHESHMEH DO	4	1352	320	
BARARE	5	1353	49	85% LOSS !
CHESHMEH	3	1352	1800	
DO BARARE	4	1353	645	64% LOSS !
	5	1354	25	96% LOSS !
CHESHMEH	3	1353	5100	
DO BARARE	4	1354	570	89% LOSS !
CHESHMEH SIAH	2	1352	440	
	3	1353	480	10% GAIN
	4	1354	130	73% LOSS !
CHESHMEH SIAH	3	1352	950	
	4	1353	136	86% LOSS !
	5	1354	11	92% LOSS !
CHESHMEH SIAH	2	1353	1660	
	3	1354	830	50% LOSS !

These facts and figures speak for themselves. Mother Nature brings the population into balance with what the carrying capacity of the river is, irregardless of whether or not the river is managed, irregardless of whether or not fishing is allowed. IT IS IMPOSSIBLE TO STOCKPILE TROUT!!!

Translating the loss figures from the preceding pages we get what would have been HARVESTABLE surpluses that should have reached the fisherman's creel. Also keep in mind that these figures are for EACH kilometer of stream! During the summer of 1353 a harvestable surplus of 271 trout/km over 24 cm in length were lost to natural mortality at Cheshmeh Do Barare. During the summer of 1353,1155 trout/km from 17 to 24 cm in length were lost to natural mortality. Another large harvestable surplus lost forever! In the summer of 1354 a harvestable surplus of 620 trout/km in excess of 24 cm length was lost to natural mortality. Why? Because fishing is not allowed in this stream. Similar figures can be presented for Cheshmeh Siah, or any one of the Lar tributaries and the Lar river itself.

As described previously in the results section of this report, the Cheshmeh Do Barare population is presently at 500% density over and above what it was in 1352. The trout at the spring are severely deformed due to a disease probably known as gas embolism about which we can do nothing. However, as was also stated in the results section, this normally inoccuous disease can give way to secondary bacterial and fungal diseases which can devastate trout populations where they occur in very high densities under a stressful environment. This is exactly the situation we already have in the Lar river, and in fact it may already be too late. However, we can hope that it is not and that we will have the opportunity to reduce the population above Kamardasht next year by opening it up to sport fishing. However, it is quite possible that the population will be brought into line with the carrying capacity by the bacterial and fungal diseases as secondary invasions after the gas embolism phenomenon has run its course on the population at Cheshmeh Do Barare.

Comparison of the statistical data presented in Table Four in checking for bias in our electroshocking we find many more instances of statistical bias this year as compared to last year's data (Nehring, 1974). This is normal, though paradoxical, as our data from this year is the most reliable that we have collected in the three years of the study. As our data becomes more reliable and accurate, the confidence limits on the data become very narrow. When subjected to statistical analysis more incidences of statistical significance occur. This is not to be totally disregarded, nor treated with great worry either. The population estimates are still reliable, only the percentage composition that each age class contributes to the population changes. Electroshocking always is more effective on larger fish. Smaller fish are more readily missed. The mathematical formula used to calculate the population estimation is such that by missing a large amount of the smaller fish and younger age class trout, our estimates are overestimating the younger year classes and underestimating the older year classes. What this means is that there should be some minor changes in the breakdown of each individual population into the various percentages attributed to each age class, where statistically significant bias is revealed. However, in virtually all cases this would mean a change of but a few percentage points from one age class to another, and it is not all that important.

It cannot be emphasized enough that Shetter and Alexander (1970) and Klein (1974) found no significant changes in the trout populations of the Au Sable and Cache la Poudre rivers, respectively, either in population densities or growth rates of the trout over a period of study spanning many years. Conversely, in the Lar river we find gross fluctuations both in population densities and growth rates from one year to the next. Kinunen (1972) also alluded to this phenomenon in his studies of the Lar. I believe the reason is the total lack of "environmental buffering" present in the habitat in the Lar valley. As stated previously, there are about seven factors that must be included in the total habitat requirements of any trout stream or trout population.

not much but some - see top of p. 16 in my report for growth diff noted due to temp.

When most of these factors are present in adequate or very adundant amounts, I hypothesize, that one factor can compensate for the absence of another. Thus, when an extremely cold summer causes water temperatures to remain cold throughout the season in the Cache la Poudre river in Colorado (a fact documented by Klein, ibid) no differences are seen in the growth rate of the trout or in trout population density. Why? Because other environmental factor "buffer" these potential negatives effects through compensation. However, this "environmental buffering" or compensation can only occur when all or most of the seven factors described above are present in adequate or near adequate amounts. When virtually all factors are flagrantly absent from a stream such as they are in the Lar (with the obvious exception of fantastic spawning habitat and nursery areas) then there is nothing to compensate for an unusually cold spring and cold water temperatures. So what happens is that the trout growth is significantly reduced from the previous year when the water temperatures were normal. Admittedly, this hypothesis obviously lacks concrete data to support it; nonetheless, I feel it bears considerably validity.

Reduction of the Cheshmeh Do Barare population to standing crop basis based on area provides a final example of the absurdity of present fishing regulations in the Lar river valley. At Cheshmeh Do Barare we found a population of 11,380 trout/km two years of age and over. The average width of the stream is less than 5 meters; however, for ease of calculation we shall assume this figure to be correct, though it is admittedly conservative. That means the population is 11,380/5000 m^2 or 22,760/ hectare (10,000 m^2 = 1 hectare)!! That is a standing crop 22 times as dense as we would have at Neur Lake assuming 100% survival of all trout stocked in 1353. Assuming a 50% mortality until now we find the standing crop at Cheshmeh Do Barare is at least 44 times as dense per unit area as we now have in Neur Lake. Perhaps some reduction in the population at Cheshmeh Do Barare is called for, perhaps?

CONCLUSIONS

1) KLEIN(1974) has found that "stockpiling" of trout has yet to be substantiated in any scientific study. Death through natural mortality is relentless. Size limits and closed areas do nothing to enhance trout size. Behnke (personal communication) concurs in this analysis. I agree that restrictive management regulations will do little if anything to change the population age structure or fish size in the Lar valley; however, to allow stretchs of stream to continue closed to fishing as we have until this year is UTTERLY ABSURD.

2) Growth of the Lar river trout was statistically significantly less than last year among all age classes of trout in the Lar river. This was due primarily to the late spring, cold weather, and snows that extended the cold water (less than 10 C) period in the Lar river by 30 - 45 days. With more than a month cut off their growing season and a lack of "environmental buffering" to act as compensation, the trout grew 2 - 3 cm less this year than last year.

3) Trout populations as we find them in the Ab Kharsang, Gahaar river, Ligvanchai river, Shahrastanak river, and possibly the Alarm are relatively healthy populations, IN BALANCE with their environment. They do not fluctuate greatly in population density from one year to the next, most surely not differences IN ORDER OF MAGNITUDE, as we see at Chehsmeh Do Barare.

4) Excessive population densities as we have at Cheshmeh Do Barare in excessively poor habitat cannot be sustained. Mother nature will reap her toll through predation, cannabilism, or disease. Natural mortality is relentless.

RECOMMENDATIONS

1) All tributaries of the Lar river (Alarm, Siahpalas, Ab-e-Sefid, Deli chai, Cheshmeh Siah, Sefid Ab, and Cheshmeh Do Barare) should be opened to public fishing in 1355. This applies particularly to Cheshmeh Do Barare, all the way from Kamardasht upstream to Cheshmeh Do Barare. If not , this population could very well suffer massive mortality from losses to diseases like fin rot and fungal infections due to the bacteria Saprolegnia sp.

2) We recommend a continuation of the 25 trout per day bag limit through 1355 on the main Lar and all tributaries.

3) The fishing season should open on 1 Khordad and remain open through 30 Mehr 1355.

4) I recommend a Fly Fishing Club to be organized under the auspices of the Department and fishing allowed on special streams open only to Club Members. Streams open to the club would include the Ab Khaysang, Varang-e-rud, and Ligvanchai. Bag limits would be two trout per day, although as many fish as possible could be caught and returned to the stream unharmed. However, this regulation need not apply to the Ligvanchai. There the limit could remain at 25 trout/day as fishing pressure has been very light there the past two seasons (about 60 licenses during 1353 and again in 1354). License fees for the club would be 5000 - 7000 rials per year to fish on any or all of the three streams outlined above. Any fisherman caught with more than two trout in his possession would be fined according to the Fishing Laws of this Department and banned from trout fishing anywhere in Iran for a period of one calendar year (12 months consecutive). It is high time the concept of "FISHING FOR FUN" and CATCH AND RELEASE fishing be introduced to the Iranian sport fishing public that is ready to accept the idea.

TABLE ONE. BIOMETRIC DATA FROM LAR RIVER & TRIBUTARIES (CENTRAL PROVINCE) & LIGVANCHAI RIVER (EAST AZARBAYJAN PROVINCE) SHAHRIVAR 1354

			LAR RIVER			
AGE (YR)	SEX	$\bar{X}$ LENGTH (CM)	RANGE (CM)	N	$\bar{X}$ WEIGHT (G)	RANGE (G)
0+ (1)	IMM	6	4 - 8	--	-----------	----------
1+ (2)	M	12.4	11 - 14	5	23.0	15 - 30
1+ (2)	F	16.0	13 - 17	4	45.0	20 - 60
2+ (3)	M	21.2	16 - 26	20	106.5	50 - 190
2+ (3)	F	20.8	16 - 24	16	103.8	50 - 170
3+ (4)	M	26.8	24 - 30	4	217.5	170- 310
3+ (4)	F	25.0	23 - 27	4	158.8	125- 200
4+ (5)	M	29.7	28 - 32	3	273.3	240 -320
4+ (5)	F	33.0	-------	1	350	--------
			LIGVANCHAI RIVER			
0+ (1)	IMM	6	4 - 8	--	-------	----------
1+ (2)	IMM(M)	11.8	11 - 13	4	12.0	10 - 15
1+ (2)	M	15.8	13 - 18	4	41.3	20 - 60
1+ (2)	IMM(F)	14.8	14 - 16	4	28.8	20 - 40
2+ (3)	M	22.0	17 - 26	11	115.0	50 - 210
2+ (3)	F	21.7	19 - 24	6	125.8	90 - 165

TABLE TWO. POPULATION ESTIMATIONS; LAR, KARADJ. & LIGVANCHAI RIVERS, SHAHRIVAR 1354.

LOCATION	ESTIMATION (KM)	95% CONFIDENCE LIMITS (KM)
AB KHARSANG (LAR)	1310	± 185
AB-E-SEFID (LAR)	NO ESTIMATE (RECAPTURE RATE TOO SMALL)	
ALARM (LAR)	751	± 248
Cheshmeh DO BARARE(LAR)	11,380	± 1576
Cheshmeh SIAH (LAR)	1705	± 444
SIAHPALAS (LAR)	2436	± 372
GAJEREH (KARADJ)	488	± 503
LOWER SHAHRASTANAK(KARADJ)	420	± 399
UPPER SHAHRASTANAK(KARADJ)	605	± 359
VARANG-E-RUD (KARADJ)	1182	± 558
LIGVANCHAI RIVER	1246	± 216

5) The Karadj river and its tributaries should be open to trout fishing from 1 Khordad through 30 Shahrivar 1355 with the exception of the Varang-e-rud. If the Fly Fishing Club is instituted as described in item 4 above, then the Varang-e-rud should be closed to fishing except for members of the Fly Fishing Club. If the Club is not initiated as described above then the Varang-e-rud should be open to public fishing along with all other tributaries of the Karadj.

6) The bag limit on the Karadj and its tributaries should be 25 trout/day as it was this year.

7) The Ligvanchai should be open to public fishing from 1 Khordad through 30 Shahrivar 1355 with a 25 trout/day bag limit.

8) License fees on all streams covered by this report should be 300 rials per day. This will mean a 200 rial per day reduction on the Lar and Karadj rivers. However, I believe it will result in an increase in total license revenues for the Department as many more people will be willing to purchase a license at the reduced price, actually bringing in an increase in revenues.

TABLE THREE. BIOMETRIC DATA ON BROWN TROUT POPULATIONS IN LAR, KARADJ, & LIGVANCHAI RIVERS (SHAHRIVAR 1354). (SEE NOTE BELOW **)

AGE (YR)	N	AVERAGE LENGTH (CM)	RANGE (CM)
		LOCATION	
		AB KHARSANG	
1+(2)	213	11.15	9 - 14
2+ (3)	132	18.36	15 - 21
3+(4)	76	24.00	22 - 27
4+(5)	10	28.90	28 - 30
		AB-E-SEFID	
1+(2)	47	12.38	10 - 16
2+(3)	7	21.00	20 - 23
3+(4)	1	30.00	———
		ALARM	
1+(2)	144	12.95	9 - 16
2+(3)	66	19.35	17 - 22
3+(4)	12	24.42	23 - 28
4+(5)	2	30.00	———
		CHESHMEH DO BARARE	
0+(1)	34	8.62	8 - 9
1+(2)	597	12.38	10 - 14
2+(3)	1066	17.83	15 - 22
3+(4)	103	24.50	23 - 28
4+(5)	4	29.25	29 - 30
		CHESHMEH SIAH	
0+(1)	10	7.2	6 - 8
1+(2)	121	12.31	9 - 15
2+(3)	147	19.20	16 - 23
3+(4)	23	24.91	24 - 28
4+(5)	2	31.50	29 - 34
		SIAHPALAS	
1+(2)	400	12.54	9 - 16
2+(3)	79	19.06	17 - 23

NOTE**: THE AGE CLASS BREAKDOWNS IN THIS TABLE ARE BASED BOTH UPON AGE-SCALE ANALYSES AND LENGTH-FREQUENCY DISTRIBUTION DIVISIONS

TABLE THREE (CONT). BIOMETRIC DATA ON BROWN TROUT POPULATIONS IN LAR, KARADJ, & LIGVANCHAI RIVERS (SHAHRIVAR 1354) NOTE BELOW**

AGE(YR)	N	LOCATION AVERAGE LENGTH (CM)	RANGE (CM)
		GAJERESH	
1+(2)	24	12.33	10 - 16
2+(3)	26	18.92	17 - 24
3+(4)	1	27.00	———
		LIGVANCHAI	
1+(2)	273	14.15	10 -18
2+(3)	107	21.24	19 - 28
		LOWER SHAHRASTANAK	
0+(1)	22	7.59	6 - 8
1+(2)	14	13.86	9 - 16
2+(3)	12	19.08	17 - 22
3+(4)	4	26.00	25 - 28
		UPPER SHAHRASTANAK	
1+(2)	64	13.02	9 - 16
2+(3)	39	19.05	17 - 23
3+(4)	3	25.33	24 - 27
		VARANG-E-RUD	
1+(2)	114	12.61	9 - 16
2+(3)	40	18.85	17 - 22

NOTE**: THE AGE CLASS BREAKDOWN IN THIS TABLE ARE BASED UPON AGE-SCALE ANALYSES AND THE LENGTH-FREQUENCY DISTRIBUTION DIVISIONS WITHIN EACH RIVER POPULATION.

TABLE FOUR. OVERALL POPULATION AGE-CLASS STRUCTURE WITH 95% CONFIDENCE LIMITS AS COMPARED TO AGE-CLASS STRUCTURE BETWEEN FIRST AND SECOND SHOCKINGS AND RECAPTURE BY AGE-CLASS ON SECOND SHOCK; % RECAPTURE IN EACH AGE-CLASS ON SECOND SHOCK WITHIN EACH POPULATION AS COMPARED TO OVERALL AVERAGE RATE OF RECAPTURE FOR THE POPULATION WITH 95% CONFIDENCE LIMITS.

AGE(YR)	% N/AGE CLASS	95 % CONFIDENCE LIMITS	1ST SHOCK	2ND SHOCK	RECAPTURE BY AGE CLASS	% RECAPTURE IN EACH AGE CLASS	AVERAGE RATE OF RECAPTURE	95% CONFIDENCE LIMITS
AB KHARSANG								
1+(2)	0.4942	±0.0472	0.4379*	0.6099*	0.2589*	0.2283**	0.3862	± 0.0560
2+(3)	0.3063	±0.0435	0.3345	0.2482*	0.4196*	0.4845**	"	"
3+(4)	0.1763	±0.0360	0.2035	0.1206*	0.2946*	0.5593**	"	"
4+(5)	0.0232	±0.0142	0.0241	0.0213	0.0268	0.4286**	"	"
AB-E-SEFID								
1+(2)	0.8545	±0.0932	0.8718	0.8125	———	———	———	———
2+(3)	0.1273	±0.0881	0.1282	0.1250	———	———	———	———
3+(4)	0.0182	±0.0353	0.0000	0.0625	———	———	———	———
ALARM								
1+(2)	0.6429	±0.0627	0.6284	0.6710	0.4815*	0.1398	0.1824	± 0.0622
2+(3)	0.2946	±0.0597	0.2905	0.3026	0.4444*	0.2791**	"	"
3+(4)	0.0536	±0.0295	0.0743	0.0132*	0.0741	0.1818	"	"
4+(5)	0.0089	±0.0123	0.0068	0.0132	0.0000	0.0000**	"	"
CHESHMEH DO BARARE								
0+(1)	0.0188[1]	±0.0063	0.0071*	0.0059*	———	———	———	———
1+(2)	0.3309	±0.0217	0.3195	0.3828*	0.2635*	0.1219**	0.1478	± 0.0207
2+(3)	0.5909	±0.0227	0.6177*	0.5920	0.6766*	0.1619	"	"
3+(4)	0.0571	±0.0107	0.0531	0.0178*	0.0539	0.1500	"	"
4+(5)	0.0022	±0.0022	0.0027	0.0015	0.0060	0.3333**		

NOTES: 1 Does not imply actual composition of the total population
* Statistically significantly different from % N/AGE CLASS at P = 0.05
** Statistically significantly different from average rate of recapture for total population at P=0.05

TABLE FOUR (CONT.). OVERALL POPULATION AGE-CLASS STRUCTURE WITH 95 % CONFIDENCE LIMITS AS COMPARED TO AGE CLASS STRUCTURE BETWEEN FIRST AND SECOND SHOCKINGS AND RECAPTURE BY AGE-CLASS ON SECOND SHOCK: % RECAPTURE IN EACH AGE-CLASS ON THE SECOND SHOCK WITHIN EACH POPULATION AS COMPARED TO OVERALL AVERAGE RATE OF RECAPTURE FOR THE POPULATION WITH 95 % CONFIDENCE LIMITS.

AGE(YR)	% N/AGE CLASS	95 % CONFIDENCE LIMITS	1ST SHOCK	2ND SHOCK	RECAPTURE BY AGE CLASS	% RECAPTURE IN EACH AGE CLASS	AVERAGE RATE OF RECAPTURE	95 % CONFIDENCE LIMITS
CHESHMEH SIAH								
0+(1)	0.0330[1]	±0.0201	———	———	———	———	———	———
1+(2)	0.3993	±0.0551	0.4312	0.4074	0.2500*	0.1064	0.1320	± 0.0449
2+(3)	0.4851	±0.0563	0.4771	0.5309	0.6000*	0.2308**	"	"
3+(4)	0.0759	±0.0298	0.0917	0.0494	0.1500*	0.3000**	"	"
4+(5)	0.0066	±0.0091	0.0000	0.0123	0.0000	0.0000**	"	"
SIAHPALAS								
1+(2)	0.8351	±0.0332	0.8138	0.8923*	0.7857*	0.2711	0.2808	± 0.0471
2+(3)	0.1649	±0.0332	0.1863	0.1077*	0.2143*	0.3231	"	"
LIGVANCHAI								
1+(2)	0.7184	±0.0503	0.6837	0.7636	0.4828*	0.2857**	0.4047	± 0.0669
2+(3)	0.2816	±0.0503	0.3163	0.2364	0.5172*	0.6618**	"	"
GAJEREH								
1+(2)	0.4706	±0.1370	0.5385	0.7500*	0.3333*	0.0476	0.0769	± 0.0836
2+(3)	0.5098	±0.1372	0.4359	0.2500*	0.3333*	0.0588	"	"
3+(4)	0.0196	±0.0380	0.0256	0.0000	0.3333*	1.0000**	"	"
VARANG-E-RUD								
1+(2)	0.7403	±0.0693	0.6962	0.7867	0.6667*	0.1818	0.1899	± 0.0865
2+(3)	0.2597	±0.0693	0.3038	0.2133	0.3333*	0.2083	"	"

NOTES: 1 Does not imply actual composition of the total population
* Statistically significantly different from % N/AGE CLASS at P = 0.05
** Statistically significantly different from average recapture rate for the total population at P=0.05

TABLE FOUR (CONT). OVERALL POPULATION AGE-CLASS STRUCTURE WITH 95% CONFIDENCE LIMITS AS COMPARED TO AGE-CLASS STRUCTURE BETWEEN FIRST AND SECOND SHOCKINGS AND RECAPTURE BY AGE-CLASS ON SECOND SHOCK; % RECAPTURE IN EACH AGE - CLASS ON THE SECOND SHOCK WITHIN EACH POPULATION AS COMPARED TO OVERALL AVERAGE RATE OF RECAPTURE FOR THE POPULATION WITH 95 % CONFIDENCE LIMITS.

AGE(YR)	% N/AGE CLASS	95% CONFIDENCE LIMITS	1ST SHOCK	2ND SHOCK	RECAPTURE BY AGE CLASS	% RECAPTURE IN EACH AGE CLASS	AVERAGE RATE OF RECAPTURE	95 % CONFIDENCE LIMITS
LOWER SHAHRASTANAK								
0+(1)	0.4231	±0.1343	0.4474	0.3571	-------	-------	-------	-------
1+(2)	0.2962	±0.1206	0.2632	0.2857	-------	-------	-------	-------
2+(3)	0.2308	±0.1145	0.2368	0.2143	-------	-------	-------	-------
3+(4)	0.0769	±0.0724	0.0526	0.1429	-------	-------	-------	-------
UPPER SHAHRASTANAK								
1+(2)	0.6038	±0.0931	0.5385	0.6667*	0.1000*	0.0357**	0.1923	± 0.1071
2+(3)	0.3679	±0.0918	0.4423	0.2963	0.9000*	0.3913**	"	"
3+(4)	0.0283	±0.0316	0.0192	0.0370	0.0000	0.0000**	"	"

NOTES: 1 Does not imply actual composition of the total population

* Statistically significantly different from % N/ AGE CLASS at P = 0.05

** Statistically significantly different from average recapture rate for the total population at P = 0.05.

TABLE FIVE. STATISTICAL EVALUATION OF AVERAGE LENGTHS OF LAR RIVER BROWN TROUT BY AGE CLASS BETWEEN 1354 AND 1353.

YEAR CLASS	N	AVERAGE LENGTH 1354	AVERAGE LENGTH 1353	T= 0.995	ACTUAL T VALUE
1+(2)	6	12.29 cm	14.56 cm	±4.032	- 9.231 *
2+(3)	5	18.76 cm	21.95 cm	±4.604	-11.106 *
3+(4)	4	24.45 cm	27.30 cm	±5.841	-15.143 *

NOTE: (*) STATISTICALLY SIGNIFICANT AT P LESS THAN 0.01

TABLE SIX. STATISTICAL EVALUATION OF AVERAGE LENGTHS OF LAR RIVER BROWN TROUT BY AGE CLASS BETWEEN 1353 AND 1352.

YEAR CLASS	N	AVERAGE LENGTH 1352	AVERAGE LENGTH 1353	T	ACTUAL T VALUE
1+(2)	5	14.40 cm	14.56 cm	±2.776(.975)	- 0.2136
2+(3)	5	19.88 cm	21.95 cm	±4.604(.995)	- 5.846*
3+(4)	5	24.10 cm	27.30 cm	±4.604(.995)	- 9.437*

NOTE: (*) STATISTICALLY SIGNIFICANT AT P LESS THAN 0.01

TABLE SEVEN. STATISTICAL EVALUATION OF AVERAGE LENGTHS OF LAR RIVER BROWN TROUT BY AGE CLASS BETWEEN 1354 AND 1352.

YEAR CLASS	N	AVERAGE LENGTH 1354	AVERAGE LENGTH 1352	T	ACTUAL T VALUE
1+(2)	6	12.29 cm	14.40 cm	±4.032(.995)	- 8.580 *
2+(3)	5	18.76 cm	19.88 cm	±3.747(.990)	- 3.899 **
3+(4)	4	24.45 cm	24.10 cm	±3.182(.975)	+ 1.866

NOTE: (*) STATISTICALLY SIGNIFICANT AT P LESS THAN 0.01

(**) STATISTICALLY SIGNIFICANT AT P LESS THAN 0.02

TABLE EIGHT. COMPARISON OF BROWN TROUT POPULATION ESTIMATIONS FROM THE LAR, KARADJ, & LIGVANCHAI RIVERS FROM YEARS 1352, 1353, & 1354

LOCATION	1352	95 % C.L.	1353	95 % C.L.	1354	95 % C.L.
AB KHARSANG	——	——	750	± 276	1310	± 185
AB - E - SEFID	130	± 72	——	——	——	——
ALARM	766	± 432	2334	± 1017	751	± 248
CHESHMEH DO BARARE	2803	± 1128	7465	± 1127	11,380	± 1576
CHESHMEH SIAH	2194	± 970	2520	± 743	1705	± 444
SIAH PALAS	726	± 296	2542	± 945	2436	± 372
KARADJ TRIBUTARIES						
VARANG - E - RUD	475(**)	± 268	1026(*)	± 846	1182	± 558
GAJEREH	1026	± 664	—— (**)	——	488	± 503
LOWER SHAHRASTANAK	518	± 152	683	± 430	420	± 399
UPPER SHAHRASTANAK	1030	± 189	1056	± 440	605	± 359
LIGVANCHAI (AZARBAYJAN)						
LIGVANCHAI	560	± 148	622	± 178	1246 (*)	± 216

NOTES: (*) ESTIMATE IN THIS YEAR (*) WAS TAKEN AT A LOCATION FURTHER UPSTREAM FROM THE PREVIOUS YEAR.

(**) ESTIMATE IN 1353 NOT COMPLETED BUT UNDOUBTEDLY LESS THAN 1352.

(**)ESTIMATES FROM 1352 AND 1354 ARE DIRECTLY COMPARABLE AS THEY WERE COMPLETED AT SAME LOCATION, BUT IN 1354 FISHING PRESSURE WAS NONEXISTENT DUE TO ABSENCE OF IRAN SAFARIS CAMP.

TABLE NINE. COMPARISON OF POPULATION AGE CLASS STRUCTURE BETWEEN YEARS 1352, 1353, & 1354.

LOCATION & AGE (YRS)	1352	1353	1354
AB-E-SEFID			
2	0.1539	0.9091	0.8545
3	0.3077	0.0000	0.1273
4	0.4769	0.0909	0.0182
5	0.0615	0.0000	0.0000
AB KHARSANG			
2	———	0.2880	0.4942
3	———	0.5360	0.3063
4	———	0.1200	0.1763
5	———	0.0480	0.0232
6	———	0.0800	0.0000
ALARM			
2	0.1270	0.6161	0.6429
3	0.3968	0.3080	0.2946
4	0.3810	0.0759	0.0536
5	0.0952	0.0000	0.0089
CHESHMEH DO BARARE			
2	0.1754	0.2228	0.3309
3	0.6491	0.6799	0.5909
4	0.1140	0.0858	0.0571
5	0.0351	0.0066	0.0022
6	0.0264	0.0049	0.0000
CHESHMEH SIAH			
2	0.2018	0.7415	0.3993
3	0.4298	0.1903	0.4851
4	0.2281	0.0540	0.0759
5	0.1403	0.0114	0.0066
6	0.0000	0.0045	0.0000

TABLE NINE (CONTINUED). COMPARISON OF POPULATION AGE CLASS STRUCTURE BETWEEN YEARS 1352, 1353, & 1354.

LOCATION & AGE (YRS)	1352	1353	1354
SIAHPALAS			
2	0.4545	0.8356	0.8351
3	0.4318	0.1422	0.1649
4	0.0909	0.0222	0.0000
5	0.0228	0.0000	0.0000
GAJEREH			
2	0.4600	0.3158	0.4706
3	0.4800	0.5789	0.5098
4	0.0600	0.1053	0.0196
VARANG-E-RUD			
2	0.5135	0.6667	0.7403
3	0.4595	0.3333	0.2597
4	0.0270	0.0000	0.0000
LOWER SHAHRASTANAK (Fishing Permitted)			
2	0.5128	0.5287	0.2962
3	0.3846	0.3678	0.2308
4	0.1026	0.0920	0.0769
5	0.0000	0.0000	0.0000
6	0.0000	0.0115	0.0000
1	0.0000*	0.0000*	0.4231
UPPER SHAHRASTANAK (Fishing NOT Permitted)			
2	0.5094	0.7429	0.6038
3	0.4340	0.2171	0.3679
4	0.0566	0.0343	0.0283
5	0.0000	0.0057	0.0000
LIGVANCHAI			
2	0.7000	0.7059	0.7184
3	0.1938	0.2549	0.2816
4	0.1062	0.0392	0.0000

NOTE(*): Does not imply 1 yr age class does not exist, only not included in the estimate.

REFERENCE SOURCES & LITERATURE CITED

Dixon, W.J., and F.J. Massey, Jr. 1969. Inference: single population, p. 95 - 108. IN W.J. Dixon and F.J. Massey, Jr. Introduction to statistical analysis. McGraw-Hill Book Company, New York.

Kinunen, Wayne. 1972. Lar river creel census. Department of Environmental Conservation. Report No. S-2-51-1.

Klein, W.D. 1974. Special regulations and elimination of stocking: influence on fishermen and the trout population at the Cache la Poudre river, Colorado. Colorado Division of Wildlife Tech. Publ. No. 30.

Mendenhall, W., L. Ott, and R.L. Scheaffer. 1971. Sampling from wildlife populations, p. 187 - 199. IN W. Mendenhall, L. Ott, and R.L. Scheaffer, Elementary survey sampling. Wadsworth Publishing Co., Inc. Belmont, California.

Shetter, D.S., and G.R. Alexander. 1970. Results of predator reduction on brook trout and brown trout in 4.2 miles (6.76 km) of the north branch of the Ausable river. Trans. Amer. Fish. Soc. 103: 59 -64.

Nehring, R.B. 1973. Lar river population estimations. Department of Environmental Conservation. Job Progress Report. 18 p.

Nehring, R.B. 1974. Lar river valley population estimations - 1353. Job Progress Report. Department of the Environment. 32 p.

JOB PROGRESS REPORT
DEPARTMENT OF THE ENVIRONMENT
FISHERIES & AQUATIC ECOLOGY SECTION

Submitted To:
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NEUR LAKE AMPHIPOD POPULATION DYNAMICS & ECOLOGY IN THE PRESENCE AND ABSENCE OF PREDATION BY RAINBOW TROUT

ABSTRACT

Detailed studies of the population density and structure throughout the spring, summer, and fall months of 1975 (1354) were completed. The population (Gammarus fasciatus) produced three generations of young during the period of the study when the population was subjected to intensive predation by rainbow trout. In contrast, the marsh population immediately adjacent to the main lake population produced only one generation during the period of the study (in the absence of predation by the trout).

A negative correlation was established between amphipod density and depth of the water, i.e., as depth increases amphipod density decreases. Although not significant at p = 0.05, all analyses were significant at p = 0.20 to p = 0.10. Amphipod population density was definitely correlated with better habitat and aquatic vegetation. In five of nine instances statistically significant differences were found between the amphipod populations on the west side of Neur Lake (leeward, absence of aquatic vegetation) and the east side population (windward, abundant aquatic vegetation) at p = 0.05 or less. In three of the remaining instances the level of significance was p= 0.2 to p = 0.10. In only one instance was the west side population more dense than the east side population.

Predation by the trout on the amphipod population had no negative effect on the amphipod population when compared with data collected during 1974 (1353) at similar time periods. Predation by the trout was restricted to the adult and sub-adult (immatures approaching sexual maturity) portions of the amphipod population.

It is recommended that detailed studies of the trout-amphipod (predator-prey) relationship be continued in 1355 (1976) on an intensive

Title: Neur Lake Amphipod Population Dynamics & Ecology in the Presence and Absence of Predation by Rainbow Trout.

Period Covered: 25 Ordibehesht - 26 Mehr 1354 (Spring, Summer, Fall 1975)

Personnel: All Fisheries Unit

Job Project Number: L - 7 - 54

Work Programs Initiated: WP 2 Fish & Aquatic Invertebrate Collections
WP 4 Population Estimations

INTRODUCTION

This study had one primary purpose: to evaluate the population dynamics and ecology of the Neur Lake amphipod population and determine what effect (if any) predation by rainbow trout has had on that amphipod population.

To accomplish this program a very ambitious sampling program was set up and carried out on a two week basis throughout the spring, summer, and fall months of 1354 (1975). This sampling program included an estimation of the amphipod population density on a bi-weekly basis, based on intensive sampling at fourteen stations in the main lake, with two substations set up at each of the 14 main stations. It also entailed collection of ten trout stomach samples on a bi-weekly basis corresponding to each period when a population estimation was carried out. This permitted a direct comparison of the actual population composition (from the lake substrate samples) with the segment of the amphipod population making up the food resource of the trout.

All samples were picked over and preserved on site at the lake and then forwarded by mail to Tehran for detailed analysis and examination under a binocular microscope in our laboratory. All amphipods were aged (or classified) by antenna segment count and from this data the population structure could be discerned. Also, the amphipods were examined for egg pouches throughout the sample period which indicates the onset of natural reproduction. When an adequate sample was available, fecundity and brood size (by inference) was determined.

METHODS

Sample stations were set up this year as described by Boettcher, 1353 (1974) with a few minor modifications and additions. Fourteen sample stations were retained , but two substations were set up at each station. Substations "A" were located in water approximately one meter depth and substations "B" were located in water 2 or more meters in depth. Ten core samples were taken at each of the substations in the main lake for a total of 280 core samples during each sample period. In addition, five sample stations were set up in the mordab (marsh) at the north end of the lake in order to compare the marsh population (where no trout predation existed) with the main lake population (where intense predation on the amphipod population was operating).

The substations (A & B) were set up to evaluate the effect of depth (if any) on the amphipod population density. Indications from last year's data led us to believe that population density decreased with increasing depth.

The core sampler was constructed such that all amphipods swimming in the water column through which the sampler passed would be trapped in the sampler together with the amphipods found on the substrate in the core sample. The entire time elapsed from the time the sampler entered the water until the core sample was drawn was less than 0.5 seconds. With the very reduced transparency of the water in the lake, it is virtually certain that no escapement of amphipods was possible due to avoidance reaction induced by the sampler. The area (cross-sectional) of the sampler was 50 cm^2. Thus, with 10 core samples being drawn at each substation, a total of 500 cm^2 of substrate was sampled or 5 % of a square meter.

Each core sample was filtered through a 460 micron mesh Tyler sieve. This small mesh sieve insured that no amphipod however small, would be missed by passage through the screen. Although detritus and organic matter did present some problems in separation of the amphipods from the core sample, it was not a severe problem. Most amphipods could readily be separated from the sample as they were observed swimming and kicking in the sample on the screen.

RESULTS

The data presented in this paper is organized as two appendices at the back. Appendix A contains a summation of all the data that will be discussed in this paper, or nearly so. Virtually all of the data presented in Appendix A is in the form of graphs and figures numbered consecutively from one through twenty-four. The data contained in these graphs and figures are summations of the data presented in tabular form in Appendix B. The data presented in Appendix B contains all of the amphipod data collected at Neur Lake during the spring, summer, and fall of 1354 (1975). Many of these tables were taken from other reports on Neur Lake written this past year; thus, in many cases, there are more than one table with the same numerical designation. However, to redue the entire Appendix B and put it into a properly organized form with all tables presented in sequential form would have been a major undertaking requiring alot of time. Thus, the sole purpose of including these data in appendix B is to insure that all data collected over this past year are presented together in some form in one report where the data can be easily found and recalled and examined, if necessary.

Figures One through Eight in Appendix A present a graphic comparison of the amphipod population in the lake (as observed in the core samples) with the segment of the amphipod population comprising the food resource of the rainbow trout in the lake. This data covers a period of almost six and a half months, running from 14 Ordibehesht (4 May) through 26 Mehr 1354 (18 October 1975). The two populations are presented by antenna segment counts based on a frequency of occurrence as percent of 100 within each sample period. Laying out these graphs in sequential form so that all of the figures can be observed in one line readily indicates the changes in the population structure and dynamics over the six month period. At all times during the study the trout fed only upon the physically largest and oldest members of the amphipod population; however, the pressure on the amphipod population was always in a constant state of flux. When the population was comprised primarily of young and juvenile amphipods then the trout fed upon physically smaller and younger amphipods.

Close scrutiny of the clear and black portions of Figures One through Eight readily reveal that two definite generations were produced this year. The first pulse in the population was already present by 14 Ordibehesht 1354 (4 May 1975) and the second was present on 2 Tir (June 23, 1975). Numerically speaking the first pulse produced in the spring was of much smaller magnitude and duration than the one produced on June 23rd. Figure Twenty-four in Appendix A shows that the main lake population remained at or less than 250 amphipods/ meter^2 until after 2 Tir 1354 (June 23, 1975) when natural reproduction really boomed and the population density for the entire lake increased to more than 1000 amphipods/m^2 in a two week time period.

Figures Nine through Fourteen present a comparison of the main lake samples with trout stomach samples from last year (1353 or 1974). Again , examination of the clear and black portions of the graphs give an indication of the change in the population structure and the population dynamics. Comparison of last year's data with this year also reveal some significant differences in population structure between the two years. Last year the older portion (1st generation amphipods) disappeared from the population entirely by the 10th of Mordad 1353 (August 1, 1974) whereas this year 1st generation adults remained in the population until after 17 Shahrivar 1354 (September 8, 1975). The possible reasons and explanations for this phenomenon will be discussed later in the report.

Figures Fifteen through Twenty compare the main lake population with the mordab (marsh) population at the north end of the lake and separated from the main lake by a 5 meter wide sand spit. Again, if these figures are laid out in sequential form so that they can all be viewed simultaneously, very profound differences in population structure and dynamics between the two populations become apparent. First of all, while the main lake population has produced a large pulse of new generation amphipods by 14 Ordibehesht 1354 (May 4, 1975); the mordab (marsh) population has produced none at all. And while the main lake population undergoes a period of dynamic growth up through 2 Tir 1354 (June 23, 1975) the marsh population actually degenerates.

It is only after 2 Tir 1354 (June 23, 1975) that the marsh population begins to reproduce and enter a state of dynamic change. However, examination of Figure Eighteen reveals that the main lake population is ahead of the marsh population in production of the second generation in the main lake, whereas the marsh population is producing the first generation .

Once the lake water temperature dropped below 10 C it was assumed that the amphipod population would not reproduce again in 1354 (1975). Thus no more data was intended to be included in this report. However, since another survey of Neur Lake was scheduled for early Azar 1354, it was decided that an attempt should be made to collect a sample of amphipods from the main lake, even though the lake was frozen over since 19 Aban 1354 (November 10, 1975), strictly for the purpose of documenting the rate at which the population aged during the winter months. Cooper (1965) indicates that natural reproduction ceases in the autumn when water temperatures begin to fall. He also indicated that with the amphipod *Hyalella azteca* growth ceases below 10 C. Thus, we were very surprised to discover that natural reproduction had taken place in the main lake just prior to ice up. The collection of amphipods on 6 Azar 1354 (November 27, 1975) shows beyond any shadow of a doubt that a third generation was produced in the lake (see Figures Eight A and Twenty A in Appendix A). Figure Nineteen shows that on 26 Mehr 1354 (October 18, 1975) the main lake population consisted of entirely adults and sub-adults and predation by the trout was operating at its maximum intensity for the year. However, by 6 Azar 1354 (November 27, 1975) a new generation is in evidence and predation by the trout is restricted to the second generation adults with the 3rd generation immature amphipods being completely ignored by the trout despite the fact that the 3rd generation amphipods comprise between 55 and 60 percent of the total population.

Figure Twenty-four in Appendix A is a graphic representation of the main lake amphipod population densities from 17 Ordibehesht 1354 (7 May 1975) through 26 Mehr 1354 (18 October 1975). Even though reproduction has already occurred at the time of the first samples, the population density remains at less than 250 amphipods/ meter^2 until the second generation is produced. Once this occurs, the population density rises from about 200 amphipods/meter^2 at the "A" substations on 2 Tir 1354 (June 23, 1975) to more than 1000/m^2 on 17 Tir 1354 (July 8, 1975) a mere two weeks later. For the next month the population density continues to increase to over 1500/m^2 and then slowly decreases after 17 Mordad 1354 (8 August 1975).

The mordab (marsh) population (Figure Twenty-four) shows an increase in density at a much earlier time. However, examination of figures 15 - 17 show that no change in the marsh population age structure occurs until 2 Tir 1354 (June 23, 1975) when the first generation in the marsh is produced. The increase in density of the marsh population through late May and June 1975 is a result of the drying out and constriction of the marsh in size. As the marsh becomes smaller and smaller, the remaining amphipods are squeezed into a smaller and smaller space, thus the "apparent" increase in the marsh amphipod population.

DISCUSSION

Tables Thirty-four, thirty-five, and thirty-six in Appendix B contain statistical evaluations of the Neur Lake amphipod population data using the T - test as described by Dixon and Massey(1969). In Table Thirty-four the population densities from adjacent bi-weekly sampling periods are analyzed for statistically significant differences. The only difference occurred during the two week period from 2 Tir 1354 (23 June 1975) and 17 Tir 1354 (8 July 1975) when the second generation of the year was produced.

Table Thirty-five is a statistical (T-test) analysis of the Neur Lake amphipod density data from 1354 (1975) and 1353 (1974) for statistically significant differences is densities at similar sampling dates between the two years. The first two comparisons show that near statistically significant differences were present between 1975 and 1974 (1354 & 1353) during the first two sampling periods, with the 1975 density being mucher lower than 1974. However, by the time the second generation was produced on 2 Tir 1354 (June 23, 1975) this situation had actually reversed itself and the 1975 densities were greater than corresponding periods in 1974. Thus, we can conclude that the trout population had no negative effect on the amphipod population in 1975 (1354) as compared to 1974 (1353). Figure Twenty-four is a graphic representation of this data. The four circled "x"s on the graph are population density estimates from 1974 (1353) plotted with the density curves for 1975 (1354). It is readily apparent that no significant difference is visible.

Table Thirty-six contains a T - test evaluation of the amphipod population for differences in population density due to differences in habitat. Two types of analyses were carried out. First of all, sub-stations 2 - 8 A were compared with substations 2 - 8 B. These are the stations on the east side (windward). This test was a check to see if any real differences existed in population density between the shallow water ("A" substations) and the deep water ("B" substations) populations. Although no differences occurred at p = 0.05, nonetheless a definite trend exists at p = 0.2 to p = 0.1 with the shallow water population being more dense. The second evaluation compared the shallow water population on the west side of the lake to the shallow water population on the east side of the lake. A definite difference in habitat existed between the east and west shores of the lake as the wind tended to blow from west to east causing an accumulation of algae, detritus, and allocthanous material on the east side of the lake thereby increasing the fertility. Thus, with better food and habitat on the windward side of the lake, one would expect greater population densities there. In five out of nine tests population densities were found to be statistically significantly greater on the east side of the lake at $p = 0.05$ or less. In most of the other instances significant differences were noted from $p = 0.20$ to $p = 0.10$. In only one of the nine tests was the population on the west shore found to be greater than that of the east shore. Thus, it is concluded that the population density is greater on the east shore and it is probably due to better food and habitat conditions.

Intensive evaluation of the mass of data assembled on this amphipod population over the past three years, especially this summer, reveal a number of parodoxes. First of all, disregarding the possibility of massive trout mortalities since May this year, the trout biomass in the lake has probably increased from 300 to 500 percent over the summer. The concomittant increase in demand for food by the trout should be proportional, thus one would expect that some decrease in the amphipod population density and/or population structure would be apparent. Yet, the converse is true. In 1353 (1974) all traces of the first generation adults had disappeared from the substrate samples by 10 Mordad 1353 (August 1, 1974), but this year first generation adults were still present in the substrate samples on the 17th of Shahrivar (September 8, 1975). The only logical explanation lies in differences in habitat from this year to last. In 1974, heavy and extensive periods of rain and snow occurred at Neur Lake during late Tir and all of Mordad (July and August). These summer rains kept the lake full of water all summer. With the lake at maximum depth and the transparency of the water reduced to perhaps less than 30-100 cm, production of rooted (submergent) aquatic macrophytes was nonexistent. The trout at that time averaged 20 cm in length and 120 grams weight. Thus, with very little refuge from the trout, the amphipod (first generation adults) population was subjected to intense predation by the trout. Once the first generation adults were cropped off (1 Shahrivar 1353 or August 23, 1974) the trout were forced to switch to an alternate food supply, in this case leeches. Predation on amphipods was nonexistent for the rest of the season.

In contrast, in 1975 (1354) no summer rains occurred. Thus, by mid summer (Tir and Mordad or July and August) the water level in the lake was about 70 cm below the level of the same period in 1353 (1974). This permitted sunlight penetration to the substrate in the shallower areas of the lake and resulted in a massive bloom of filamentous algae and growth of rooted aquatic macrophytes. It is my contention that this dense growth of algae provided not only additional food resources and substrates for attachment by the amphipods, but also greater protection from trout predation since the trout at this time averaged over 1000 grams and 40 cm (much larger than last year) and were undoubtedly restricted in their ability to feed effectively in this mass of algae due to their large physical size. With a reduced level of predation the first generation amphipods remained in the substrate population up until 17 Shahrivar 1354 (September 8, 1975). By this time, the second generation amphipods were also approaching a larger size and sexual maturity providing a continuing forage supply on into the fall. With an abundance of amphipods present right through until freeze - up, the trout never switched to another food supply in 1975 (1354) as compared to last year when they switched to leeches after late August (Shahrivar).

A second paradox is that a third generation of amphipods was produced in the lake just prior to or after ice up this year. At that time the water temperature was only 2 C. Both Cooper (1965) and Pennak (1953) indicate that growth and reproduction are temperature dependent and that reproduction ceases as water temperatures drop during the fall. Yet this population (Gammarus fasciatus) produced a generation in late fall which continues to grow at a rate not all unlike the growth rate of mid-summer this year. Pennak (ibid) also states that amphipods require " an abundance of dissolved oxygen" as " an environmental necessity". However, this population thrives during the winter months at D.O. levels less than 0.5 mg/l.

Comparison of the amphipod population age structure over the past three years, together with the water temperatures, reveals that some factor other than water temperature definitely governs the onset of natural reproduction. On 25 Ordibehesht 1352 (15 May 1973) the water temperature was 7 C. On 25 Ordibehesht 1353 (15 May 1974) the water temperature was 17 C. Yet the amphipod population age structure was quite similar (see Figure Twenty-two in Appendix A). During the period 14 - 20 Ordibehesht 1354 (May 4 - 10, 1975) the water temperature remained stable at 9 - 10 C. However, drastic differences in the population age class structure between this year and the two preceding years are readily apparent when one examines the graphs in Figure Twenty-three. This year a massive pulse of first generation amphipods had been produced during the period of May 4 - 10, 1975, in fact the first generation was produced much earlier than this, perhaps just after ice out and the over wintering adults (amphipods with 22 antenna segments or greater) had almost been completely cropped from the population by the trout. In contrast, in the two preceding years, the populations consist largely of overwintering adults. In 1352 (1973) no first generation amphipods were in evidence by May 15 (25 Ordibehesht) as the minimum antenna segment count was 16 segments (first molt instars have six antenna segments). In the spring of 1353 (1974) when 5000 trout were present in the lake, a minor pulse of first generation amphipods was present by 25 Ordibehesht (15 May) with 14 - 18 antenna segments while the main portion of the population is still overwintering adults. In contrast, in 1975 (1354) the majority of the population consists of first generation amphipods in the early stages of development (14 - 20 antenna segments). At this time there were between 100,000 and 200,000 trout in the lake averaging 30 cm length and 300 grams weight. Does this indicate that perhaps the trout population (predation) has induced the amphipod population in the main lake to reproduce earlier and in a much greater magnitude than the two previous years? (See Figure Twenty-three). Evidence will be presented to support this hypothesis.

As stated previously, the amphipod population of Neur Lake in the spring (May or Ordibehesht) 1973 and 1974 (1352 & 1353) consisted of primarily overwintering adults. There was no evidence of reproduction in 1973 at all and very little again in 1974 (see Figure Twenty-two) despite a 10 C. differential in water temperature between the two years. The vast majority of the amphipods in the population had 20 - 28 antenna segments. Comparison of figure twenty-two with the portion of Figure Fifteen pertaining to the marsh amphipod population reveals that the marsh population structure from this past spring would virtually superimpose onto the data from the two previous years on Figure twenty-two. In contrast, the main lake amphipod population this year has an entirely different structure than the two previous years, in 1975 most of the population consists of first generation immature amphipods with 14 - 20 antenna segments. It is my hypothesis that intensive predation on the amphipod population by the rainbow trout has somehow (either directly or indirectly) induced a more rapid rate of turnover in the main lake population.

Examination of Figures One through Eight A and fifteen through twenty (when lined up in sequential form with each succeeding figure below the former) several things become apparent. In Figures fifteen through twenty the rapid growth and rate of change in the main lake population (clear and black portions) or left to right movement between successive sampling periods stands out in stark contrast to the marsh (mordab) population where there is actually a degeneration of the overwintering population (slight movement from right to left between sampling periods. This scenesence in the marsh population is evident not only in the right to left movement as spring progresses towards summer, but also in the decrease in the proportion of the largest (most antenna segments) amphipods in the population. Since predation is not operating in the marsh population, apparently the largest adults are dying without ever having reproduced. Not until 2 Tir 1354 (June 23, 1975), when the overwintering adults in the marsh population are rapidly dying off, does any evidence of natural reproduction become evident.

In addition, examination of Figures Eighteen through twenty reveal that natural reproduction began later and stopped sooner in the marsh population than the main lake where predation by trout was the only additional factor operating on the main lake population that did not operate on the marsh population. The pulses (1st generation amphipods) from the marsh population are very narrow in width, indicating that reproduction commenced and ceased over a very short time interval, whereas in the main lake population natural reproduction (2nd generation amphipods) was well underway before 2 Tir 1354 (June 23, 1975) and continued on at least through 17 Mordad 1354 (August 8, 1975). This is evidenced by the presence of amphipods with seven antenna segments in the main lake population all the way through the month of Mordad but not evidenced in the marsh population. Thus, it definitely appears that predation by the trout in the main lake has in some manner induced a more dynamic rate of growth and natural reproduction in the main lake population. The second generation in the main lake is produced over a longer period of time and actually becomes evident in the population prior to production of the first generation in the marsh population.

Figures Eight A and Twenty A definitely indicate that a third generation was produced in the main lake about the time of freeze-up. Unfortunately, a check of the marsh population was not made at the same time. However, a check of both populations will be made in Dey 1354 (January 1976) and it should be possible to determine from comparison of the two population's age structures whether or not a late fall generation was produced in the marsh population as well.

To isolate the mechanism that directly controls the reproductive cycle of this amphipod and what role predation by trout plays in the phenomenon would probably take many years to deduce. However, some hypotheses readily come to mind and will be discussed below.

Natural reproduction in the amphipod population may be controlled by some hormone or combination of hormones that brings on the formation of eggs in the female. These hormone levels may be controlled by or depend upon the population density. When the population is comprised of a large number of mature individuals present in very high densities the hormonal balance may inhibit the production of eggs in the females. As the population density decreases, either through predation by trout or natural mortality due to old age, the hormone balance may change and the formation of eggs may take place. In this case the trout population would be acting indirectly on the amphipod population by effecting the hormone levels in the amphipods.

Another possibility is that the amphipods control natural reproduction themselves. At high population densities it may be possible that copulation or fertilization does not occur. If copulation and fertilization occurs then perhaps the female may consume the eggs herself, or the male may destroy the young before they become mobile. Other possibilities undoubtedly exist. Whatever the mechanism may be, we definitely know that 1st instar amphipods did not appear in the marsh population until 2 Tir 1354 (June 23 , 1975). Throughout the entire spring the marsh population densities remained at about 600 - 800 amphipods/meter^2. In contrast, the main lake population never averaged more than about 200/m^2 until after 2 Tir when the second generation was produced. During Khordad (late May to mid June) the main lake population dropped to 100/m^2 or less. It was at this time the second generation was produced. Extrapolation of the population density data after 26 Mehr 1354 (October 18, 1975) and extension of the graph on Figure Twenty-four into Aban indicates that the amphipod population at that time again approached a density of 100 - 200/meter^2. And once again reproduction again took place. Admittedly this does not prove that reproduction is density dependent, nonetheless, the correlation does exist.

Predation by the trout on the amphipod population is governed by two factors; 1) population density, and 2) age structure of the amphipod population. Examination of Figures One through Twelve reveal the manner in which predation is governed by age class structure in the amphipod population. In Figure Nine we see that on 10 Mordad 1353 (August 1, 1975) the actual composition of the amphipod population was totally early instar immature amphipods. In contrast, stomach samples analyses revealed the trout had fed only upon the 1st generation adults and in fact had totally removed them from the lake population with such efficiency that not one 1st generation adult showed up in our substrate samples at this time. In contrast the data presented in Figures Two and Eleven reveal just the opposite extreme where the trout have already consumed the adult generation amphipods and are now feeding intensively upon the sub-adults (immatures approaching sexual maturity) which comprise the entire population.

Although Figures Two and Eleven just cited indicate that the grazing pressure (exerted by the trout) coincides almost exactly with the population age structure, i.e., there is very little selectivity on the part of the trout for the largest amphipods, these figures do not reflect in any way what percentage of the trout population is feeding upon amphipods. This is governed strictly by the population density (amphipod population density). Although no factual or numerical data has been gathered over the past two years to document this, general observations were made during each survey since May 1974. It virtually every case where the graphs (such as Figures Two and Eleven) indicate that predation by the trout is most intense, just exactly the opposite is true. That is to say, the trout population as a whole rarely feeds upon immature amphipods (less than 22 antenna segments) at all. Thus, the data presented in Figures Two and Eleven are based on those trout stomach samples with amphipods in the food bolus; however, perhaps only 5 - 10% of the trout stomachs examined at those particular times even contained one amphipod. Trout predation is is generally most intense on the amphipod population as a whole when and only when adult amphipods are present in large numbers. Furthermore, when the population density (amphipod) drops to less than 200 amphipods per square meter over the entire lake, trout predation virtually ceases to act on the amphipods.. Thus, Figure One A, indicates no predation by the trout on the amphipod population during the period 1 - 3 Khordad 1354 (22 - 24 May 1975). Such was the case, not one trout could be caught with amphipods in the food bolus. Similarly, during the months of late Shahrivar, Mehr, and Aban 1353 (October and November 1974) predation was virtually nonexistent. More than 99% of the trout in the lake were feeding entirely upon leeches to the point where the leeches extruded from the mouths of trout entangled in the gill nets. The data on amphipods contained in the food bolus during those months (Figures Eleven and Twelve) only reflect the portion of the amphipod population subjected to predation by the trout.

CONCLUSIONS

1)The information collected over the past three years indicates that the trout predation on the amphipod population has had no negative effect whatsoever. On the contrary, if anything the effect of predation has made the amphipod population more dynamic, probably increasing the number of generations produced per year from one (prior to introduction of the trout) to three or possibly more generations per year under intense predation pressures.

2) A definite correlation exists between depth of the lake and density of the amphipod population and the correlation is negative, i.e., as depth increases population density decreases. The correlation is statistically significant at P= 0.20 to P = 0.10.

3) Amphipod population density is definitely correlated with habitat throughout the entire sampling period in 1975 (1354). In five out of nine instances, the population was statistically significantly greater at substations 2 - 8 A (east and windward side of the lake) than at substations 1, 9 - 14 A (west and leeward side of the lake). In five of the nine instances the significance was at $p = 0.05$ or less. In three of the remaining instances significant differences were observed at $p = 0.20$ to $p = 0.10$. In only one instance was the west side population greater than the east side population.

4) Trout predation on the amphipod population as a whole is most intense in the early spring right after ice-out and is directed at the overwintering adults. It is less intense during the spring months when the amphipod population densities drop to $200/m^2$ or less, and then increases towards its maximum intensity throughout most of the summer months when the amphipod population is at its most dynamic state. At this time the trout restrict themselves to the 1st generation adults. When either population densities fall to less than $200/meter^2$ or adult amphipods are unavailable, the trout switch to a more readily available source of food. This was most pronounced in late August 1974 when the amphipod population was at its most dense point (more than $1000/m^2$) but the entire population consisted of early instar amphipods with nine to 13 antenna segments and the trout then switched to an exclusive leech diet.

5) The ability of the adult amphipods to escape predation by the trout is a function of habitat and the density of aquatic vegetation. In 1974, with no production of filamentous algae or rooted aquatic macrophytes, the 1st generation adults were readily cropped off by the trout in a very short period of time. Conversely, in 1975 (1354) the dense growths of filamentous algae and rooted aquatic macrophytes resulted in 1st generation adults surviving on into September when they were completely cropped of by August 1st in 1974. The large size of the trout in 1975 perhaps decreased their efficiency in feeding through decreased mobility in the masses of aquatic vegetation.

6) From ice-out in the spring to ice-up in the fall of this year the mordab (marsh)population only produced one generation of amphipods. The production of the first generation in the marsh coincided almost precisely with the production of the second generation of the year in the main lake where trout predation was a factor.

7) No statistical differences in population densities collected at similar times in 1974 and 1975 (1353 and 1354) could be discerned when the paired data points were subjected to statistical evaluation (T - test).

RECOMMENDATIONS

1) In the event of stocking 400,000 rainbow fingerlings in Neur Lake in the spring of 1976 (1355), monthly gill net surveys should be made to document any differences in selective predation between the large trout which escape the spring commercial fishery and the fingerling trout throughout the summer.

2) Bi-weekly population estimates should be conducted again in 1976 (1355) to see if the doubling of the fingerling stocking rate has a negative effect on the amphipod population.

3) A minimum of one hundred amphipods should be collected daily in both the main lake and the marsh population from ice out up until the time when the first population estimation is performed to document any differences in fecundity of the two populations and/or differences in the times of the onset of natural reproduction. This will allow us to examine the females in the laboratory for egg production.

4) As a final check on whether or not the trout have induced the amphipod population in the main lake to reproduce more often than the marsh population, the following experiment should be completed. One hundred meters^2 should be screened off in the marsh and stocked with trout at the same rate as the main lake and the population density inside the screen be compared to that outside the screen all summer long.

LITERATURE CITED

Boettcher, J. 1974 (1353). Neur lake limnological investigation II, 6 - 11 Mordad 1353. Department of the Environment. Job Progress Report. 17 p.

Cooper, W.E. 1965. Dynamics and production of a natural population of a fresh-water amphipod, Hyalella azteca. Ecological Monographs. 35:377-394.

Dixon, W.J., and F.J. Massey, Jr. 1969. Inference: two populations, p. 109-126. IN W.J. Dixon and F.J. Massey, Jr. Introduction to statistical analysis. McGraw-Hill, New York.

Pennak, R.W. 1953. Amphipods (scuds, sideswimmers), p. 435-446. IN R.W. Pennak, Freshwater invertebrates of the United States. Ronald Press Co., New York.

APPENDIX A

APPENDIX B

TABLE THREE. BIOMETRIC DATA, NEUR LAKE, 14,19 ORDIBEHESHT +⅓_4

Ave. Length (cm)	Ave. Weight (g)	N	SEX	Net Specifications
29.1	232	30	Male	50 m X 2 m X 20 mm
30.9	288	30	Female	50 m X 2 m X 20 mm
32.5	270	41	Both	13 m X 2 m X 35 mm
47.0	1450	1	Male	
50	1960	1	Female	
50	1920	1	Male	

TABLE FOUR. AMPHIPOD POPULATION DATA, NEUR LAKE, 17 ORDIBEHESHT 1354

STATION #	TOTAL "A"	TOTAL "B"	AVE. "A"	AVE. "B"	A $\#/M^2$	$B\#/M^2$
1	26	2	2.6	0.2	520	40
2	9	5	0.9	0.5	180	100
3	79	10	7.9	1.0	1580	200
4	18	0	1.8	0	360	0
5	7	4	0.7	0.4	140	80
6	2	3	0.2	0.3	40	60
7	2	1	0.2	0.1	40	20
8	6	0	0.6	0	120	0
9	0	2	0	0.2	0	40
10	6	1	0.6	0.1	120	20
11	50	0	5.0	0	1000	0
12	1	1	0.1	0.1	20	20
13	16	0	1.6	0	320	0
14	3	1	0.3	0.1	60	20
15	34	—	3.4	—	680	—
16	32	—	3.2	—	640	—
17	49	—	4.9	—	980	—
18	24	—	2.4	—	480	—
19	69	—	6.9	—	1380	—

TABLE FIVE. AVERAGE AMPHIPOD POPULATION DATA, NEUR LAKE, 17/2/54.

STATIONS	AVERAGE/ $METER^2$
1 - 14 A	$321/m^2$
1 - 14 B	$42.8/m^2$
1 - 8 A	$373/m^2$
9 - 14 A	$253/m^2$
15 - 19	$832/m^2$

TABLE SIX. AMPHIPOD ANTENNA SEGMENT DATA, NEUR LAKE, 17 ORDIBEHESHT 1354

STATION #	AVE.($\bar{X}$)	N	RANGE
1A	16.1	25	12 - 20
1B	0	0	
2A	16.4	8	13 - 18
2B	18.0	4	16 - 20
3A	19.3	77	13 - 27
3B	19.2	10	15 - 24
4A	16.7	17	12 - 20
4B	0	0	———
5A	15.4	7	14 - 18
5B	19.3	4	15 - 24
6A	17.0	2	17
6B	17.0	2	17
7A	18	1	18
7B	19	1	19
8A	20.2	6	16 - 27
8A	0	0	———
9A	0	0	———
9B	20.5	2	20 - 21
10A	17.3	6	14 - 20
10B	16	1	16
11A	20.5	48	15 - 29
11B	0	0	———
12A	18	1	18
12B	16	1	16
13A	18.4	16	15 - 26
13B	0	0	———
14A	17	2	15 - 19
14B	18	1	18
15	23.0	28	17 - 31
16	21.9	32	18 - 30
17	23.3	45	17 - 28
18	23.1	22	18 - 30
19	22.8	66	13 - 31

TABLE SEVEN. FEMALE AMPHIPOD FECUNDITY & ANTENNA SEGMENT DATA; 17/2/54

ANTENNA SEGMENTS			FERTILE EGGS		
$\bar{X}$	N	RANGE	$\bar{X}$	N	RANGE
23.0	10	20 - 26	24.9	10	16 - 30

TABLE EIGHT. ANTENNA SEGMENT DATA FROM AMPHIPODS CONSUMED BY RAINBOW TROUT IN NEUR LAKE, 14 - 20 ORDIBEHESHT 1354.

Fish #	$\bar{\bar{X}}$	N	RANGE
1	24.0	10	17 - 28
2	27.0	21	21 - 31
3	26.5	10	21 - 35
4	26.1	10	23 - 28
5	26.9	10	21 - 32
6	27.1	10	24 - 31
7	27.3	10	23 - 30
8	28.6	10	26 - 35
9	25.8	10	22 - 28
OVERALL AVERAGE	26.6		

TABLE ONE. AMPHIPOD ANTENNA SEGMENT DATA, NEUR LAKE, 1-3 KHORDAD 1354

STATION #	AVE. ($\bar{\bar{X}}$)	N	RANGE
1A	17.0	9	15 - 20
1B	0	0	-------
2A	18.0	10	14 -20
2B	18.2	8	.15 -20
3A	17.8	10	12 - 21
3B	19.0	4	17 - 22
4A	15.3	26	13 - 18
4B	17.9	13	15 - 21
5A	18.6	14	16 -20
5B	20.0	2	17 - 23
6A	0	0	-------
6B	18.3	13	17 - 23
7A	18.9	9	16 - 27
7B	23.8	11 (104)	17 - 34
8A	20.3	11	17 - 27
9A	19.2	6	15 - 26
9B	0	0	-------
10A	18.8	21	16 - 22
10B	19.0	1	-------
11A	18.8	11	16 - 21
11B	22.7	4	18 - 28
12A	0	0	-------
12B	22	2	21 - 23
13A	18.1	16	14 - 24
13B	0	0	-------
14A	17	2	-------
14B	0	0	-------
15	23.8	27	19 - 31
16	24.3	8	17 - 29
17	23.5	24	16 - 30
18	25.2	20	20 - 31
19	26.0	1	-------

TABLE TWO. NEUR LAKE FEMALE AMPHIPOD FECUNDITY DATA, 1-3 KHORDAD 1354

antenna segments			eggs		
$\bar{X}$	N	Range	$\bar{X}$	N	Range
24.2	13	21 - 29	38.2	13	18 - 58

Table Three. NEUR LAKE AMPHIPOD POPULATION DATA, 1-3 KHORDAD 1354

STATION #	TOTAL "A"	TOTAL "B"	AVE "A"	AVE "B"	A #/M^2	B #/M^2
1	11	0	1.1	0	220	0
2	10	11	1.0	1.1	200	220
3	10	4	1.0	0.4	200	80
4	26	15	2.6	1.5	540	300
5	14	3	1.4	0.3	280	60
6	0	14	0	1.4	0	280
7	10	104	1.0	10.4	200	2080
8	11	2	1.1	0.2	220	40
9	6	0	0.6	0	120	0
10	25	1	2.5	0.1	500	20
11	11	4	1.1	0.4	220	80
12	0	2	0	0.2	0	40
13	17	0	1.7	0	340	0
14	2	0	0.2	0	40	0
15	30	-	3.0	---	600	---
16	8	-	0.8	---	160	---
17	24	-	2.4	---	480	---
18	21	-	2.1	---	420	---
19	1	-	0.1	---	20	---

TABLE THREE A. NEUR LAKE AVERAGE AMPHIPOD POPULATION DATA, 1-3 KHORDAD 1354

STATIONS	AMPHIPODS / METER^2
1-14 A	220 / METERS ^{2}
1 - 14 B	226 / METER ^{2}
1 - 8 A	233 / METER ^{2}
9 - 14 A	203 / METER ^{2}
15 - 19	336 / METER ^{2}

NOTES: SIX FISH STOMACHS WERE EXAMINED FOR FOOD CONTENT FROM FISH COLLECTED ON 2 KHORDAD 1354 AND NONE WERE FOUND TO CONTAIN LARGE AMOUNTS OF AMPHIPODS AS WAS THE CASE IN ORDIBEHESHT. THIS SHORTAGE OF AMPHIPODS INDICATES THE MAJORITY OF THE TROUT ARE NOT FEEDING ON AMPHIPODS AS HEAVILY AS THE DENSITY OF THE AMPHIPODS DECREASES. NO ANTENNA WERE "READABLE" AND THUS NOT DATA COMPARING POPULATION DATA WITH PORTION OF THE POPULATION SUBJECT TO PREDATION BY TROUT. TWO OF THE SIX TROUT WERE STUFFED WITH CHIRONOMID PUPAE INDICATING THE TROUT PROBABLY ARE QUITE SUCCESSFUL IN REDUCING THE NUMBER OF SUCCESSFUL " EMERGERS" IN THE CHIRONOMID POPULATION.. ALTHOUGH LEECHES AND SNAILS MAKE UP A GREATER PORTION OF THE BIOMASS OF AQUATIC INVERTEBRATES ON THE SUBSTRATE, NONE WERE OBSERVED IN THE TROUT STOMACHS. MANY FEMALES (BOTH IN THE MORDAB AND THE MAIN LAKE)NOW HAVE MANY EGG CLUTCHES IN THE THORACIC AREA, BUT AS YET ARE UNFERTILIZED. SIGNIFICANTLY, THE FECUNDITY IS ALMOST 50 % GREATER WITH THIS "SECOND" GENERATION THAN WITH THE FIRST ONE PRODUCED THIS SPRING. THIS INDICATES A MUCH LARGER POPULATION TO COME IN THE SECOND GENERATION,

Table Four. Neur Lake Amphipod Population Data, 16-17 TIR 1354

STATION #	TOTAL "A"	TOTAL "B"	AVE "A"	AVE "B"	A #/M^2	B #/M^2
1	10	7	1	0.7	200	140
2	14	7	1.4	0.7	280	140
3	8	51	0.8	5.1	160	1020
4	3	48	0.3	4.8	60	960
5	14	31	1.4	3.1	280	620
6	55	35	5.5	3.5	1100	700
7	133	140	13.3	14.0	2660	2800
8	83	159	8.3	15.9	1660	3180
9	120	41	12.0	4.1	2400	820
10	213	16	21.3	1.6	4260	320
11	102	3	10.2	0.3	2040	60
12	14	14	1.4	1.4	280	280
13	13	21	1.3	2.1	260	420
14	18	24	1.8	2.4	360	480
		MORBAB				
15	352	----	35.2	----	7040	----
16	25	----	2.5	----	500	----
17	72	----	7.2	----	1440	----
18	40	----	4.0	----	800	----
19	8	----	0.8	----	160	----

Table Five. Neur Lake Average Amphipod Population Data, 15-17 Tir 1354

STATIONS	AMPHIPODS/METER^2	RANGE
1 - 14 A	1143 / meters^2	60 - 4260
1 - 14 B	853 / meter ^{2}	60 - 3180
1 - 14 A&B	998 / meter ^{2}	60 - 4260
15 - 19	1990 / meter ^{2}	160 - 7040

Table Six. Neur Lake Amphipod population Data, 16 - 17 Khordad 1354

STATION #	TOTAL "A"	TOTAL "B"	AVE "A"	AVE "B"	A #/ M^2	B # /M^2
1	17	1	1.7	0.1	340	20
2	4	1	0.4	0.1	80	20
3	14	0	1.4	---	280	0
4	4	10	0.4	1.0	80	200
5	14	6	1.4	0.6	280	120
6	6	6	0.6	0.6	120	120
7	19	9	1.9	0.9	380	180
8	15	4	1.5	0.4	300	80
9	5	2	0.5	0.2	100	40
10	5	2	0.5	0.2	100	40
11	---	---	---	---	0	0
12	---	---	---	---	0	0
13	---	---	---	---	0	0
14	1	0	0.1	---	20	0
			MORDAB			
15	33	---	3.3	---	660	---
16	21	---	2.1	---	420	---
17	36	---	3.6	---	720	---
18	29	---	2.9	---	580	---
19	18	---	1.8	---	360	---

Table Seven. Neur Lake Average Amphipod Population Data, 15-17 Khordad 1354

STATIONS	AMPHIPODS / $METER^2$	RANGE
1 - 14 A	148/ $meter^2$	0 - 380
1 - 14 B	58.5 / $meter^2$	0 - 200
15 - 19	568/ $meter^2$	360 - 720
1 - 14 A & B	103/ $meter^2$	0 - 380

Table Eight. Neur Lake Amphipod Population Data, 2 Tir 1354

STATION #	TOTAL "A"	TOTAL "B"	AVE "A"	AVE "B"	A #/M^2	B #/M^2
1	18	1	1.8	0.1	360	20
2	2	3	0.2	0.3	40	60
3	7	9	0.7	0.9	140	180
4	20	3	2.0	0.3	400	60
5	0	3	0	0.3	0	60
6	24	5	2.4	0.5	480	100
7	4	1	0.4	0.1	80	20
8	14	12	1.4	1.2	280	240
9	5	2	0.5	0.2	100	40
10						
11	20	3	2.0	0.3	400	60
12	4	4	0.4	0.4	80	80
13	5	1	0.5	0,1	100	20
14	3	1	0.3	0.1	60	20
			MORDAB			
15	143	—	14.3	—	2860	—
16	3	—	0.3	—	60	—
17	40	—	4.0	—	800	—
18	56	—	5.6	—	1120	—
19	36	—	3.6	—	720	—

Table Eight A. Neur Lake Amphipod Population Averages. 2 Tir 1354

STATIONS	AMPHIPODS/ $METER^2$
1 - 14 A	180/ $meter^2$
1 - 14 B	68.6/ $meter^2$
1 - 14 A & B	124/ $meter^2$
15 - 19	1112/$meter^2$

TABLE NINE. NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA, 2 TIR 1354

STATION#	$N_{IMMATURE}$	$\bar{X}_{IMMATURE}$	RANGE	$N_{A\ \&\ SA*}$	$\bar{X}_{A\ \&\ SA*}$	RANGE
1A	13	9.4	8-11	5	21.4	18-25
1B	0	—		1	23	—
2A	2	10	—	0	—	—
2B	2	10.5	10-11	1	26	—
3A	2	10	—	5	24.6	23-26
3B	2	9	—	7	23.8	22-25
4A	14	6.9	6 - 8	6	22.8	19-26
4B	0	—	—	3	22.3	18-26
5A	C /	—	—	0	—	—
5B	0	—	—	3	26.0	22-26
6A	17	9.9	9- 11	7	21.6	20-24
6B	3	11	—	2	20.5	20-21
7A	4	10	8- 11	0	—	—
7B	1	7	—	0	—	—
8A	8	9.4	6- 12	6	22.8	20-27
8B	11	9.7	7- 12	1	31	—
9A	5	9.8	8- 11	0	—	—
9B	2	11.5	11-12	0	—	—
10B**	1	11	—	4	22	19-25
11A	10	10	9- 12	10	22.2	21-25
11B	1	9	—	2	22.5	20-25
12A	4	9.5	8- 12	0	—	—
12B	4	9.0	8- 11	0	—	—
13A	5	8.9	7- 11	0	—	—
13B	1	10	—	0	—	—
14A	1	11	—	2	22	—
14B	1	10	—	0	—	—
			MORDAB			
15	32	6.9	6 - 8	111	23.3	17-31
16	0	—	—	3	35.7	24-27
17	0	—	—	40	24.7	16-30
18	18	7.0	—	38	24.8	20-31
19	0	—	—	36	23.4	17-30

* S & SA indicates subadults and adults as compared to immatures(2nd gen.)

** 10A Destroyed due to improper preservation

TABLE TEN. COMPARISON OF ANTENNA SEGMENT DATA FROM MAIN LAKE, MORDAB, AND TROUT STOMACH ANALYSES. 2 TIR 1354.

ANTENNA SEGMENTS	MAIN LAKE		MORDAB		TROUT STOMACHS	
NUMBERS	N	%	N	%	N	%
6	5	2.8	4	1.5	0	0
7	10	5.6	45	16.2	0	0
8	14	7.8	1	0.4	0	0
9	31	17.3	0	0	0	0
10	20	11.2	0	0	0	0
11	27	15.1	0	0	0	0
12	7	3.9	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	0	0	1	0.4	0	0
17	0	0	4	1.4	0	0
18	2	1.1	8	2.9	0	0
19	3	1.7	3	1.0	2	2
20	4	2.2	11	4.0	4	4
21	11	6.1	12	4.3	7	7
22	10	5.6	28	10.0	4	4
23	9	5.0	34	12.0	15	15
24	10	5.6	31	11.0	15	15
25	8	4.5	10	3.6	14	14
26	5	2.8	22	7.9	15	15
27	1	0.6	20	7.2	10	10
28	1	0.6	20	7.2	6	6
29	0	0	13	4.7	4	4
30	0	0	8	2.9	11	1
31	1	0.6	2	0.7	2	2
32	0	0	0	0	1	1

In the main lake more than 60 % of the numerical population of amphipods consists of very early instars of the second generation. In contrast, only 17 % of the population in the mordab consisted of early instar second generation amphipods. And in the trout stomach analysis no amphipods were consumed with less than 19 antenna segments. Eighty-three percent of the amphipods consumed by the trout had 22 or more antenna segments. However, less than 25% of the amphipod population in the main lake possessed 22 or more antenna segments. This again indicates a very selective food habit on the part of the trout.

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TABLE ELEVEN. NEUR LAKE AMPHIPOD POPULATION DATA, 1-3 MORDAD 1354

STATION #	TOTAL "A"	TOTAL "B"	AVE "A"	AVE "B"	A#/M²	B#/M²
1	35	36	3.5	3.6	700	720
2	105	53	10.5	5.3	2100	1060
3	79	23	7.9	2.3	1580	460
4	113	132	11.3	13.2	2260	2640
5	91	60	9.1	6.0	1820	1200
6	107	88	10.7	8.8	2140	1760
7	75	110	7.5	11.0	1500	2200
8	119	97	11.9	9.7	2380	1940
9	59	36	5.9	3.6	1180	720
10	41	49	4.1	4.9	820	980
11	31	1	3.1	0.1	620	20
12	28	54	2.8	5.4	560	1080
13	30	42	3.0	4.2	600	840
14	4	24	0.4	2.4	80	480
		MORDAB				
15	320	----	32.0	----	6400	----
16	305	----	30.5	----	6100	----
17	272	----	27.2	----	5440	----
18	355	----	35.5	----	7100	----
19	315	-----	31.5	----	6300	----

TABLE TWELVE . NEUR LAKE AMPHIPOD POPULATION AVERAWAGES, 1 - 3 MORDAD 1354

STATION #	AVERAGE (#/ METER²)	RANGE (#/ METER²)
1 - 14 A	1310	80 - 2380
1 - 14 B	1150	20 - 2640
1 - 8 A	1034	700 - 2380
9 - 14 A	643	80 - 1180
1 - 8 B	856	720 - 2640
9 - 14 B	686	20 - 1080
1 - 14 A & B	1230	20 - 2640
15 - 19	6268	5440 - 7100

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TABLE THIRTEEN. NEUR LAKE AMPHIPOD POPULATION DATA' 15 - 17 MORDAD 1354

STATION #	TOTAL "A"	TOTAL "B"	AVE "A"	ABE "B"	A #/ M^2	B #/ M^2
1	63	51	6.3	5.1	1260	1020
2	49	140	4.9	14.0	980	2800
3	216	32	21.6	3.2	4320	640
4	50	59	5.0	5.9	1000	1180
5	177	87	17.7	8.7	3540	1740
6	62	122	6.2	12.2	1240	2440
7	69	30	6.9	3.0	1380	600
8	86	79	8.6	7.9	1720	1580
9	36	39	3.6	3.9	720	780
10	68	38	6.8	3.8	1360	760
11	8	46	0.8	4.6	160	920
12	47	47	4.7	4.7	940	940
13	53	51	5.3	5.1	1060	1020
14	54	31	5.4	3.1	1080	620
			MORDAB DATA			
15	3044	----	304.4	----	60,880	-----
16	1221	----	122.1	----	24,420	-----
17	767	----	76.7	----	15,340	-----
18	495	----	49.5	----	9,900	-----
19	1676	----	167.6	----	33,520	-----

TABLE FOURTEEN. NEUR LAKE AMPHIPOD POPULATION AVERAGES, 15 - 17 MORDAD 1354

STATION #	AVERAGE (# / METER ^{2})	RANGE (# / METER ^{2})
1 - 14 A	1483	160 - 4320
1 - 14 B	1217	600 - 2800
1 - 8 A	1930	980 - 4320
9 - 14 A	887	160 - 1360
1 - 8 B	1500	600 - 2800
9 - 14 B	840	620 - 1020
1 - 14 A & B	1350	160 - 4320
15 - 19	28,812	9,900 - 60,880

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TABLE FIFTEEN. COMPARISON OF ANTENNA SEGMENT DATA FROM MAIN LAKE, MORDAB, AND TROUT STOMACHS ANALYSES, 15-17 MORDAD 1354, AND TROUT STOMACH ANALYSES FROM 7 MORDAD 1354.

ANTENNA SEGMENT NUMBERS	MAIN LAKE N	%	MORDAB SAMPLES N	%	TROUT STOMACHS 17 MORDAD N	%	TROUT STOMACHS 7 MORDAD N	%
6	0	----	0	----	0	----	0	----
7	55	2.4	0	----	0	----	0	----
8	3	0.1	0	----	0	----	0	----
9	6	0.3	4	1.2	0	----	0	----
10	18	0.9	0	----	0	----	0	----
11	54	2.6	2	0.7	0	----	0	----
12	83	4.0	16	4.8	0	----	0	----
13	184	8.8	44	13.3	0	----	1	1
14	140	6.7	33	10.0	1	1	1	1
15	296	14.2	91	27.6	2	2	6	6
16	173	8.3	50	15.0	8	8	10	10
17	274	13.1	41	12.4	5	5	15	15
18	130	6.2	11	3.3	6	6	15	15
19	198	9.5	9	2.7	8	8	18	18
20	131	6.3	2	0.7	14	14	11	11
21	81	3.9	0	----	17	17	6	6
22	63	3.0	22	0.7	11	11	5	5
23	34	1.6	6	1.8	12	12	2	2
24	57	2.7	7	2.1	6	6	1	1
25	32	1.5	5	1.5	3	3	3	3
26	23	1.1	3	0.9	6	6	1	1
27	17	0.8	1	0.3	1	1	1	1
28	14	0.7	2	0.7	0	----	1	1
29	11	0.5	0	----	0	----	1	1
30	6	0.3	1	0.3	0	----	1	1
31	3	0.1	1	0.3	0	----	1	1
32	3	0.1	0	----	0	----	0	----

In the main lake 81 % of the amphipod populati on had 20 antenna segments or less. In contrast, 70 % of the amphipods consumed by the trout had 20 antenna segments or more, thereby again indicating that the trout are feeding on the larger (physically bigger amphipods, sexually mature or nearly so) segment of the amphipod population. It is also interesting that on the 7th of Mordad the amphipods consumed by the trout had fewer antenna segments than those eaten by the trout on 20 Mordad. This indicates that the amphipod population was perhaps made up of primarily younger individuals on the 7th of Mordad than on the 20th, thus causing the trout to feed on smaller amphipods on the average on this period of time. Such was the case. Younger individulas made up a larger segemnt of the population on 7 Mordad than on 20 Mordad. Comparing data from 2 Tir 1354 (together with the trends in predation noted last year by Boettcher) we see that the trout feed on the smaller segment of the population as the summer progresses.

TABLE FIFTEEN. SNAIL, LEECH, & CHIRONOMID DENSITIES, 1 - 3 TIR 1354, NEUR LAKE.

STATION #	SNAILS/ M^2	LEECHES/ M^2	CHIRONOMIDS/ M^2
1A	100	140	20
1B	40	60	20
2A	60	240	40
2B	---	---	---
3A	20	20	40
3B	40	60	100
4A	100	20	20
4B	20	80	180
5A	20	240	20
5B	220	280	40
6A	20	400	20
6B	20	80	20
7A	40	220	40
7B	220	80	340
8A	40	40	60
8B	80	40	120
9A	20	100	140
9B	20	220	400
10A	---	---	---
10B	80	120	20
11A	240	100	20
11B	100	40	40
12A	100	80	20
12B	20	40	20
13A	20	60	20
13B	20	40	100
14A	20	140	20
14B	20	220	40

TABLE SIXTEEN. NEUR LAKE AMPHIPOD FECUNDITY DATA, 15 - 17 MORDAD 1354

ANTENNA SEGMENTS			FERTILE EGGS		
$\bar{X}$	N	RANGE	$\bar{X}$	N	RANGE
25	3	24 - 26	30	3	26 - 33

TABLE SEVENTEEN. SNAIL, LEECH, & CHIRONOMID DENSITIES, 15 - 17 MORDAD 1354 1354, NEUR LAKE.

STATION #	SNAILS/ M^2	LEECHES/ M^2	CHIRONOMIDS/ M^2
1A	0	140	160
1A	40	0	0
2A	100	120	100
2B	0	0	0
3A	0	60	0
3B	100	100	360
4A	40	0	60
4B	20	20	140
5A	80	160	1160
5B	0	0	0
6A	0	20	20
6B	0	60	100
7A	460	20	0
7B	0	0	760
8A	80	40	780
8B	0	0	0
9A	0	0	0
9B	20	60	960
10A	0	0	20
10B	20	0	0
11A	0	0	0
11B	0	20	0
12A	0	20	0
12B	0	20	0
13A	0	0	0
13B	20	0	0
14A	40	0	0
14B	0	0	0

TABLE EIGHTEEN. COMPARISON OF AMPHIPOD ANTENNA SEGMENT DATA FROM NEUR LAKE, MAIN LAKE, MORDAB, AND TROUT STOMACHS FROM 1 to 3 MORDAD 1354.

ANTENNA SEGMENTS	MAIN LAKE		MORDAB		TROUT STOMACHS	
	N	%	N	%	N	%
7	28	2.0	1	0.24	0	0
8	0	0	0	0	0	0
9	2	0.14	4	0.87	0	0
10	8	0.57	3	0.73	0	0
11	61	4.4	22	5.4	0	0
12	66	4.7	32	7.8	0	0
13	148	10.6	123	30.0	1	1
14	75	5.4	43	10.5	1	1
15	208	14.9	53	12.9	6	6
16	112	8.0	14	3.4	10	10
17	223	16.0	10	2.4	15	15
18	125	9.0	4	0.97	15	15
19	98	7.0	1	0.24	18	18
20	26	1.87	1	0.24	11	11
21	24	1.72	2	0.49	6	6
22	7	0.50	3	0.73	5	5
23	20	1.43	6	1.46	2	2
24	31	2.22	7	1.70	1	1
25	40	2.88	17	4.1	3	3
26	26	1.87	20	4.9	1	1
27	25	1.80	9	2.2	1	1
28	14	1.00	10	2.4	1	1
29	9	0.64	11	2.7	1	1
30	4	0.29	5	1.21	1	1
31	3	0.21	8	1.95	1	1
32	6	0.43	2	0.49	0	0
33	1	0.07	0	0	0	0
34	2	0.14	0	0	0	0
35	0	0	0	0	0	0
36	1	0.07	0	0	0	0

GENERAL NOTES: DURING THIS SAMPLING PERIOD THOSE AMPHIPODS WITH 18 OR MORE ANTENNA SEGMENTS MADE UP 33% OF THE POPULATION IN THE MAIN LAKE. TROUT STOMACH SAMPLES TAKEN AT THE SAME TIME INDICATED THAT AMPHIPODS WITH 18 OR MORE ANTENNA SEGMENTS COMPRISED 67% of THE FOOD CONSUMED BY THE TROUT, AS FAR AS AMPHIPODS WERE CONCERNED. 49% OF THE AMPHIPOD POPULATION IN THE MAIN LAKE HAD 17 OR MORE ANTENNA SEGMENTS AND 82% OF THE AMPHIPODS CONSUMED BY THE TROUT HAD 17 OR MORE ANTENNA SEGMENTS. AT THIS TIME THE POPULATION WAS COMPRISED PRIMARILY OF YOUNG IMMATURE AMPHIPODS (67% OF THE POPULATION IN THE MAIN LAKE WITH 17 OR LESS ANTENNA SEGMENTS). THUS, AS WOULD BE EXPECTED, OUR DATA FROM 15-17 MORDAD SHOW THAT AS THE POPULATION YWO WEEKS LATER WAS COMPRISED OF LARGER AMPHIPODS SO TOO WAS THE MAJORITY OF THE AMPHIPOD RESOURCE CONSUMED BY THE TROUT MADE OF OF LARGER, OLDER AMPHIPODS. AT THAT TIME 81 % OF THE AMPHIPOD POPULATION HAD 20 OR MORE ANTENNA SEGMENTS AND THIS PROTION OF THE POPULATION COMPRISED 70% OF THE AMPHIPODS CONSUMED BY THE TROUT.

TABLE NINETEEN. NEUR LAKE AMPHIPOD POPULATION ESTIMATIONS; 1 - 3 SHAHRIVAR 1354

STATION #	TOTAL "A"	TOTAL "B"	AVE "A"	AVE "B"	#A/ M^2	#B/ M^2
1	15	14	1.5	1.4	300	280
2	49	52	4.9	5.2	980	1040
3	104	78	10.4	7.8	2080	1560
4	51	43	5.1	4.3	1020	860
5	102	55	10.2	5.5	2040	1100
6	70	77	7.0	7.7	1400	1540
7	91	114	9.1	11.4	1820	2280
8	133	64	13.3	6.4	2660	1280
9	38	25	3.8	2.5	760	500
10	40	31	4.0	3.1	800	620
11	25	32	2.5	3.2	500	640
12	27	25	2.7	2.5	540	500
13	46	34	4.6	3.4	920	680
14	32	26	3.2	2.6	640	520

TABLE TWENTY. NEUR LAKE AMPHIPOD POPULATION AVERAGES ; 1 - 3 SHAHRIVAR 1354

STATION #	AVERAGE/ (#/$METER^2$)	RANGE (#/$METER^2$)
1 - 14 A	1175	300 - 2660
1 - 14 B	957	280 - 2280
1 - 8 A	1538	300 - 2660
1 - 8 B	1243	280 - 2280
9 - 14 A	693	500 - 920
9 - 14 B	576	500 - 680
1 - 14 A & B	1066	280 - 2660

TABLE TWENTY-ONE˙ ANTENNA SEGMENT DATA, NEUR LAKE; 1 - 3 SHAHRIVAR 1354

ANTENNA SEGMENTS	MAIN LAKE N	MAIN LAKE %	TROUT STOMACHS N	TROUT STOMACHS %
10	7	0.5	0	0
11	28	2.0	0	0
12	25	1.8	0	0
13	86	6.0	0	0
14	47	3.3	0	0
15	129	9.1	0	0
16	93	6.5	2	2
17	161	11.3	1	1
18	103	7.2	5	5
19	159	11.2	12	12
20	132	9.3	11	11
21	136	9.6	10	10
22	82	5.8	15	15
23	92	6.5	17	17
24	32	2.3	9	9
25	41	2.8	8	8
26	26	1.8	2	2
27	19	1.3	4	4
28	4	0.3	2	2
29	5	0.4	2	2
30	7	0.5	0	0
31	5	0.4	0	0
32	2	0.1	0	0

GENERAL NOTES: ONCE AGAIN THE PATTERN IS BORN OUT WHERE THE MAJORITY OF THE POPULATION IS MADE UP OF IMMATURE and SUBADULT AMPHIPODS; HOWEVER, THE TROUT CONTINUE TO FEED ON THE LARGER (PHYSICALLY) SEGMENT OF THE AMPHIPOD POPULATION. EIGHTY PERCENT OF ALL AMPHIPODS CONSUMED BY THE TROUT COMPRISE THE LARGEST OR UPPER 40% OF THE AMPHIPOD POPULATION. ANALYSIS OF THIS AND PREVIOUS DATA SHOWS THAT THE POPULATION PEAKED NUMERICALLY BETWEEN MID MORDAD AND 1 SHAHRIVAR WHEN THE OVERALL AVERAGE FOR THE ENTIRE LAKE DROPPED BY 300 AMPHIPODS/ METER^2. the POPULATION CONTINUES TO BE MADE UP OF A BROAD SPECTRUM OF ALL AGES OF AMPHIPODS AT THIS TIME; WHEREAS LAST YEAR, ALL ADULTS HAD BEEN REMOVED FROM THE POPULATION BY SHAHRIVAR WITH ONLY YOUNG IMMATURES REMAINING. THIS IS MOSTLY DUE TO THE DENSE VEGETATION ON THE EAST SIDE OF THE LAKE WHICH PROVIDES PROTECTION.

TABLE TWENTY-TWO. NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA; 15 - 17 SHAHRIVAR 1354

NUMBER OF ANTENNA SEGMENTS	MAIN LAKE N	MAIN LAKE %	TROUT STOMACH SAMPLES N	TROUT STOMACH SAMPLES %
8	1	0.1	0	0
9	0	0	0	0
10	3	0.3	0	0
11	10	1.0	0	0
12	20	1.9	0	0
13	40	3.9	1	1
14	24	2.3	0	0
15	62	6.0	0	0
16	47	4.6	3	3
17	75	7.3	3	3
18	58	5.7	4	4
19	93	9.1	13	13
20	80	7.8	15	15
21	123	12.0	9	9
22	92	9.0	16	16
23	90	8.8	11	11
24	51	5.0	10	10
25	50	4.9	6	6
26	31	3.0	4	4
27	27	2.6	1	1
28	19	1.9	2	2
29	11	1.1	1	1
30	11	1.1	1	1
31	4	0.4	0	0
32	3	0.3	0	0
33	1	0.1	0	0

GENERAL NOTES: THE GENERAL PREDATION PATTERN HAS NOT CHANGED SIGNIFICANTLY SINCE THE SURVEY ON 1 - 3 SHAHRIVAR 1354 EXCEPT FOR THE FACT THAT THE POPULATION HAS GOTTEN A LITTLE MORE SKEWED TOWARDS OLDER INDIVIDUALS IN THE POPULATION AS A WHOLE, BUT WITH EACH ANTENNAL SEGMENT GROUP MAKING UP A SMALLER PERCENTAGE OF THE POPULATION THAN BEFORE. PREDATION BY THE TROUT HAS NOT CHANGED AT ALL WITH THE TROUT STILL FEEDING UPON THE SAME SIZE GROUP AS TWO WEEKS PREVIOUSLY. HOWEVER, THIS DOES INDICATE THAT THE TROUT ARE BEGINNING TO FIND IT HARDER TO SELECT FOR LARGER AMPHIPODS AS THEY BECOME A SMALLER MORE SCARCE SEGMENT OF THE POPULATION. I ANTICIPATE SOME VERY SIGNIFICANT CHANGES IN THE POPULATION BY 1 MEHR 1354 as THE POPULATION OF AMPHIPODS BEGINS TO RAPIDLY FALL OFF WITH THE CESSATION OF NATURAL REPRODUCTION AND THE TROUT PREDATION BEGINS TO MAKE SERIOUS INROADS ON THE AMPHIPOD POPULATION. WHEN THIS HAPPENS THE TROUT WILL CONSTANTLY SELECT FOR A SMALLER AND SMALLER AND MORE IMMATURE SEGMENT OF THE POPULATION UNTIL THE POPULATION DENSITY REACHES SUCH A LOW LEVEL THAT THE TROUT WILL SWITCH TO A MORE READILY AVAILABLE SOURCE OF FOOD, PROBABLY LEECHES AS WAS OBSERVED IN MEHR AND ABAN 1353.

TABLE TWENTY - THREE.

NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA; 15 - 17 KHORDAD 1354

ANTENNA SEGMENTS	MAIN LAKE N	MAIN LAKE %	MORDAB N	MORDAB %	TROUT STOMACHS N	TROUT STOMACHS %
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	2	1.56	0	0
16	0	0	1	0.78	0	0
17	1	0.7	1	0.78	1	1
18	4	2.8	3	2.34	0	0
19	12	8.3	2	1.56	5	5
20	13	9.0	3	2.34	2	2
21	29	20.2	18	14.1	5	5
22	21	14.6	11	8.6	19	19
23	27	18.8	21	16.4	15	15
24	14	9.7	9	7.0	11	11
25	8	5.5	15	11.7	15	15
26	3	2.1	10	7.8	11	11
27	4	2.8	10	7.8	6	6
28	5	3.5	9	7.0	2	2
29	1	0.7	7	5.5	3	3
30	2	1.4	3	2.34	5	5
31	0	0	3	2.34	0	0

GENERAL NOTES: AS YET THE AMPHIPOD POPULATION HAS NOT YET STARTED TO "BOOM AND THE TROUT ARE BEGINNING TO FEED MORE HEAVILY ON THE AMPHIPODS THAN TWO WEEKS AGO WHEN 7 OF THE 10 TROUT STOMACHS EXAMINED HAD NO AMPHIPODS IN THEM. THE COMPARISON OF THE AMPHIPOD DATA FROM THE MAIN LAKE WITH THAT OF THE TROUT STOMACHS SHOWS THE TROUT TO BE SELECTING FOR THE LARGER AMPHIPODS MOST DEFINITELY; HOWEVER, THE ARE NOT AS SELECTIVE FOR THE LARGER AMPHIPODS AS THEY WILL BE ONCE THE POPULATION BEGINS TO "BOOM" LATER IN THE SUMMER.

TABLE TWENTY-FOUR. NEUR LAKE AMPHIPOD POPULATION ESTIMATIONS, 16 SHAHRIVAR 1354.

STATION #	TOTAL "A"	TOTAL "B"	AVERAGE "A"	AVERAGE "B"	#"A"/M^2	#"B"/M^2
1	33	35	3.3	3.5	660	700
2	26	27	2.6	2.7	520	540
3	22	35	2.2	3.5	440	700
4	54	88	5.4	8.8	1080	1760
5	121	63	12.1	6.3	2420	1260
6	31	26	3.1	2.6	620	520
7	40	19	4.0	1.9	800	380
8	38	28	3.8	2.8	760	560
9	30	65	3.0	6.5	600	1300
10	26	23	2.6	2.3	520	640
11	31	35	3.1	3.5	620	700
12	53	26	5.3	2.6	1060	520
13	36	35	3.6	3.5	720	700
14	32	43	3.2	4.3	640	860

TABLE TWENTY-FIVE. NEUR LAKE AMPHIPOD POPULATION AVERAGES, 16 SHAHRIVAR 1354.

STATIONS	#/$METER^2$
1 - 14 A	818.57
1 - 14 B	795.71
1 - 8 A	912.50
9 - 14 A	693.33
1 - 14 A & B	807.14

TABLE TWENTY-SIX. NEUR LAKE AMPHIPOD POPULATION ESTIMATIONS, 26 MEHR 1354.

STATION #	TOTAL "A"	TOTAL "B"	AVERAGE "A"	AVERAGE "B"	#"A"/M^2	#"B"/M^2
1	0	10	0	1.0	0	200
2	24	5	2.4	0.5	480	100
3	12	1	1.2	0.1	140	20
4	0	50	0	5.0	0	1000
5	47	47	4.7	4.7	940	940
6	5	24	0.5	2.4	100	480
7	28	4	2.8	0.4	560	80
8	32	25	3.2	2.5	640	500
9	6	8	0.6	0.8	120	160
10	0	8	0	0.8	0	160
11	0	13	0	1.3	0	260
12	0	0	0	0	0	0
13	0	9	0	0.9	0	180
14	0	15	0	1.5	0	300

TABLE TWENTY-SEVEN. NEUR LAKE AMPHIPOD POPULATION AVERAGES, 26 MEHR 1354

STATIONS	#/ $METER^2$
1 - 14 A	222.4
1 - 14 B	323
1 - 8 A	358
9 - 14 A	20.0
1 - 14 A & B	262.5

TABLE TWENTY-EIGHT. COMPARISON OF NEUR LAKE AMPHIPODS ANTENNA SEGMENTS FROM THE LAKE POPULATION WITH ANTENNA SEGMENT COUNTS FROM TROUT STOMACH ANALYSES, 26 MEHR 1354.

ANTENNA SEGMENTS	MAIN LAKE SAMPLES		TROUT STOMACH SAMPLES	
	N	%	N	%
13	4	1.1	0	0
14	4	1.1	1	1
15	14	3.8	0	0
16	12	3.3	1	1
17	20	5.4	0	0
18	25	6.8	8	8
19	39	10.6	2	2
20	37	10.0	4	4
21	39	10.6	12	12
22	39	10.6	16	16
23	41	11.2	16	16
24	36	9.8	13	13
25	25	6.8	12	12
26	17	4.6	4	4
27	9	2.5	5	5
28	4	1.1	1	1
29	1	.27	4	4
30	0	0	0	0
31	0	0	0	0
32	1	.27	0	0
33	0	0	0	0
34	0	0	1	1

AT THE TIME OF THIS SURVEY IN THE LAKE POPULATION OF AMPHIPODS 63% OF THE POPULATION HAD 22 ANTENNA SEGMENTS OR LESS. IN CONTRAST, THE AMPHIPODS FROM THE TROUT STOMACH SAMPLES WERE MUCH LARGER WITH 70% OF THOSE AMPHIPODS EXAMINED FROM TROUT STOMACHS HAVING 22 or MORE ANTENNA SEGMENTS.THUS, THE TREND THAT HAS BEEN ESTABLISHED ALL SUMMER STILL MANIFESTS ITSELF, I.E., THE TROUT FEED ON THE OLDER SEGMENT OF THE AMPHIPOD POPULATION.

TABLE TWENTY- NINE. COMPARISON OF NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA FROM 25 ORDIBEHESHT 1352 AND 25 ORDIBEHESHT 1353.

ANTENNA SEGMENTS	25 ORDIBEHESHT 1352		25 ORDIBEHESHT 1353	
	N	%	N	%
12	0	0	0	0
13	0	0	0	0
14	0	0	1	1
15	0	0	4	4
16	0	0	8	8
17	2	4	3	3
18	0	0	6	6
19	1	2	2	2
20	3	6	3	3
21	5	10	3	3
22	9	18	8	8
23	4	8	16	16
24	8	16	10	10
25	5	10	19	19
26	3	6	7	7
27	6	12	0	0
28	3	6	5	5
29	0	0	5	5
30	1	2	0	0

In 1352 the water temperature was only 7.0 C on 25 Ordibehesht and the amphipod population was just beginning to copulate and reproduce. No evidence of previous reproduction was in evidence. In contrast, in 1353 the water temperature was up to 17 C on 25 Ordibehesht and the amphipod population had already been observed in copulation as early as 6 Ordibehesht when the water temperature was 2 C. Thus it is obvious from the data that 2 generations were present on 25 Ordibehesht 1353, the first new generation of 1353 as well as "overwintering" adults. The new generation having 14 - 19 antenna segments and the overwintering adults 20 - 30 antenna segments.

TABLE THIRTY. COMPARISON OF AMPHIPOD ANTENNA SEGMENTS FROM NEUR LAKE SAMPLES WITH THESE TAKEN FROM TROUT STOMACHS (10 MORDAD 1353).

ANTENNA SEGMENTS	LAKE SAMPLES		TROUT STOMACH SAMPLES	
	(N)	%	N	%
9	4	16.7	0	0
10	6	25.0	0	0
11	12	50.0	0	0
12	1	4.15	0	0
13	1	4.15	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	1	3.4
23	0	0	0	0
24	0	0	4	13.3
25	0	0	4	13.3
26	0	0	12	40.0
27	0	0	2	6.7
28	0	0	3	10.0
29	0	0	1	3.4
30	0	0	2	6.7
31	0	0	1	3.4

Our lake substrate samples at this time indicate the entire population consists of only the second generation of amphipods; however, the trout stomach samples indicate the entire population consists of only the adult segment of the population. If the population had very many adults remaining in the population they would have shown up in our substrate samples, or should have. This leads us to two possible conclusions: 1) The adult amphipods are now found only in the pelagic zones of the lake outside our sampling stations, or 2) The trout have cropped off virtually all of the adult segment of the population so that only young remain.

TABLE THIRTY -ONE. COMPARISON OF NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA WITH TROUT STOMACH ANTENNA SEGMENT DATA, 9 SHAHRIVAR 1353.

ANTENNA SEGMENTS	LAKE SAMPLES		TROUT STOMACH SAMPLES	
	N	%	N	%
10	1	1.1	0	0
11	7	7.7	0	0
12	11	12.1	0	0
13	37	40.6	0	0
14	7	7.7	4	7.3
15	15	16.5	5	9.1
16	6	6.6	7	12.7
17	5	5.5	11	20.0
18	1	1.1	6	10.9
19	0	0	1	1.8
20	1	1.1	3	5.5
21	0	0	0	0
22	0	0	4	7.3
23	0	0	1	1.8
24	0	0	0	0
25	0	0	5	9.1
26	0	0	3	5.5
27	0	0	2	3.6
28	0	0	0	0
29	0	0	1	1.8
30	0	0	2	3.6
31	0	0	0	0

Several interesting points come to light when this data is compared with the data from 10 Mordad 1353. The lake samples show a much wider range of amphipods of different sizes in the population in Shahrivar than in Mordad, indicating two things, first that the oldest members of the second generation are growing quite fast and second that natural reproduction in the amphipod population is probably still going on. However, comparison of the trout stomach sample data from Shahrivar with Mordad indicates that the first generation adults are now becoming very scarce and the trout are having to prey upon much smaller and younger amphipods than they were in Mordad, although a few 1st generation adults still remain.

TABLE THIRTY-TWO. COMPARISON OF NEUR LAKE ANTENNA SEGMENT DATA FROM AMPHIPODS WITH ANTENNA SEGMENT DATA FROM TROUT STOMACH SAMPLES, 3-5 MEHR 1353.

ANTENNA SEGMENTS	LAKE SAMPLES		TROUT STOMACH SAMPLES	
	N	%	N	%
11	0	0	0	0
12	1	1.9	0	0
13	4	9.4	0	0
14	7	13.2	1	3.03
15	10	19.0	6	20.0
16	10	19.0	5	16.7
17	11	20.8	6	20.0
18	5	9.4	8	26.7
19	2	3.8	3	10.0
20	2	3.8	1	3.03
21	1	1.9	1	3.03
22	0	0	1	3.03
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	1	3.03
28	0	0	0	0

Comparison of this data from early Mehr 1353 with the data from Mordad and Shahrivar 1353 reveals some striking differences. First of all it appears that natural reproduction of the amphipods has stopped for this year as there are no amphipods in the sample with less than 10 antenna segments (1st instar amphipods have 6-7 antenna segments). Second, predation on the amphipod population by the trout is presently probably cropping off the greatest percentage of the biomass of the amphipod population as compared to any time during the past 12 months. All 1st generation amphipods (adults) have now disappeared from the population (both in the substrate samples and in the trout stomachs) and the trout are feeding only upon the 2nd generation amphipods. However, it must be noted that at this time the trout (90% of them) were feeding exclusively on leeches and as a whole the amphipods made up a very insignificant portion of the trout diet both in numbers & biomass.

TABLE THIRTY- THREE. COMPARISON OF AMPHIPOD ANTENNA SEGMENT DATA FROM NEUR LAKE AND TROUT STOMACH SAMPLES , 3 - 5 ABAN 1353.

ANTENNA SEGMENTS	NEUR LAKE SAMPLES		TROUT STOMACH SAMPLES	
	N	%	N	%
12	4	8	0	0
13	3	6	0	0
14	7	14	0	0
15	6	12	0	0
16	10	20	0	0
17	6	12	0	0
18	5	10	1	2
19	5	10	5	10
20	2	4	3	6
21	2	4	7	14
22	1	2	5	10
23	0	0	6	12
24	0	0	3	6
25	0	0	6	12
26	0	0	6	12
27	0	0	1	2
28	0	0	2	4
29	0	0	2	4
30	0	0	2	4
31	0	0	0	0
32	0	0	0	0
37	0	0	1	2
38	0	0	0	0

Our data at this time indicates that pressure on the amphipod population by the trout is minimal, for two reasons. First, the trout are again selecting only for the physically larger portionof the population and second, at this time more than 95% of the trout's diet consists of leeches. Less than 10% of the trout stomachs examined had any amphipods in them at all. Of those 10 trout with amphipods in their stomachs, most of the bolus consisted of leeches and other items. Only about 1% of the trout stomachs examined contained exclusively amphipods.

TABLE THIRTY- FOUR. STATISTICAL EVALUATION OF NEUR LAKE AMPHIPOD POPULATION DATA FOR 1354.

DATE	$\bar{X}$	N	Actual T Value	Bounds of T Value
17 Ordibehesht	346.15	13	± 0.6458	$T_{.70} < T < T_{.80}$
1 Khordad	256.67	12	± 1.192	$T_{.80} < T < T_{.90}$
15 Khordad	189.09	11	± 1.096	$T_{.80} < T < T_{.90}$
17 Ordibehesht	346.15	13		
1 Tir	210	12	± 0.3429	$T_{.60} < T < T_{.70}$
15 Khordad	189.09	11		
1 Tir	210	12	± 2.499*	$T_{.99} < T < T_{.995}$ **
15 Tir	1143	14	± 2.240*	$T_{.975} < T < T_{.990}$ **
17 Ordibehesht	346.15	13		
1 Mordad	1310	14	± 0.4202	$T_{.60} < T < T_{.70}$
15 Tir	1143	14		
15 Mordad	1483	14	± 0.7515	$T_{.70} < T < T_{.80}$
15 Tir	1143	14		
15 Mordad	1483	14	± 0.8757	$T_{.80} < T < T_{.90}$
1 Shahrivar	1175	14		
1 Shahrivar	1175.71	14	± 1.5391	$T_{.90} < T < T_{.95}$
16 Shahrivar	818.57	14		
26 Mehr	425.71	7	± 1.8922	$T_{.95} < T < T_{.975}$ **

NOTE: (**) Statistically significant at P = 0.05 or less.

TABLE THIRTY- FIVE. STATISTICAL EVALUATION OF NEUR LAKE AMPHIPOD POPULATIONS ON SIMILAR DATES BETWEEN 1353 AND 1354 FOR SIGNIFICANT DIFFERENCES.

DATE	N	$\bar{X}$	T Value	BOUNDS ON T VALUE
21 Ordibehesht 1353	8	605	$\pm$ 1.2799	$T_{.80} < T < T_{.90}$
17 Ordibehesht 1354	13	346.15		
21 Ordibehesht 1353	8	605	$\pm$ 2.604**	$T_{.99} < T < T_{.995}$
1 Khordad 1354	12	256.67		
10 Mordad 1353	13	1201.92	$\pm$ 0.8410	$T_{.70} < T < T_{.80}$
1 Mordad 1354	14	1310		
10 Mordad 1353	13	1201.92	$\pm$ 0.699	$T_{.70} < T < T_{.80}$
15 Mordad 1354	14	1483		
16 Shahrivar 1354	14	818.57	$\pm$ 0.7243	$T_{.70} < T < T_{.80}$
3 Mehr 1353	12	626.67		
26 Mehr 1354	7	425.71	$\pm$ 0.6052	$T_{.70} < T < T_{.80}$
3 Mehr 1353	12	626.67		
26 Mehr 1354	7	425.71	$\pm$ 0.1425	$T_{.66} \geq 0.1425$
3 Aban 1353	11	392.73		

NOTE: (**) Statistically significant at P = 0.05 or less.

TABLE THIRTY-SIX. STATISTICAL EVALUATION OF NEUR LAKE AMPHIPOD SUB-POPULATIONS FOR STATISTICALLY SIGNIFICANT DIFFERENCES IN POPULATION DENSITIES IN DIFFERENT AREAS DUE TO HABITAT DIFFERENCES.

DATE	STATION SAMPLES	N	$\bar{X}$	T VALUE	BOUNDS ON T VALUE
17 Ordibehesht	2 - 8 A	7	351.43	$\pm$ 1.030	$T_{.80} < T < T_{.90}$
17 Ordibehesht	2 - 8 B	6	92.00		
17 Ordibehesht	2 - 8 A	7	351.43	$\pm$ 0.0428	$T_{.10} < T$
17 Ordibehesht	1,9-14A	6	340.00		
15 Khordad	2 - 8 A	7	217.14	$\pm$ 1.7466	$T_{.90} < T < T_{.95}$
15 Khordad	2 - 8 B	6	120.00		
15 Khordad	2 - 8 A	7	217.14	$\pm$ 1.718	$T_{.90} < T < T_{.95}$
15 Khordad	1,9-14A	4	80.00		
2 Tir	2 - 8 A	6	236.67	$\pm$ 1.795	$T_{.90} < T < T_{.95}$
2 Tir	2 - 8 B	7	102.86		
2 Tir	2 - 8 A	6	236.67	$\pm$ 0.5538	$T_{.70} < T < T_{.80}$
2 Tir	1,9-14A	6	183.33		
15 Tir	2 - 8 A	7	885.71	$\pm$ 0.6775	$T_{.70} < T < T_{.80}$
15 Tir	2 - 8 B	7	1345.71		
15 Tir	2 - 8 A	7	885.71	$\pm$ 0.7379	$T_{.70} < T < T_{.80}$
15 Tir	1,9-14A	7	1400		
1 Mordad	2 - 8 A	7	1968.57	$\pm$ 1.163	$T_{.80} < T < T_{.90}$
1 Mordad	2 - 8 B	7	1608.57		
1 Mordad	2 - 8 A	7	1968.57	$\pm$ 7.368	$T_{.995} < T$
1 Mordad	1,9-14A	7	651.43		

TABLE THIRTY-SIX. STATISTICAL EVALUATION OF NEUR LAKE AMPHIPOD SUB-POPULATIONS FOR STATISTICALLY SIGNIFICANT DIFFERENCES IN POPULATION DENSITIES IN DIFFERENT AREAS DUE TO HABITAT DIFFERENCES, FOR YEAR 1354.

DATE	SAMPLE STATION	N	$\bar{X}$	T VALUE T VALUE	BOUNDS ON T VALUE
15 Mordad	2 - 8 A	7	2025.71	$\pm$ 0.7627	$T_{.70} < T < T_{.80}$
15 Mordad	2 - 8 B	7	1568.57		
15 Mordad	2 - 8 A	7	2025.71	$\pm$ 2.048	$T_{.95} < T < T_{.975}$
15 Mordad	1,9-14A	7	940.0		
1 Shahrivar	2 - 8 A	7	1714.29	$\pm$ 1.252	$T_{.80} < T < T_{.90}$
1 Shahrivar	2 - 8 B	7	1222.86		
1 Shahrivar	2 - 8 A	7	1714,29	$\pm$ 4.389	$T_{.995} < T$
1 Shahrivar	1,9-14A	7	637.14		
16 Shahrivar	2 - 8 A	7	948.57	$\pm$ 0.9772	$T_{.80} < T < T_{.90}$
16 Shahrivar	1,9-14A	7	688.57		
16 Shahrivar	2 - 8 A	7	948.57	$\pm$ 0.4102	$T_{.60} < T < T_{.70}$
16 Shahrivar	2 - 8 B	7	817.14		
26 Mehr	2 - 8 A	6	476.67	$\pm$ 1.9970	$T_{.95} < T < T_{.975}$
26 Mehr	1,9-14B	6	210.00		
26 Mehr	2 - 8 A	6	476.67	$\pm$ 0.1503	$T_{.60} = T = \pm 0.1503$
26 Mehr	2 - 8 B	7	445.71		

GENERAL NOTES ON AMPHIPOD DATA FROM 2 TIR 1354.

The stomach analyses data indicate that more than 99 % of the food consumed by the trout at this time was amphipods. Once again they were feeding upon the oldest and largest (physical size) segment of the amphipod population. No mature amphipod eggs or gravid females were observed from this sample. A second generation has obviously been produced during a few days prior to 2 Tir 1354 from the number of immature amphipods present in the samples both in the main lake and in the mordab. This undoubtedly means the population produces at least three generations annually, perhaps even four or five. The data taken together indicates that the trout are removing almost all of the older amphipods in the main lake from the population soon after maturity and successful reproduction, yet the population levels do not seem to be diminished in comparision with last year. This could indicate that either the fecundity of the amphipod population in the main lake has increased or that fecundity of the population is depressed in the mordab where a large portion of the population is comprised of sexually mature individuals (82% of the population with 23 or more antenna segments).

تاریخ ....

شماره ....

پیوست ....

سازمان حفاظت محیط زیست

NEUR LAKE. MISCELLANEOUS THOUGHTS ON THE ECOLOGY OF THE AMPHIPODS.

THE AMPHIPOD POPULATION IS DEFINITELY MORE DENSE ON THE WINDWARD SIDE OF THE LAKE THAN THE LEEWARD SIDE. ALLOCTHANOUS MATTER COLLECTS ON THE WINDWARD SIDE THEREBY INCREASING THE FERTILITY AND THE PRODUCTIVITY OF THAT SIDE OF THE LAKE. NATURALLY THE AMPHIPODS CONGREGATE THERE AND THE POPULATION IS MORE DENSE. THE FOOD IS BETTER AND THE HABITAT IS BETTER, BOTH IN RESPECT TO LIVING SPACE AND COVER FROM PREDATION BY THE TROUT.

DESPITE THE FACT THAT THE BIOMASS OF TROUT IN THE LAKE IS PROBABLY ON THE ORDER OF ~~XXX~~ 300 PERCENT GREATER THAN LAST YEAR, NONETHELESS THE AMPHIPOD POPULATION IS AS DENSE OR MORE SO THAN LAST YEAR AT THIS TIME. NOT ONLY IS IT MORE DENSE BUT A GREATER PORTION OF THE POPULATION IS MADE UP OF OLDER AMPHIPODS THAN AT LAST YEAR IN MORDAD. THIS PHENOMENON IS UNDOUBTEDLY DUE TO THE FACT THAT THE WATER IS ~~XXXXXX~~ 50 - 70 CM LOWER THAN LAST YEAR WHICH HAS PERMITTED A MASSIVE GROWTH OF AQUATIC VEGETATION AND FILAMENTOUS ALGAES TO DEVELOP IN THE Lake DUE TO THE SHALLOWER WATER THAN LAST YEAR. IN TURN, THIS DENSE GROWTH OF ALGAE AND ROOTED AQUATIC MACROPHYTES HAS PERMITTED TO AMPHIPODS (OLDER SEGMENT OF THE POPULATION).TO LIVE WITH LESS CHANCE OF BEING CONSUMED BY TROUT.

IN THE MORDAB WHERE THE POPULATION DENSITY HAS GONE UP TO ALMOST 30,000 PER SQUARE METER ON THE AVERAGE WITH THE MAXIMUM OBSERVED AT STATION SIXTEEN WHERE IT WAS OVER 60,000 PER SQUARE METER IT IS DUE MAINLY TO THE DRYING UP OF THE MORDAB. AS THE WATER DRIES UP AND BECOMES SHALLOWER THE PRODUCTION OF ORGANIC MATTER BECOMES SO DENSE AND EXISTS OVER A VERTICAL DISTANCE OF 10 - 20 CM OR MORE, SUCH DENSE POPULATIONS ARE POSSIBLE. THIS PHENOMENON MIGHT BE CALLED THE "SKYSCRAPER EFFECT", WHERE THE POPULATION ACTUALLY DEVELOPS IN SEVERAL LAYERS FROM SUBSTRATE UPWARDS. THIS IS NOT POSSIBLE IN THE MAIN LAKE AS THE COLUMN OF ORGANIC MATERIAL IS BUT A FEW CENTIMETERS IN THICKNESS IF AT ALL MORE THAN UNIPLANAR. WITH SUCH GREAT POPULATIONDDENSITIES OBSERVED IN THE MORDAB HOWEVER, IT APPEARS THAT NO LIMIT HAS YET BEEN REACHED IN THE POPULATION DENSITY WHERE NATURAL POPULATION CONTROL MECHANISMS TAKE EFFECT THROUGH DECREASED FECUNDITY OR OTHER MECHANISMS.

THIS YEAR THE MORDAB HAS DECREASED IN TOTAL AREA BY MORE THAN ~~XX~~ 50 PERCENT OF ITS AREA. BECAUSE OF THIS DECREASE IN AREA AND THE FACTTHAT THE AMPHIPODS ARE MOBILE (CAPABLE OF ESCAPING DESSICATION) THE POPULATION IS NOW CONCENTRATED IN AN AREA ONE HALF THE NORAML SIZE OF THE MORDAB, THUS CONTRIBUTING TO THE ALMOST UNBELIEVEABLE DENSITY OF AMPHIPODS IN THE MORDAB.

Department of Environmental Conservation

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TESTS ON NEUR LAKE AMPHIPODS FRO 1355

1) Have Yahyavi coblect 100 or so amphipods each day from the lake with the plankton net., both from the main lake and the mordab and store tham in formalin as a check on the fecundity differences in the two populations

Equipment needed. 1) Plankton net 2) Formalin 3) Sample vials

This should tell the story as to whether not not even mating is inhibited, or that mating owcurs but some other mechanism in the population prevents the eggs from either hatching, or the adults perhaps prey on the young when the populatkion is very dense as it is in the mordab.

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1) ONLY ONE GENERATION OF AMPHIPODS WAS PRODUCED IN NEUR LAKE PRIOR TO THE INTRODUCTION OF TROUT IN 1973, I.E., ONE GENERATION PRODUCED PER YEAR.

SUPPORTING EVIDENCE

1) GRAPHS COMPARING MORDAB & MAIN LAKE FOR 1354 CLEARLY SHOW THERE was NO NATURAL REPRODUCTION IN THE MORDAB UNTIL MID TIR 1354

2) The comparison of the population structure from the main lake in Ordibehesht over the past three springs shows:
   a) in Ordibehesht 1352 (no fish present) there was no generation produced in Ordibehesht
   b) In Ordibehesht 1353, in the presence of 5000 rainbow trout, a very small pulse was produced in the population
   c) In Ordibehesht 1354, in the face of predation by 200,000 rainbow trout weigh9ing 300 grams each, a massive pulse is produced in the population on the main lake, but not in the Mordab.

2) AFTER INTRODUCTION OF 200,000 RAINBOW TROUT, TWO GENERATIONS ARE PRODUCED EACH YEAR.

SUPPORTING EVIDENCE

a) GRAPHS OF THE MAIN LAKE POPULATION SHOW VERY PLAINLY TWO PEAKS OR GENERATIONS PRODUCED, ONE IN ORDIBEHESHT AND ANOTHER IN TIR

ADDITIONAL NOTES:

The mordab population is apparently inhibited by the absence of of predation and the extremely dense population levels (together with poor environmental conditions - cold water, no algae bloom, etc) no natural reproduction occurs until the oldest and largest adults in the mordab population begin to die off. When this occurs, the smallest and slowest maturing segment of the population no suddenly matures, mates and the first generation of young is produced, EXACTLY in coincidence with the SECOND generation in the main lake.

CONVERSELY, the main lake population, in the face of intense predation an abundant foos supply, and dwindling numbers, produce a very large pulse in the population in 1354 in the spring of the year.

The mordab population, although under no predation from trout or any other predator, once natural reproduction has occurred, the adult amphipods rapidly disappear from the population, just as fast as the adults in the main lake are eaten b the trout; however, in the mordab they die of old age rather than as food for the trout.

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DIRECT COMPARISON OF THE MORDAB AND MAIN LAKE POPULATIONS FROM 1354.

From 17 - 20 Ordibehesht 1354 the 1st generation has already been produced in the main lake, yet no reproduction has occurred in the mordab population. By 1 - 3 Khordad 1354 the main lake population has become almost exclusively 1st generation with no overwintering adults remaining, yet in the mordab only overwintering adults are present. By 15 - 17 Khordad 1354, the 1st generation from the main lake has literally caught up with the youngest and slowest maturing segment of the overwintering population of amphipods in the mordab. Two peaks in each population coincide almost exactly, the fewer antenna segment group in each pOopulation being the females and the greater antenna segment peaks being the males. However, a very dense population of"senile" (Scenesent) amphipods still comprises the majority of the mardab population. Thus, by 1 Tir 1354, the main lake population has not only caught up with the mordab population, it has actually PASSED THE MORDAB POPULATION! The 2nd generation produced in the main lake is actually larger and produced earlier than the 1st generation fromthe mordab. As can be seen from the graps between ordibehesht and Tir for 1354, the mordab population actually regresses ,i.e., the number of antenna segments found in the populati9n mea actuall decreases in number through Khordad into Tir as the scenescent protion of the population dies and the slow maturers grow up and breed , producing the 1st generation, and the ONLY generation

GENERAL NOTES ON AMPHIPOD STATISTICAL EVALUATIONS

1) Data indicates greater population densities with increasing densities of vegetation & detritus (Food and habitat).

2) Population densities decrease with increasing depth but not statistically significant.

3) In Ordibehesht, Khordad, Tir, before the vegetation blooms, there are no statistical differences in population levels between east and west shore populations of the lake,

4) Until the amphipod population "booms" in Tir, the trout do not feed heavily on the amphipods.

5) When the amphipod densities fall below $100/m^2$, trout do not feed on them and seek out other sources of food.

6) There are no statistical differences of consequence between this year's populations and last year's.

7) The amphipod population structure is drastically different this year than last year (especially after the population booms and the second generation has been produced. Many more adult amphipods are present into Mordad and Shahrivar this year, especially Mordad.

8) Population data for statistical analyses in many cases are biased on the high side as far as statistical evaluation is concerned as the zero data points are discarded since the zero data points cannot be easily & properly handled statistically.

Thoughts on Neur Lake Amphipod report for 1354

1) All of the amphipod data from this year indicates that the amphipod population was about one month advanced in its development this year all the way from spring throught fall of this year. The weather conditions this year also support that such a phenomenon is natural with the decreased water levels, increased aquatic vegetation growth, etc, together with less efficient (?) predation by the trout since they are very large and unable to manuveur and feeding effectively and efficiently in the shallow water. However, if water temperatures strictly control the time of first reproduction each spring (together with daylength) then Ordibehesht data collected over the past three years does not correlate with population trends in relation to temperature. For Example, in 1352 the water temperature was only 7 C on 25 Ordibehesht 1352. Conversely, on 25 Ordibehesht 1353 the water temperature was 17 C. Yet, the population structure between 1352 and 1353 varied hardly at all despite the wide fluctuation in temperatures between the two periods. In 1354 (14 - 20 Ordibehesht) the water temperature was 9-10 C over a one week period, yet, our amphipod data indicates that the population reproduced much earlier this year than in th the previous two years yet the water temperatures were intermedieate between 1352 and 1353. Is it possible that the trout have induced the amphipod population to reproduce at an earlier time?

There can be no doubt whatsoever, that the trout cropped off the adult amphipods from the population this past spring much faster that they disappeared from the population in the two previous years when trout predation was either at a minimum or nonexistent (no fish in 1352, only 5000 trout in 1352 - the last six months and 1353 up until 25,2 , 1353). This undoubtedly depressed the population below prepredation levels at similar tome periods in Ordibehesht 1352 and 1353 as compared to 1354. However, once the second generation was produced this year, no significant decreases in population density was observed this year compared to similar time periods last year. However, as was stated above the development of the population this year appeared to be 2 - 4 weeks ahead of last year timewise throughout the entire summer.

نخست وزیری

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Notes for Neur Lake Studies for the Remainder of 1354 and into 1355.

1) Attempt at spawning those trout that congregate at the big spring at NE corner of the lake this winter. Possible to collect 20-40 million eggs from the lake if 5,000 to 10,000 trout congregate at the spring again this winter. Eggs could be sold to Ousia this winter for marketing at his perogative.

2) Incubate 1-2 million eggs at the big spring in covered egg trays constructed at the lake and stock the lake with these fingerlings rather than pruchasing ~~eggs XXXXX~~ fingerlings from Ousia.

3) Eggs can be flown out of the lake to Tehran in the Heliocourier.

4) Is there any segregation fo large and small trout into differnet feeding niches and differnet habitats in the lake in 1355 when we have to very large age classes of trout in the lake.? Do the big trout occupy the pelagic zones of the lake and feed more on amphipods found there than in the shallows? Amphipod population densities and population structure from 1354 vs, 1353 indicates that the amphipods were more abundan this year than last year and that the amphipod population structure this year was skewed more towards older individuals than last. This indicates that perhaps the small trout last year fed more actively in the shallows and probably even put more pressure on the amphipod population last year than the big trout did this year, even though the biomass of trout in the lake this year was 3-5 times as great as last year. To test this hypothesis. set large and small gill nets in both shallow and pelagic portions of the lake next year (same number of meters of each) to check for intraspecific segregation into differnent feeding niches and different habitats. Stomach samples should also be collected.

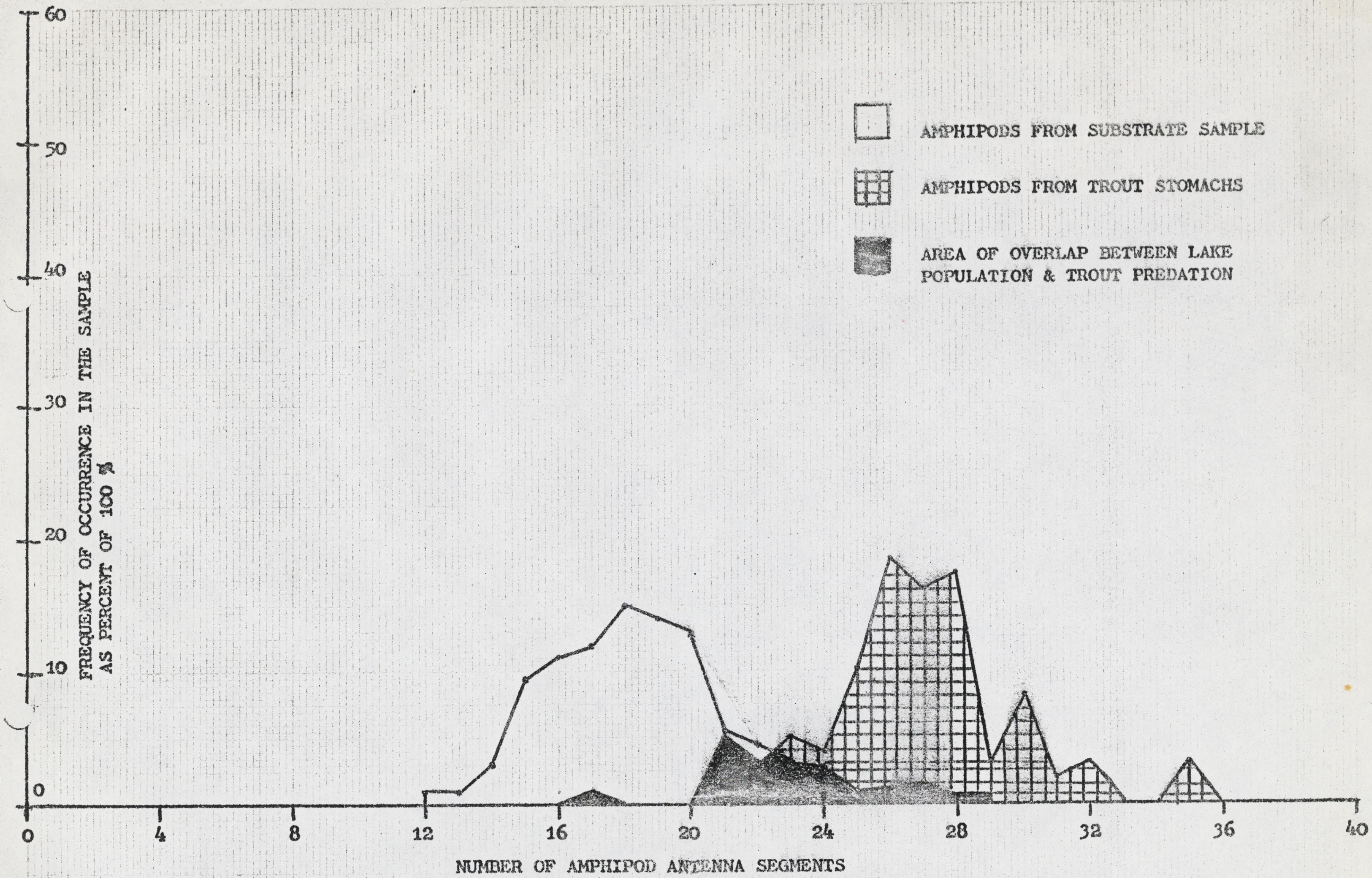


FIGURE ONE. SELECTIVE PREDATION BY TROUT ON NEUR LAKE AMPHIPOD POPULATION, NEUR LAKE, 14-20 ORDIBEHESHT 1354

FIGURE ONE A. NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA, 1 - 3 KHORDAD 1354.

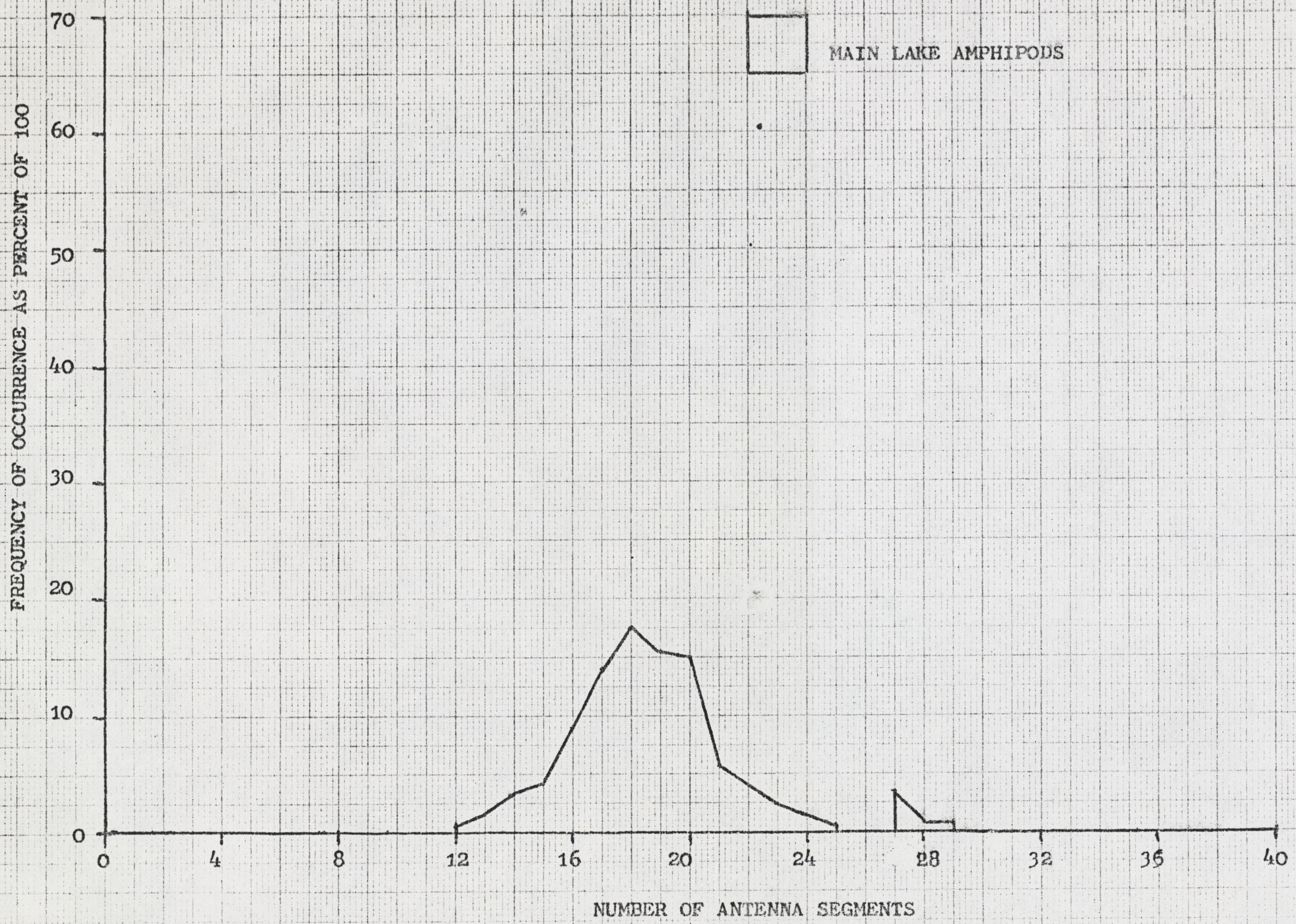
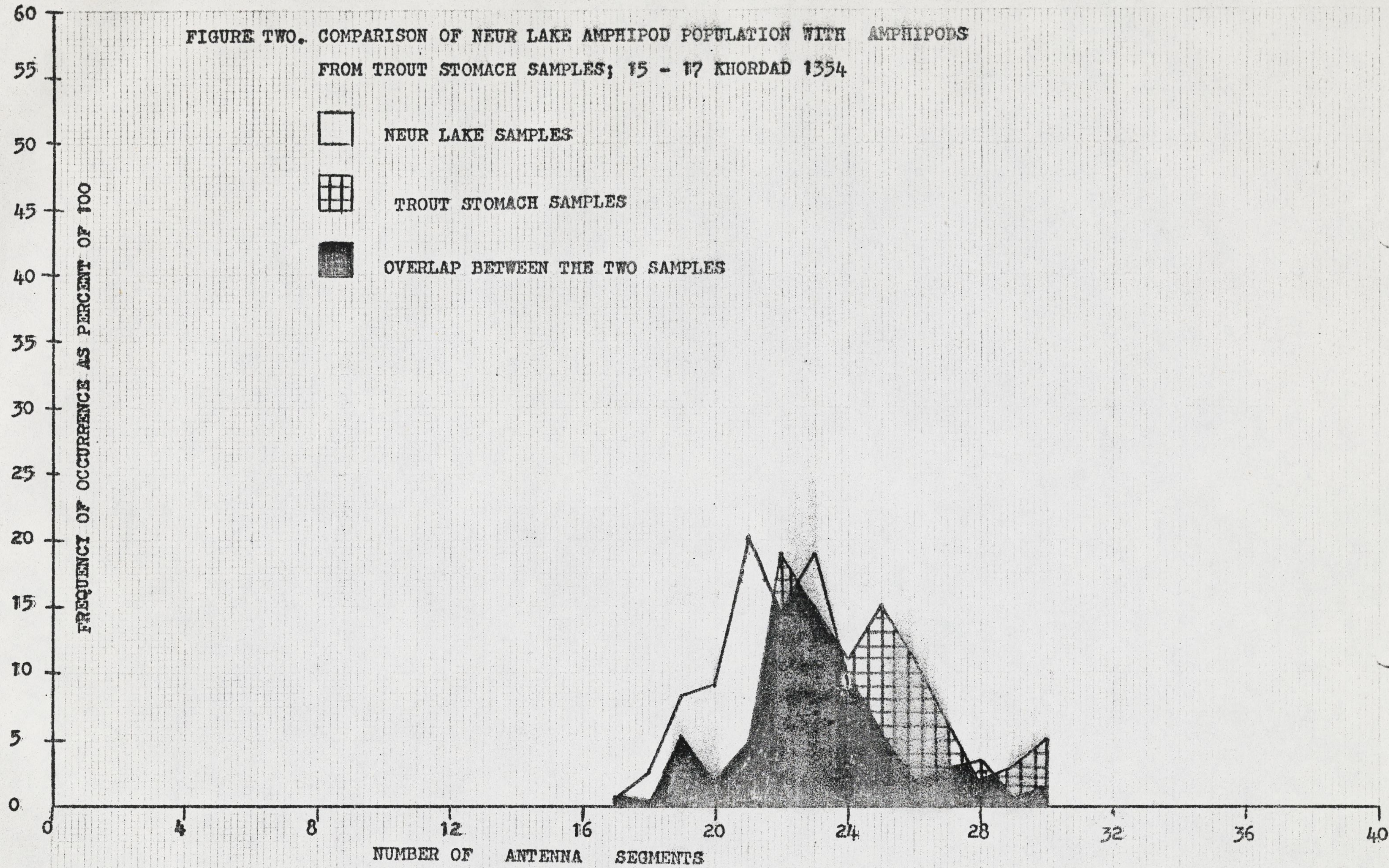


FIGURE TWO. COMPARISON OF NEUR LAKE AMPHIPOD POPULATION WITH AMPHIPODS FROM TROUT STOMACH SAMPLES; 15 - 17 KHORDAD 1354



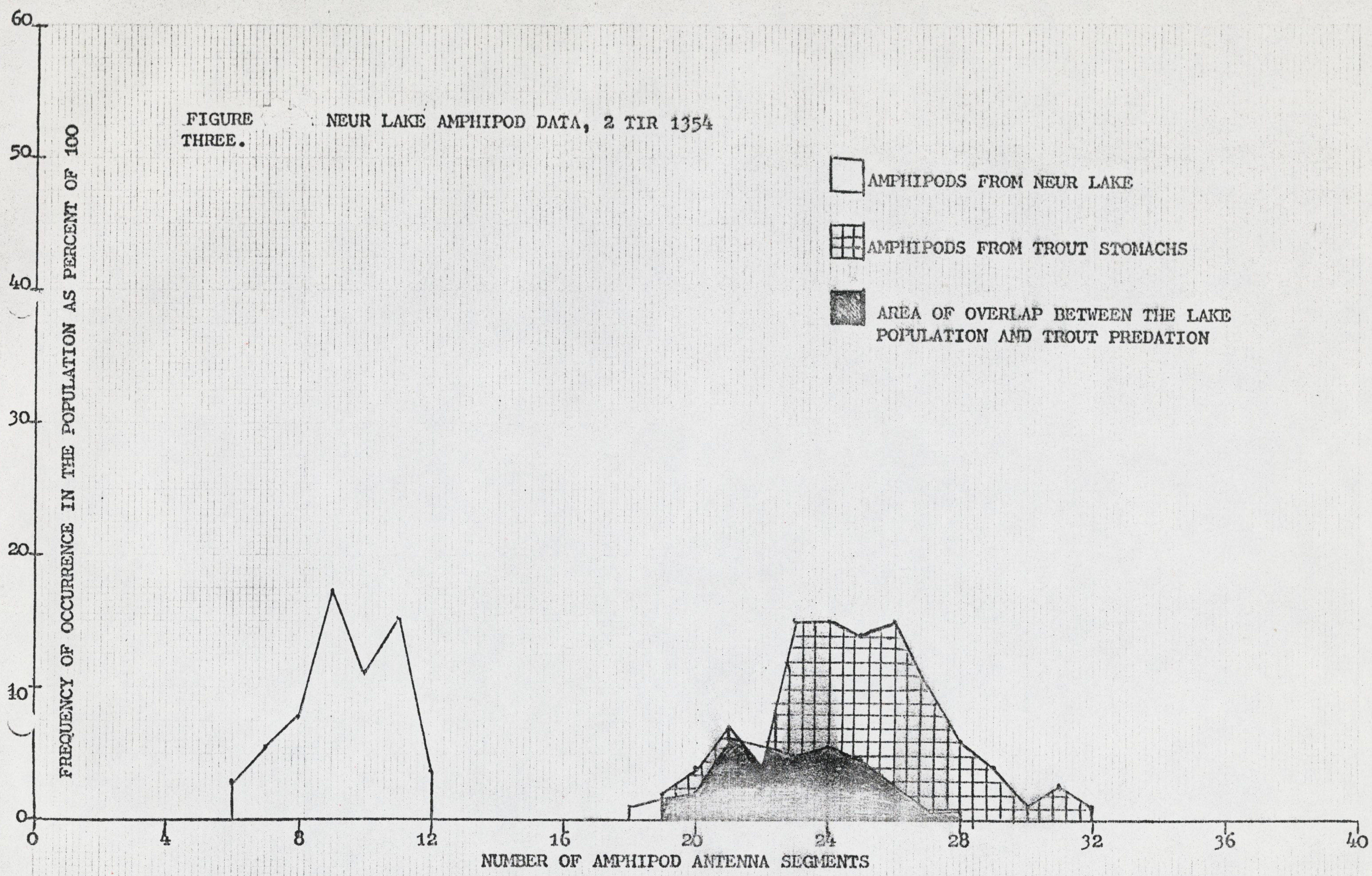


FIGURE THREE. NEUR LAKE AMPHIPOD DATA, 2 TIR 1354

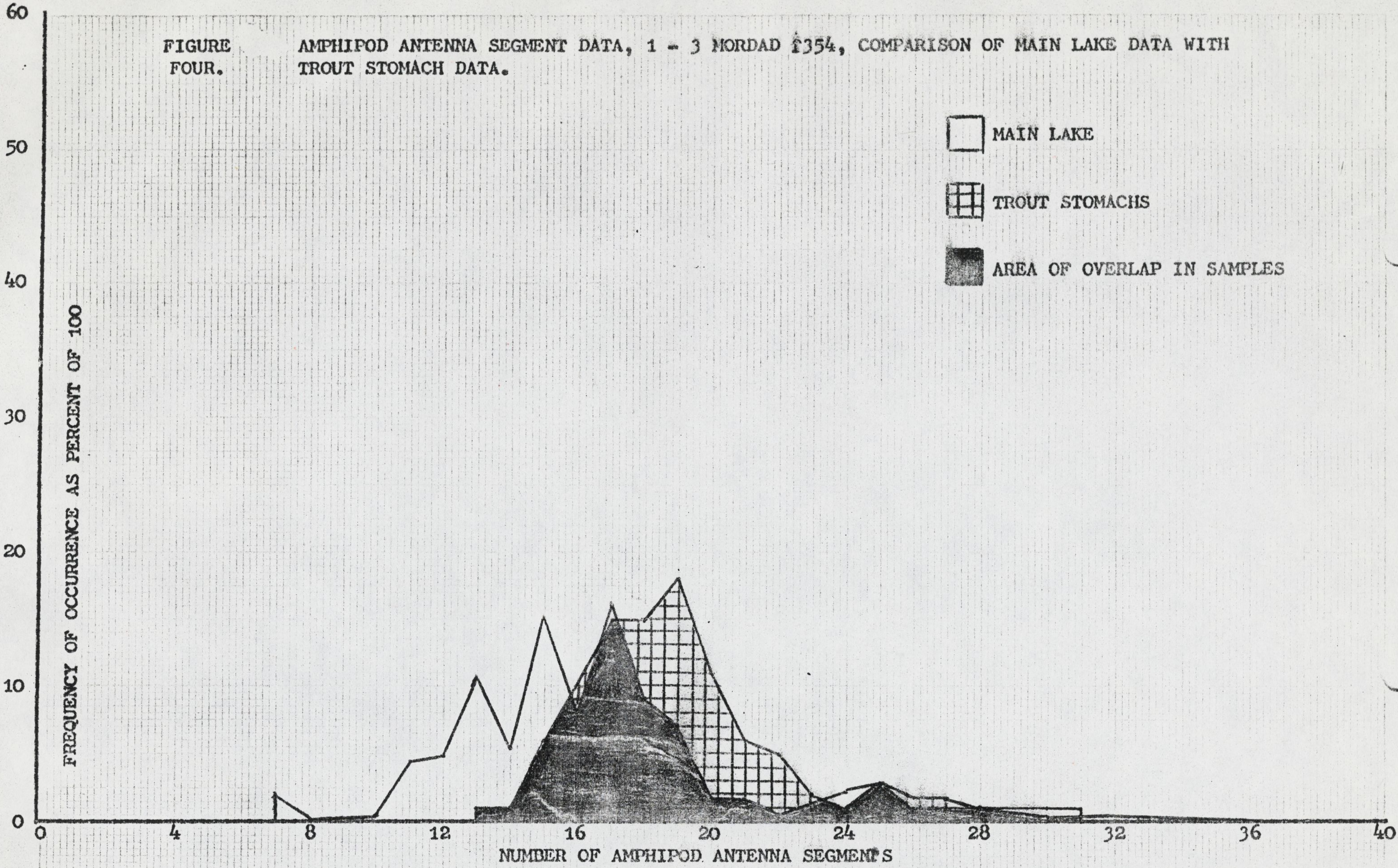


FIGURE FOUR. AMPHIPOD ANTENNA SEGMENT DATA, 1 - 3 MORDAD 1354, COMPARISON OF MAIN LAKE DATA WITH TROUT STOMACH DATA.

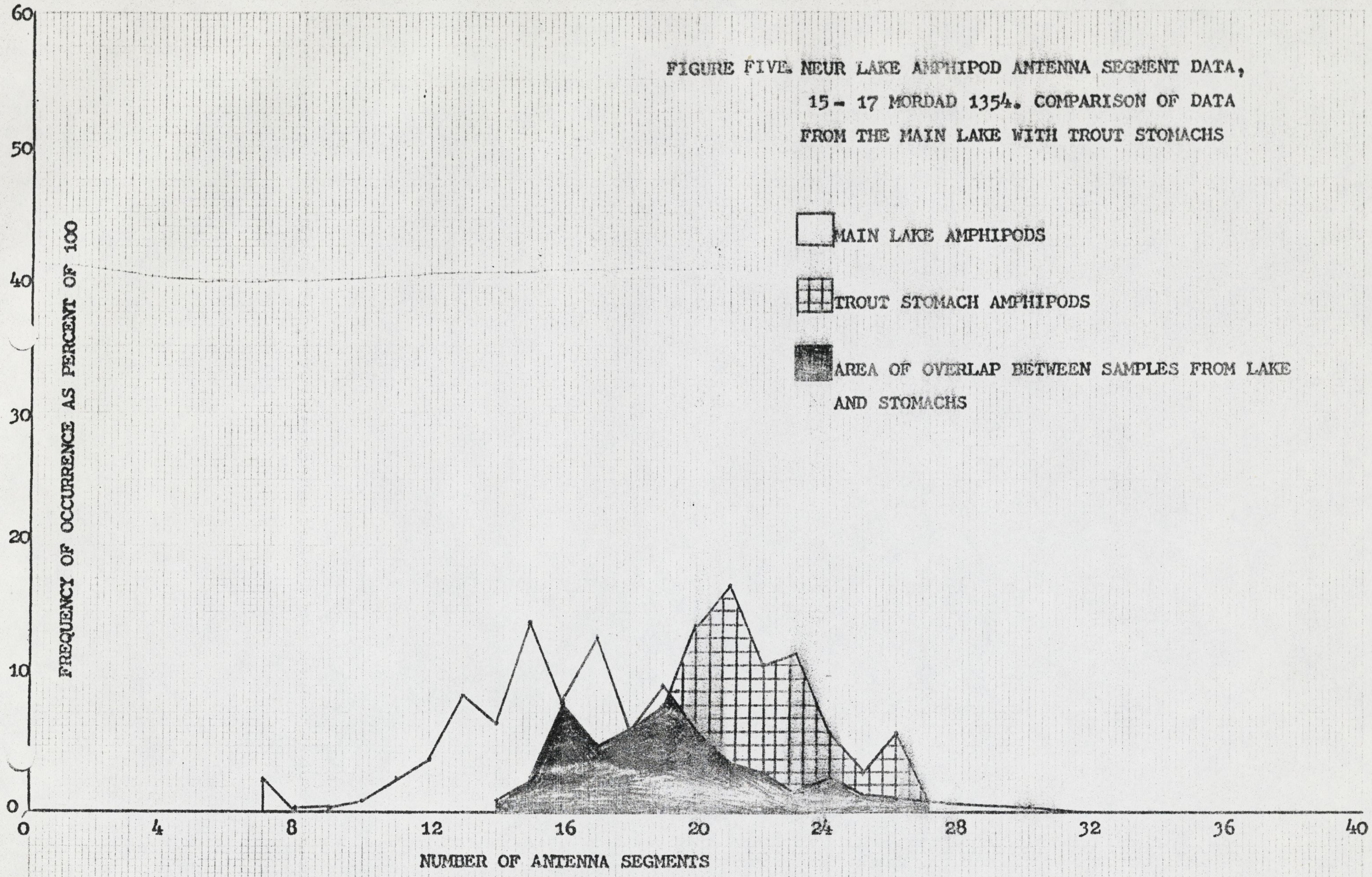


FIGURE FIVE. NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA,
15 - 17 MORDAD 1354. COMPARISON OF DATA
FROM THE MAIN LAKE WITH TROUT STOMACHS
MAIN LAKE AMPHIPODS
TROUT STOMACH AMPHIPODS
AREA OF OVERLAP BETWEEN SAMPLES FROM LAKE AND STOMACHS
FREQUENCY OF OCCURRENCE AS PERCENT OF 100
60
50
40
30
20
10
0
0
4
8
12
16
20
24
28
32
36
40
NUMBER OF ANTENNA SEGMENTS

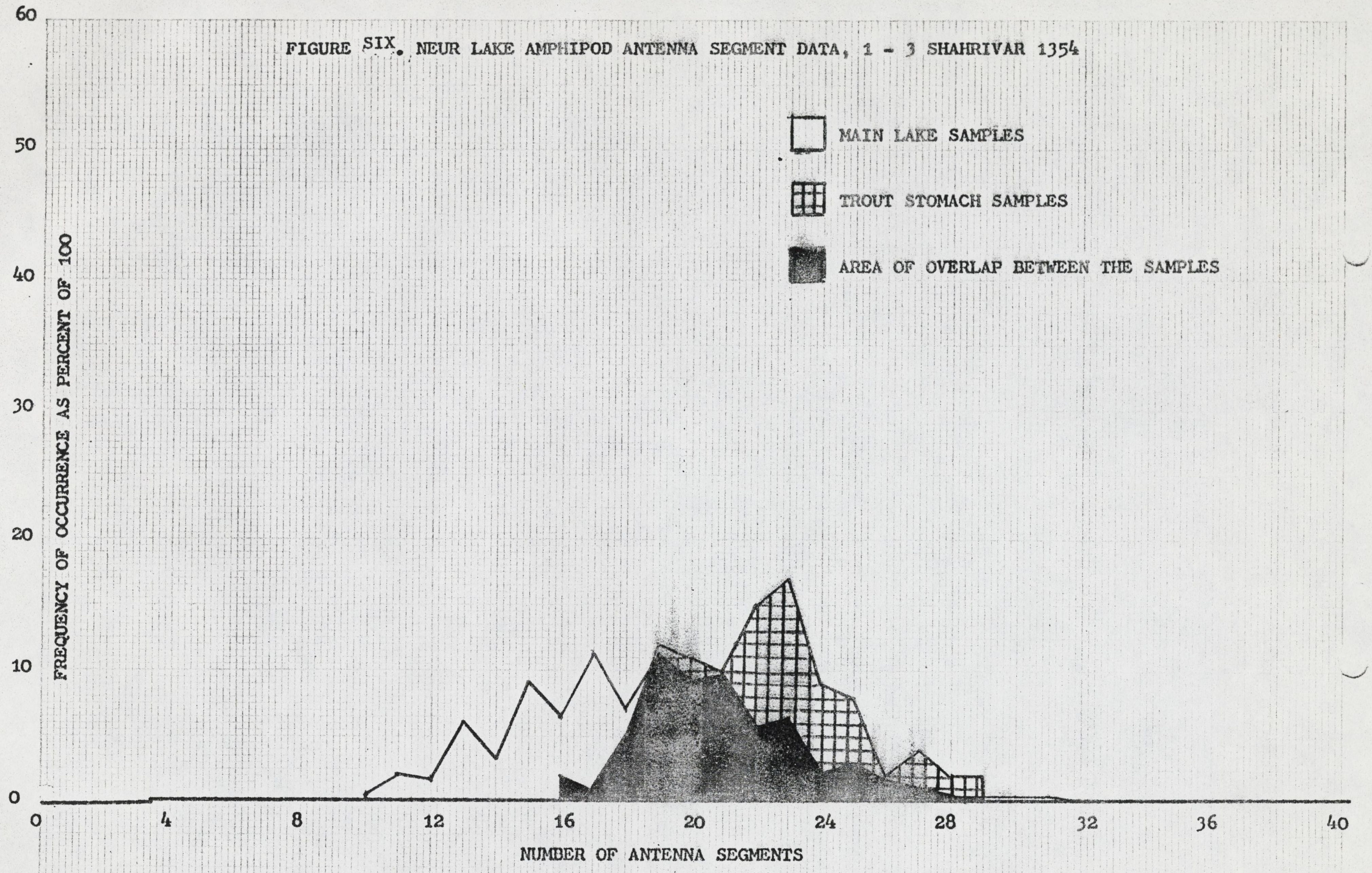
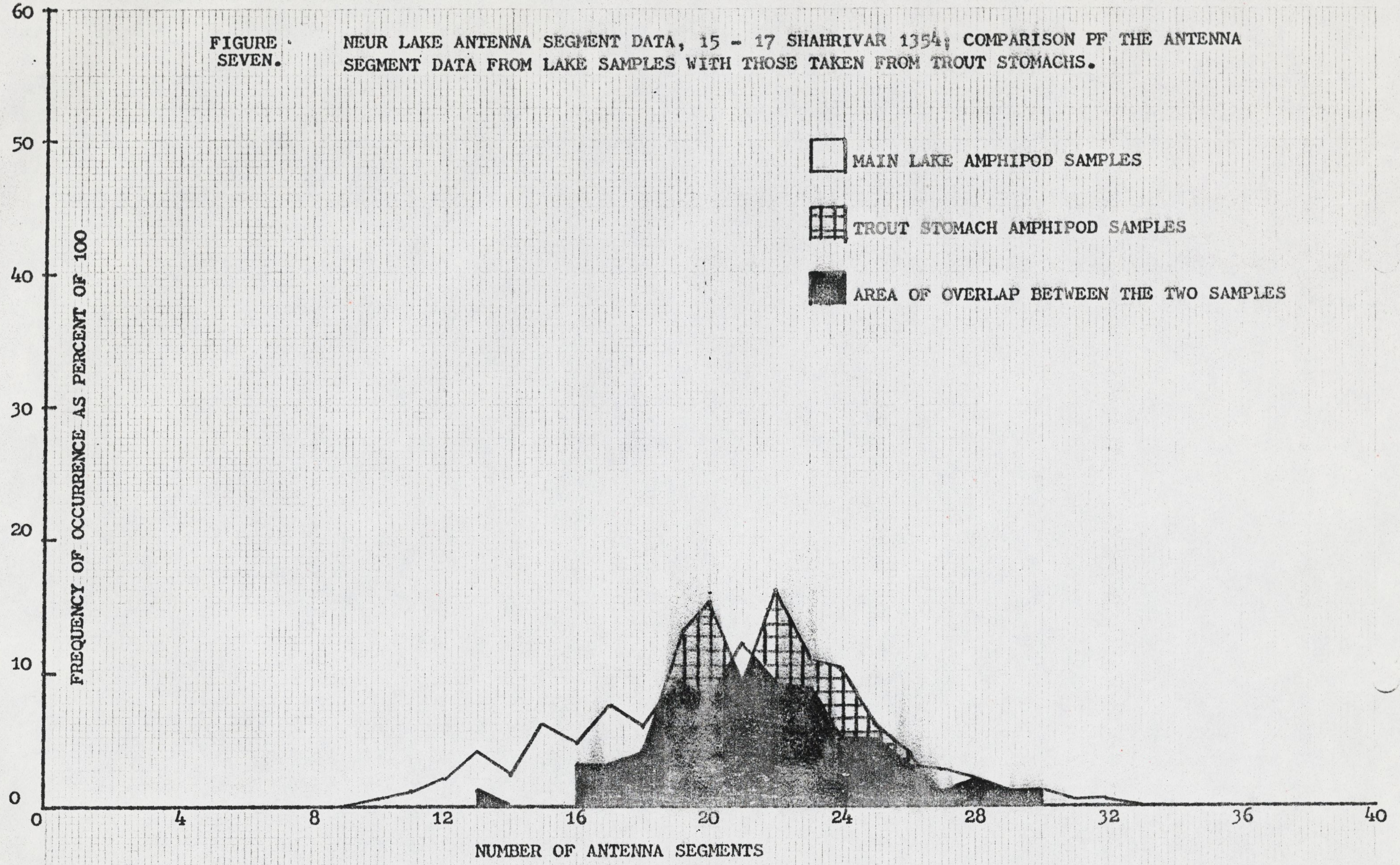


FIGURE SIX. NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA, 1 - 3 SHAHRIVAR 1354
MAIN LAKE SAMPLES
TROUT STOMACH SAMPLES
AREA OF OVERLAP BETWEEN THE SAMPLES
FREQUENCY OF OCCURRENCE AS PERCENT OF 100
60
50
40
30
20
10
0
0
4
8
12
16
20
24
28
32
36
40
NUMBER OF ANTENNA SEGMENTS

FIGURE SEVEN. NEUR LAKE ANTENNA SEGMENT DATA, 15 - 17 SHAHRIVAR 1354; COMPARISON PF THE ANTENNA SEGMENT DATA FROM LAKE SAMPLES WITH THOSE TAKEN FROM TROUT STOMACHS.



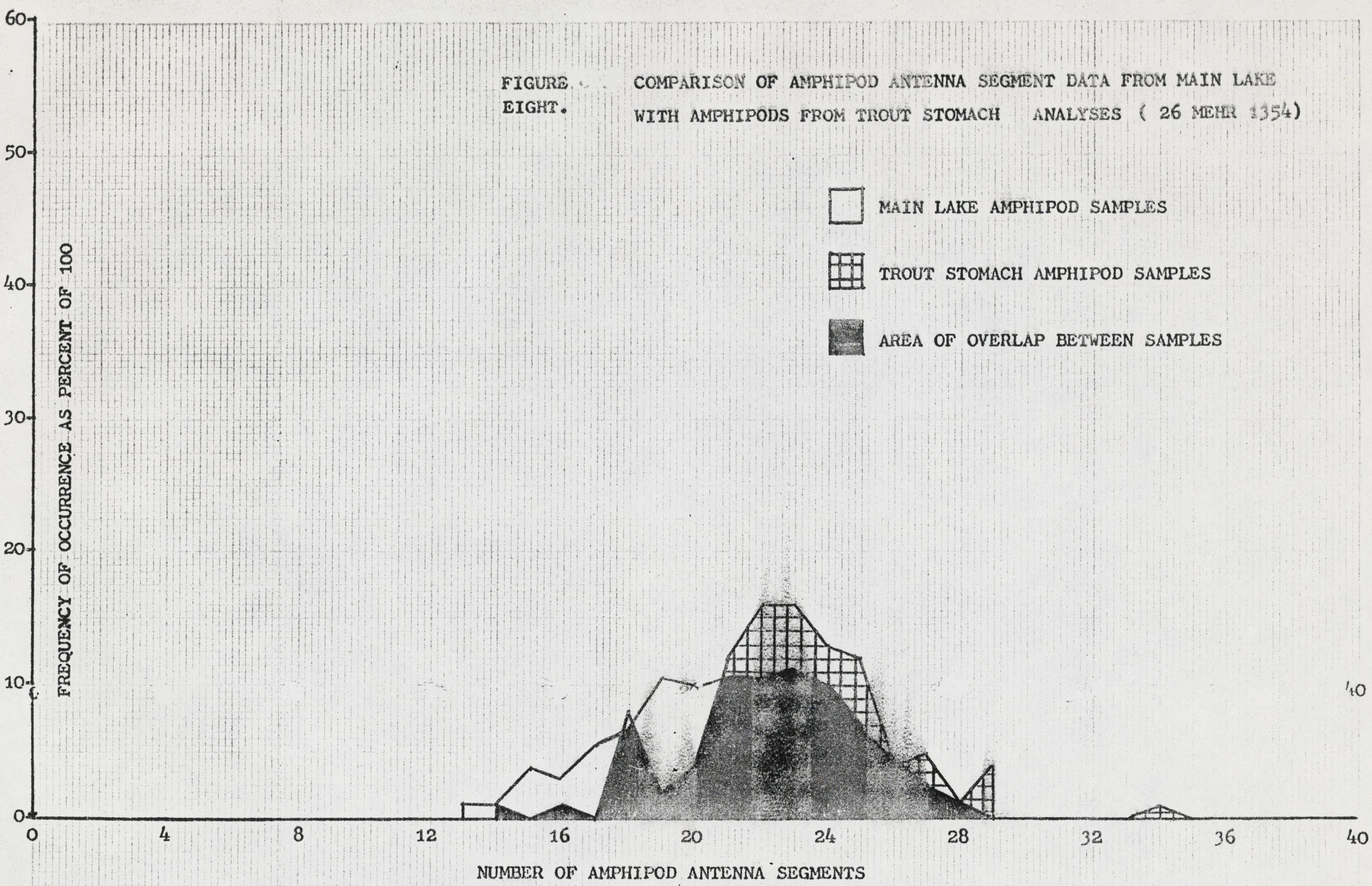


FIGURE EIGHT. COMPARISON OF AMPHIPOD ANTENNA SEGMENT DATA FROM MAIN LAKE WITH AMPHIPODS FROM TROUT STOMACH ANALYSES (26 MEHR 1354)

FIGURE EIGHT A. COMPARISON OF NEUR LAKE AMPHIPOD SAMPLES
WITH TROUT STOMACH SAMPLES, 6 AZAR 1354.

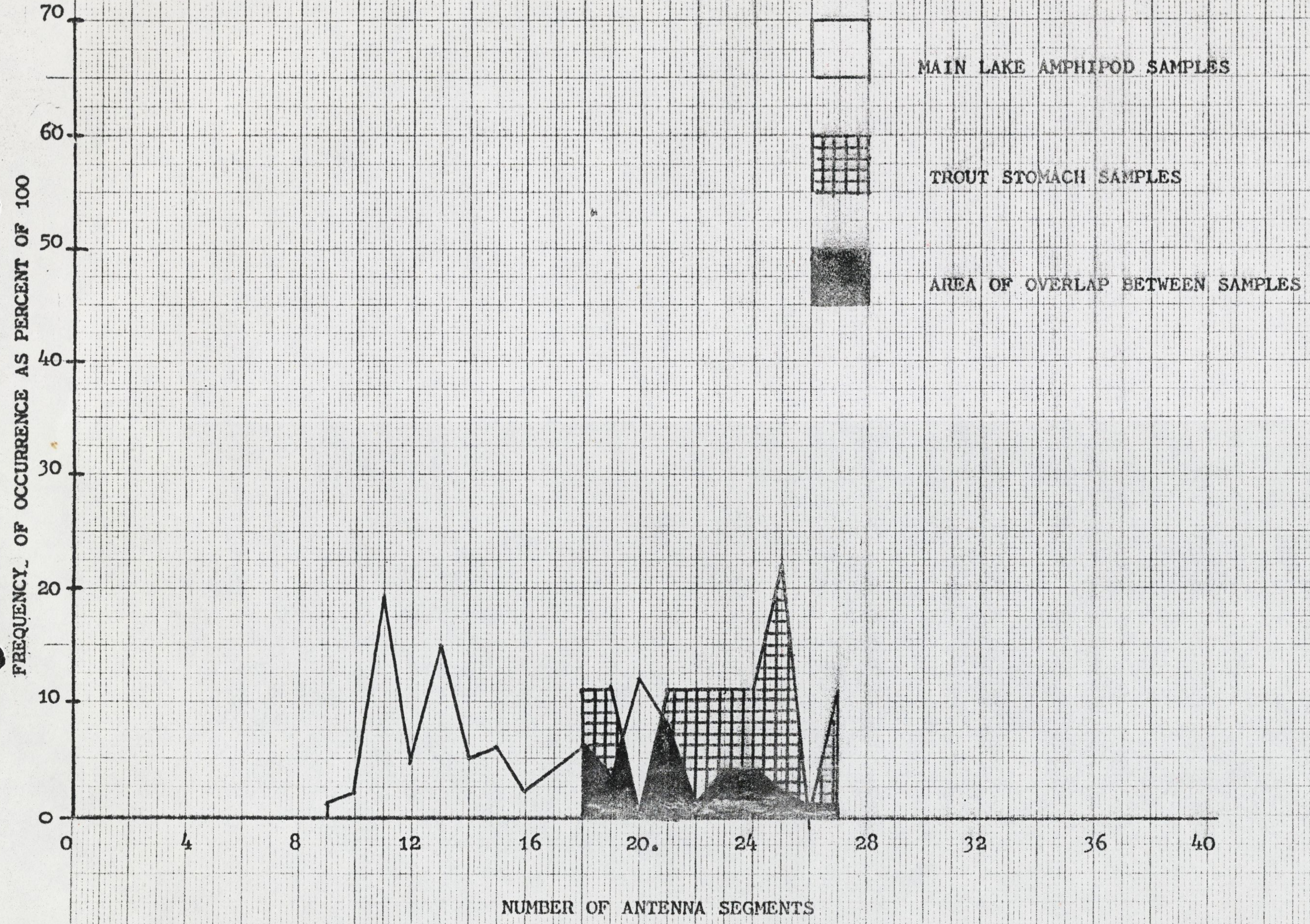
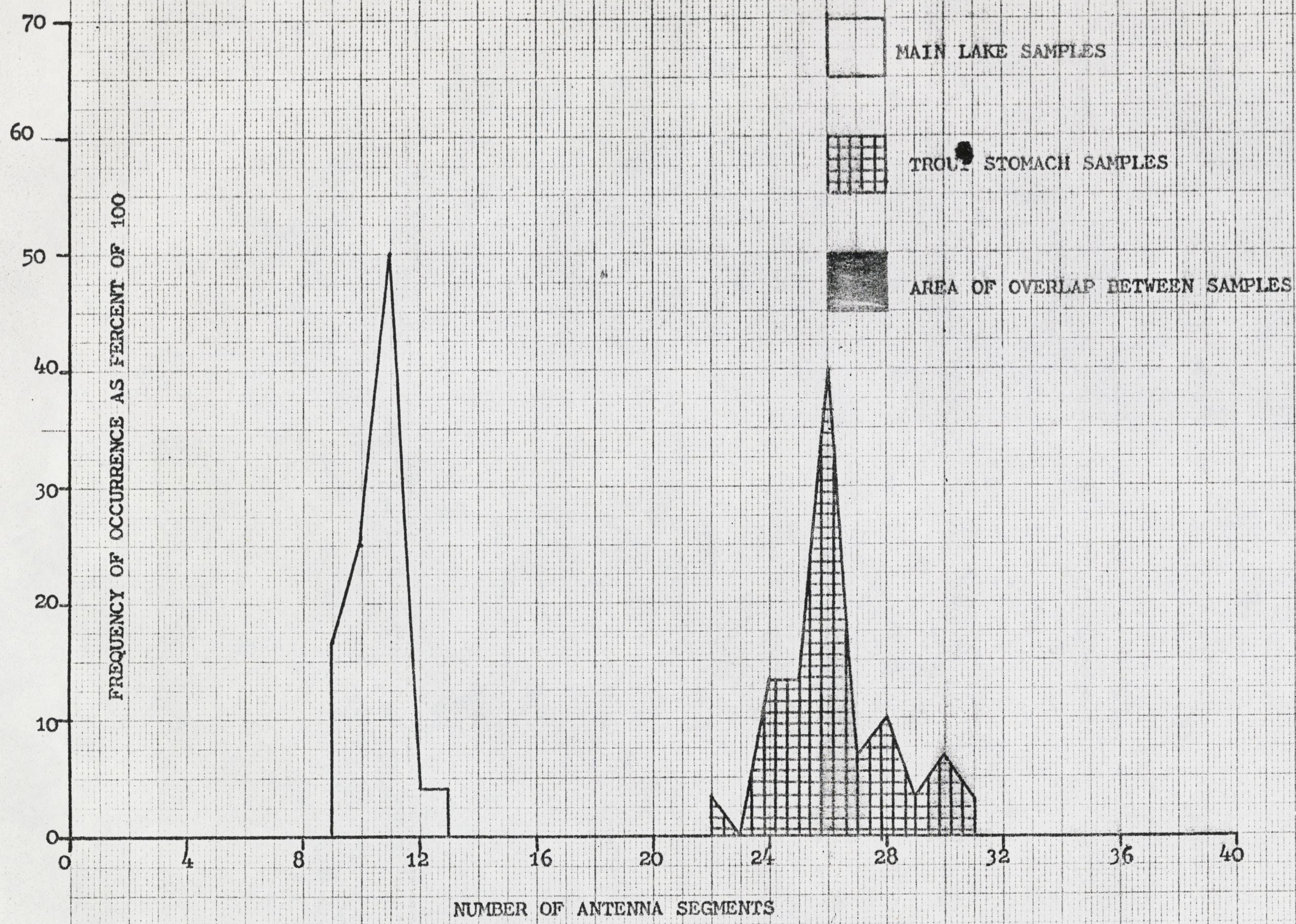


FIGURE NINE. COMPARISON OF AMPHIPOD ANTENNA SEGMENT DATA FROM MAIN LAKE WITH SAMPLES FROM TROUT STOMACHS, 10 MORDAD 1353



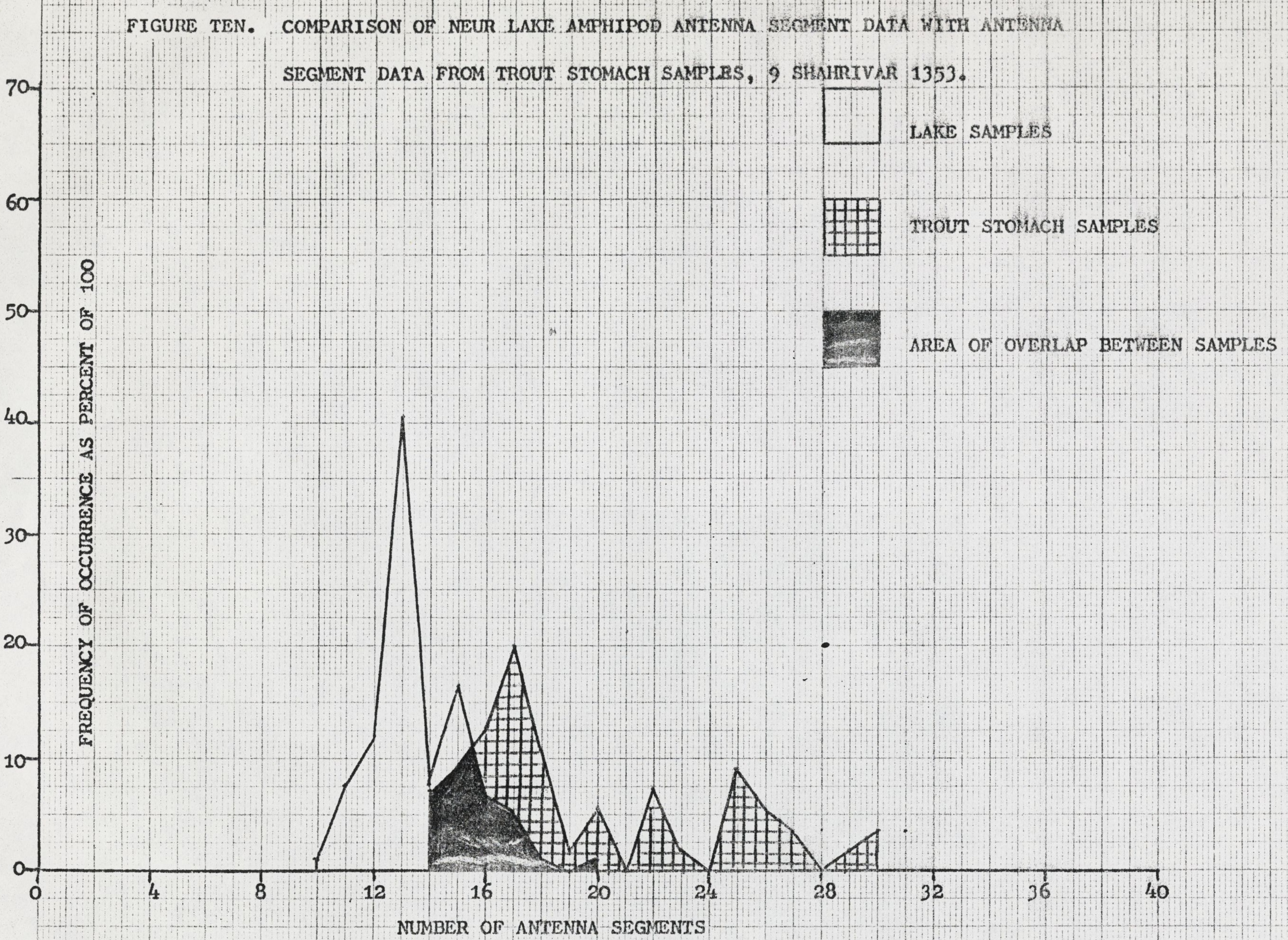


FIGURE TEN. COMPARISON OF NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA WITH ANTENNA SEGMENT DATA FROM TROUT STOMACH SAMPLES, 9 SHAHRIVAR 1353.
LAKE SAMPLES
TROUT STOMACH SAMPLES
AREA OF OVERLAP BETWEEN SAMPLES
FREQUENCY OF OCCURRENCE AS PERCENT OF 100
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
28
32
36
40
NUMBER OF ANTENNA SEGMENTS

FIGURE ELEVEN . COMPARISON OF NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA WITH ANTENNA SEGMENT DATA FROM TROUT STOMACH SAMPLES, 3 MEHR 1353

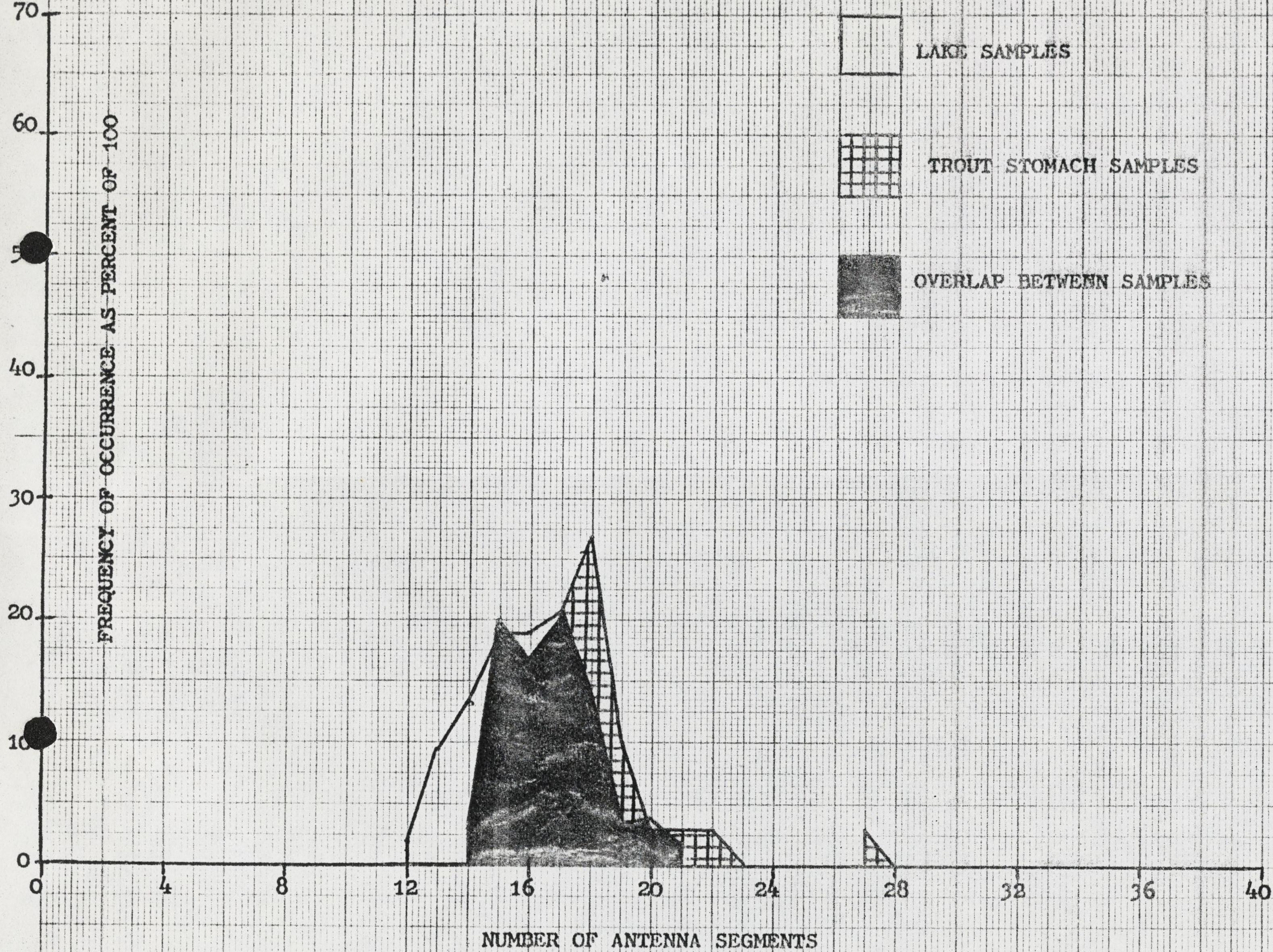


FIGURE TWELVE. COMPARISON OF NEUR LAKE AMPHIPOD DATA ON ANTENNA SEGMENTS WITH ANTENNA SEGMENTS DATA FROM TROUT STOMACH AMPHIPOD SAMPLES , 3 ABAN 1353

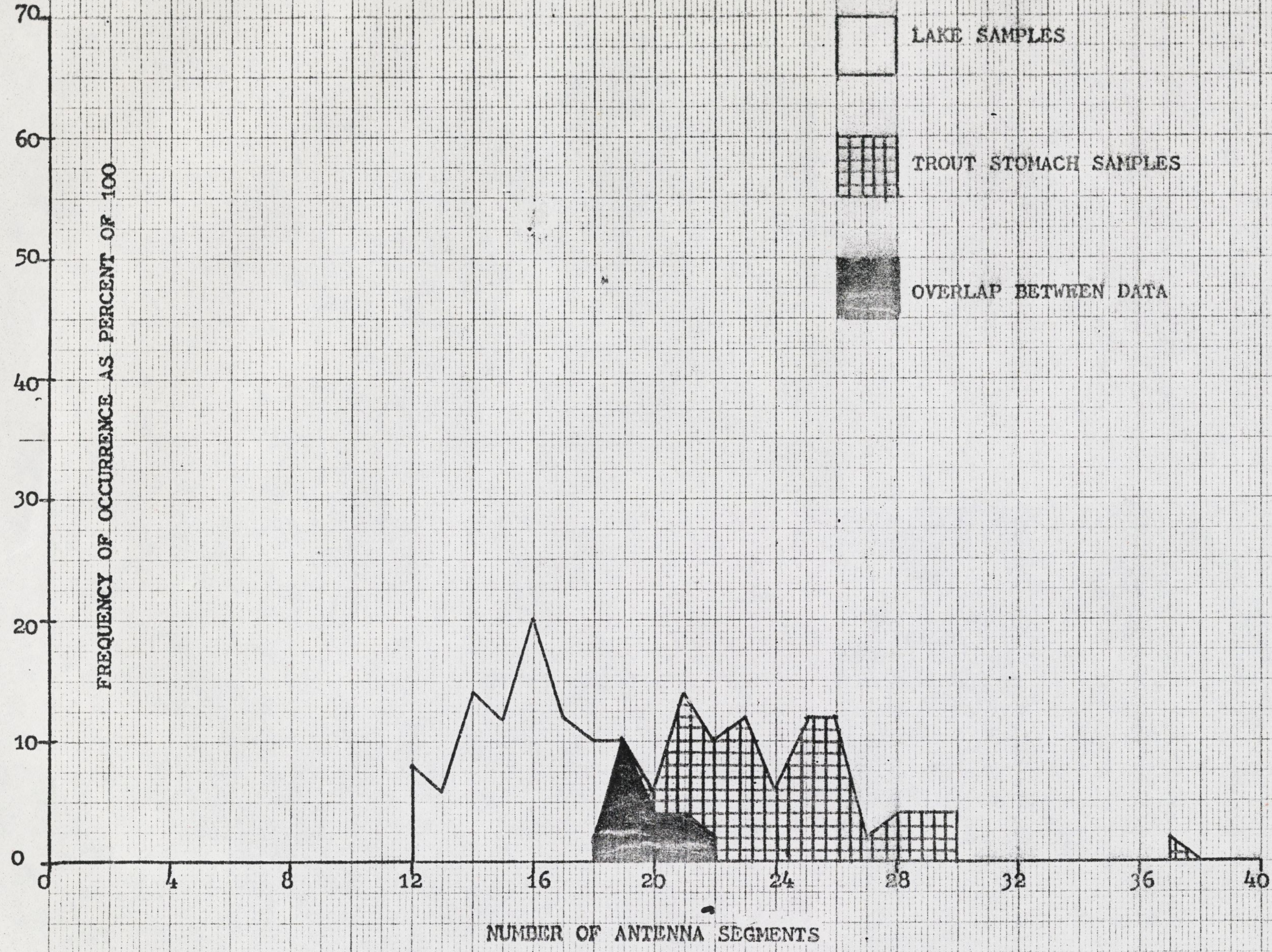
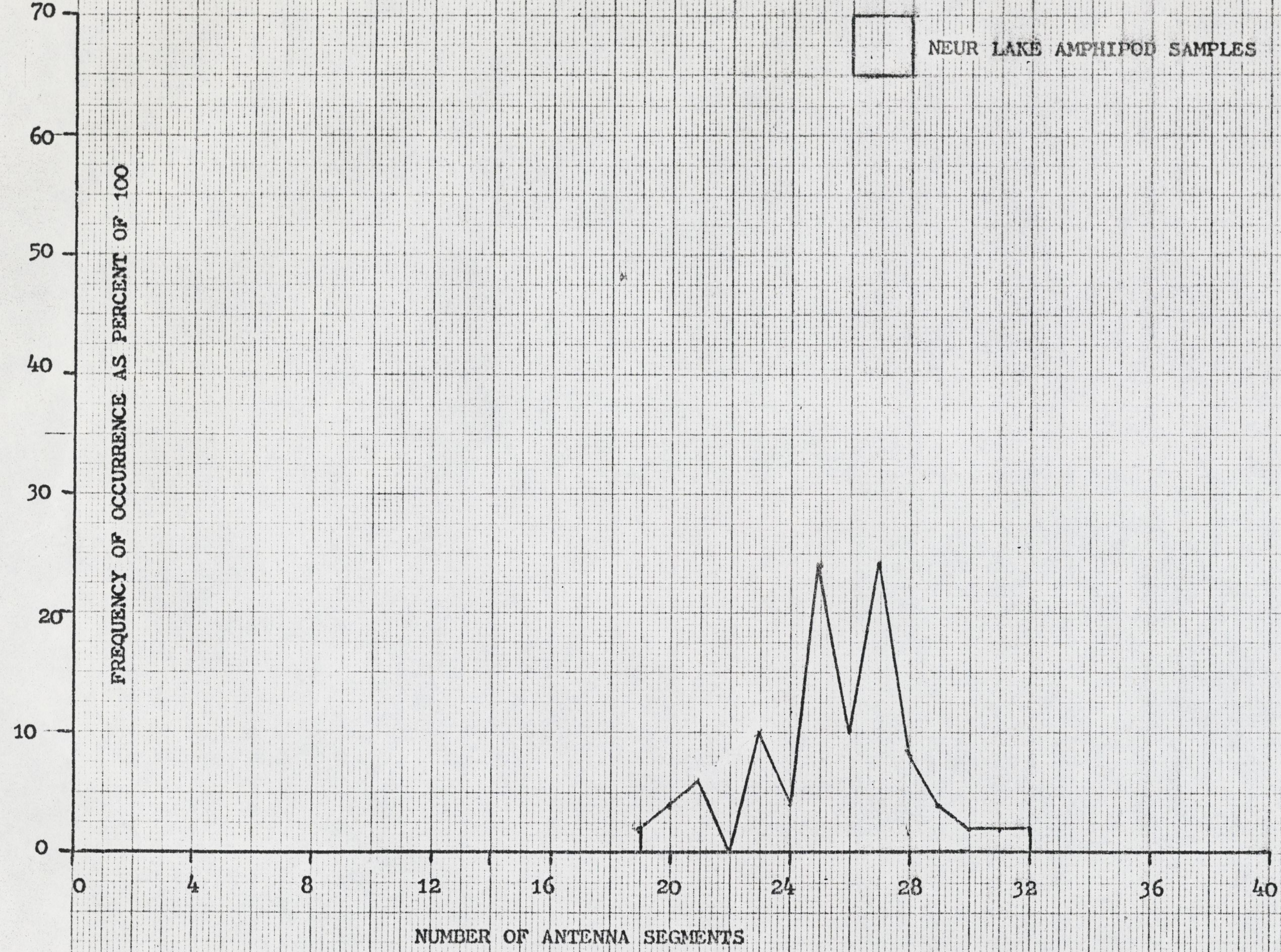


FIGURE FOURTEEN . NEUR LAKE AMPHIPOD DATA, 18 DEY 1353.



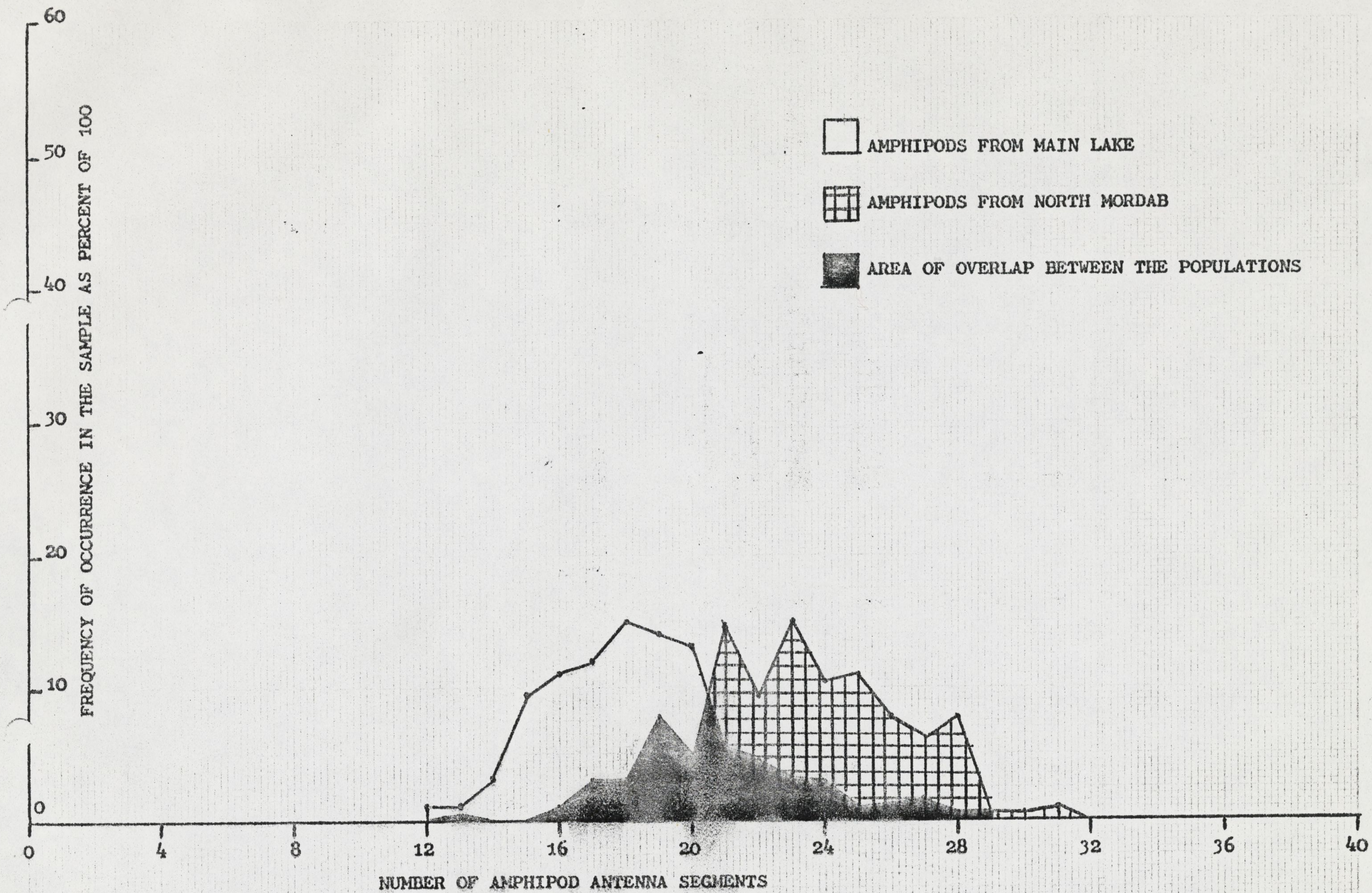


FIGURE FIFTEEN. COMPARISON OF GROWTH RATE OF AMPHIPODS FROM MAIN LAKE & MORDAB AT NEUR LAKE, 17 ORDIBEHESHT 1354

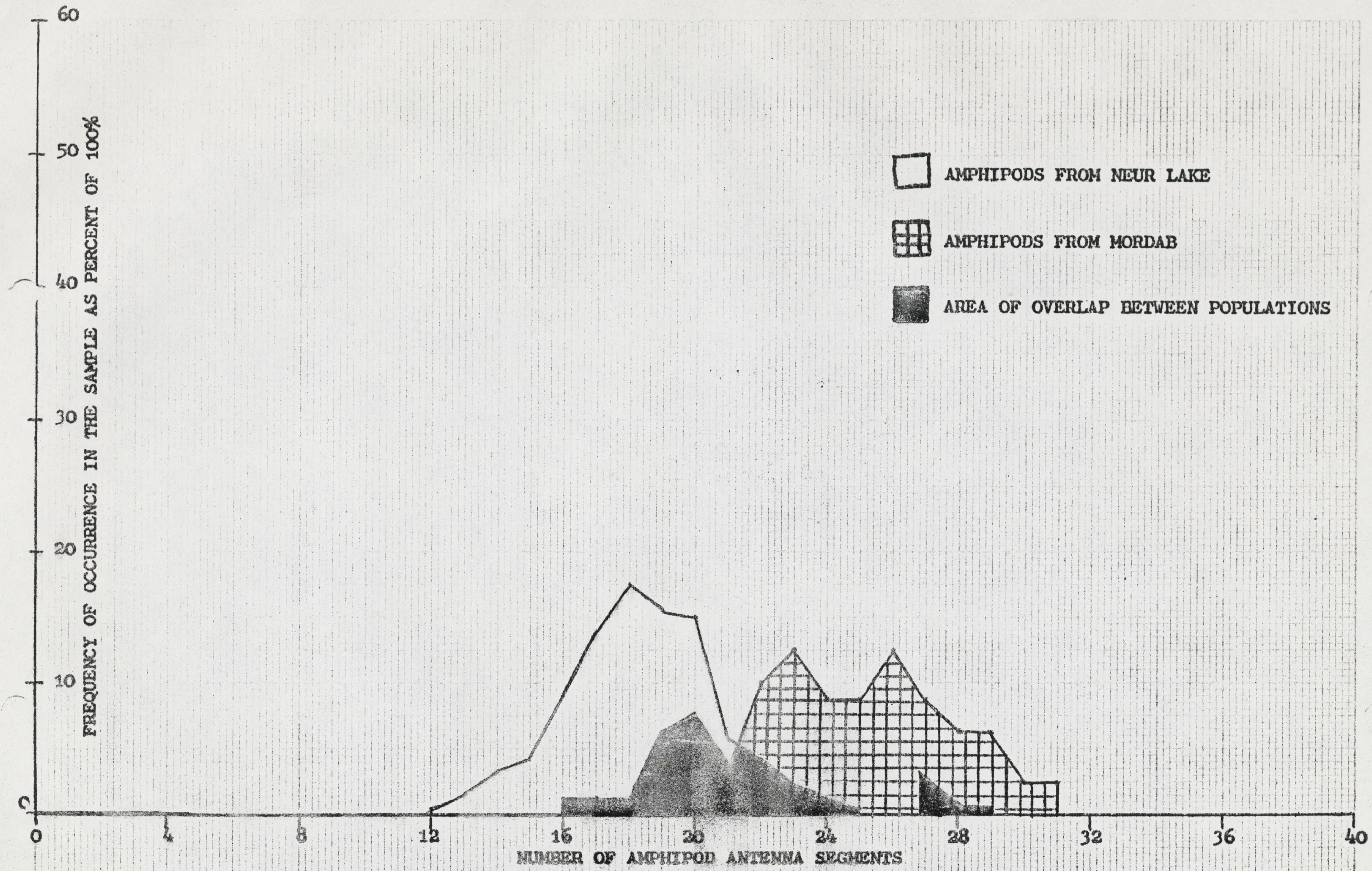


FIGURE SIXTEEN. COMPARISON OF GROWTH RATE OF NEUR LAKE AMPHIPODS WITH MORDAB AMPHIPODS 1 - 3 KHORDAD 1354

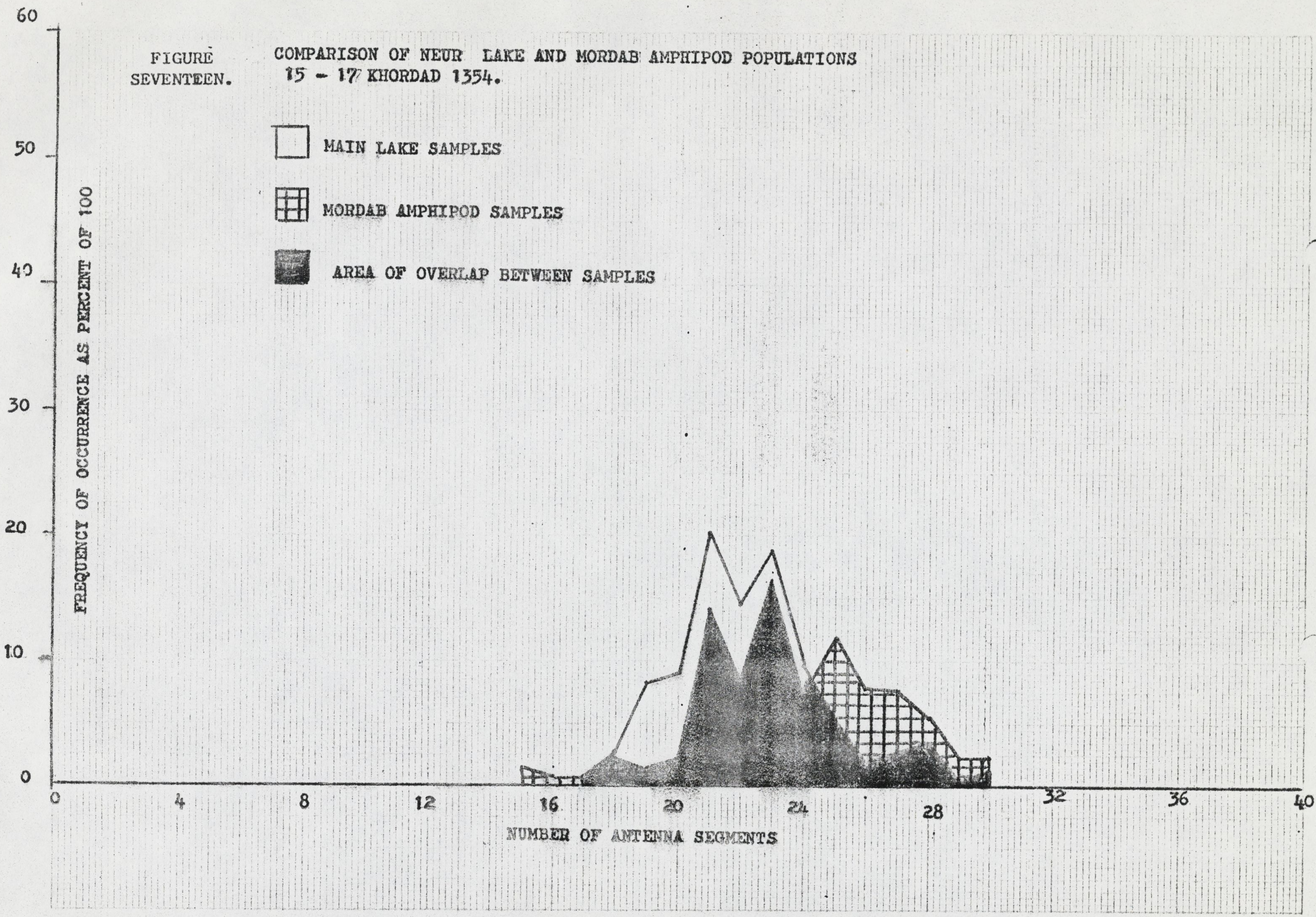


FIGURE SEVENTEEN.
COMPARISON OF NEUR LAKE AND MORDAB AMPHIPOD POPULATIONS
15 - 17 KHORDAD 1354.
MAIN LAKE SAMPLES
MORDAB AMPHIPOD SAMPLES
AREA OF OVERLAP BETWEEN SAMPLES
FREQUENCY OF OCCURRENCE AS PERCENT OF 100
NUMBER OF ANTENNA SEGMENTS
0
10
20
30
40
50
60
4
8
12
16
20
24
28
32
36
40

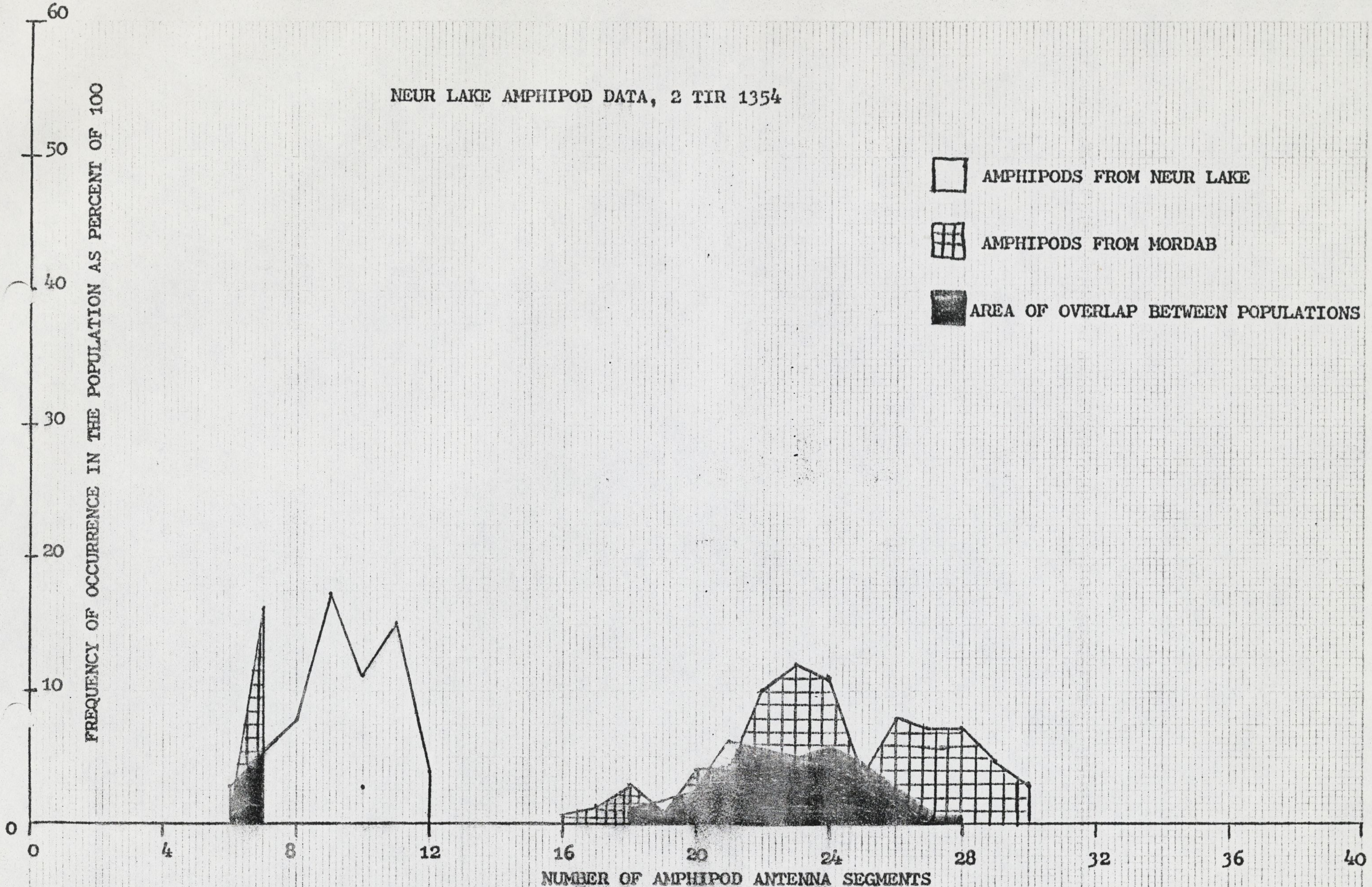
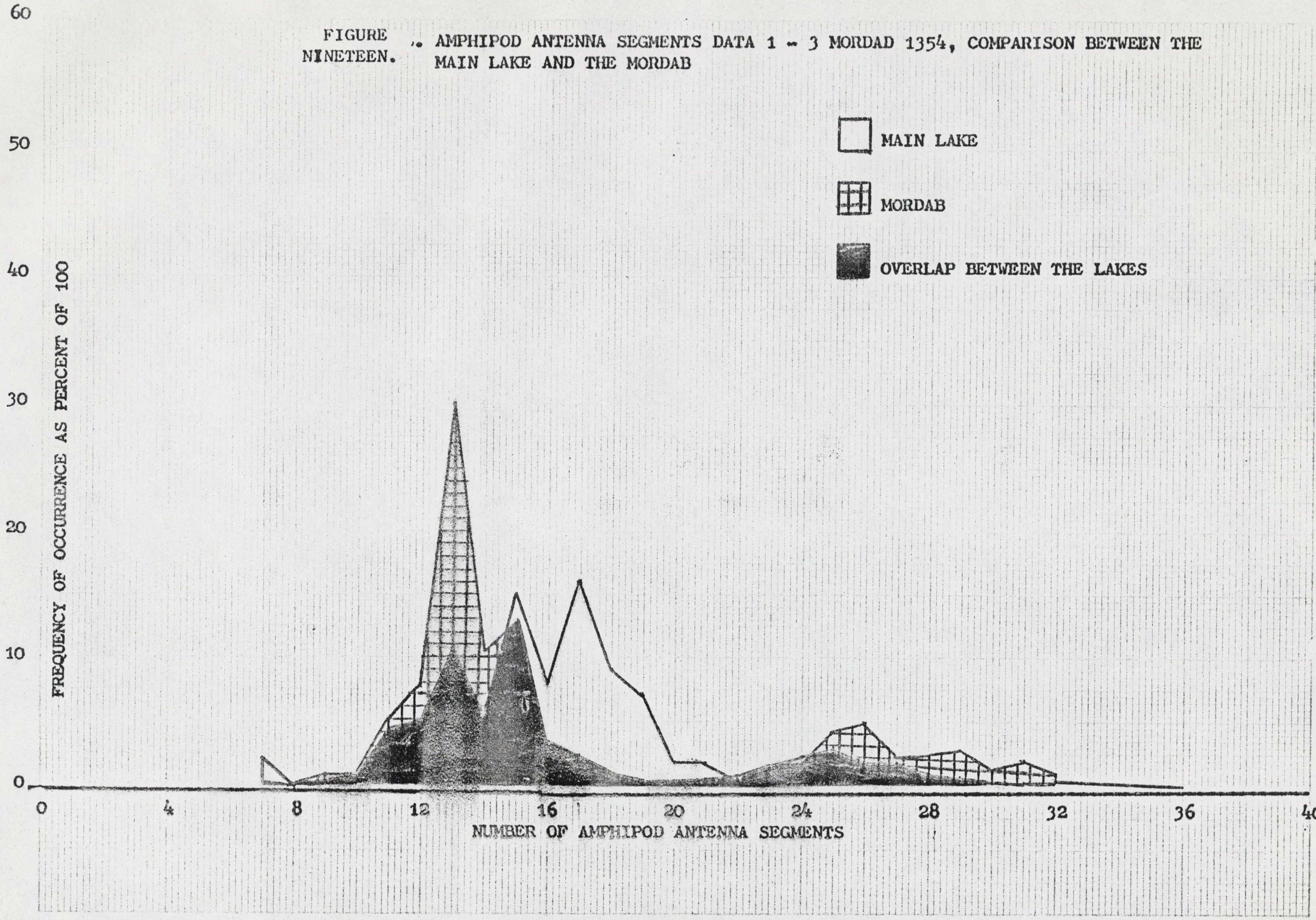


FIGURE EIGHTEEN. COMPARISON OF AMPHIPOD POPULATION STRUCTURE BETWEEN THE MAIN LAKE AND THE MORDAB, 2 TIR 1354

FIGURE NINETEEN. AMPHIPOD ANTENNA SEGMENTS DATA 1 - 3 MORDAD 1354, COMPARISON BETWEEN THE MAIN LAKE AND THE MORDAB



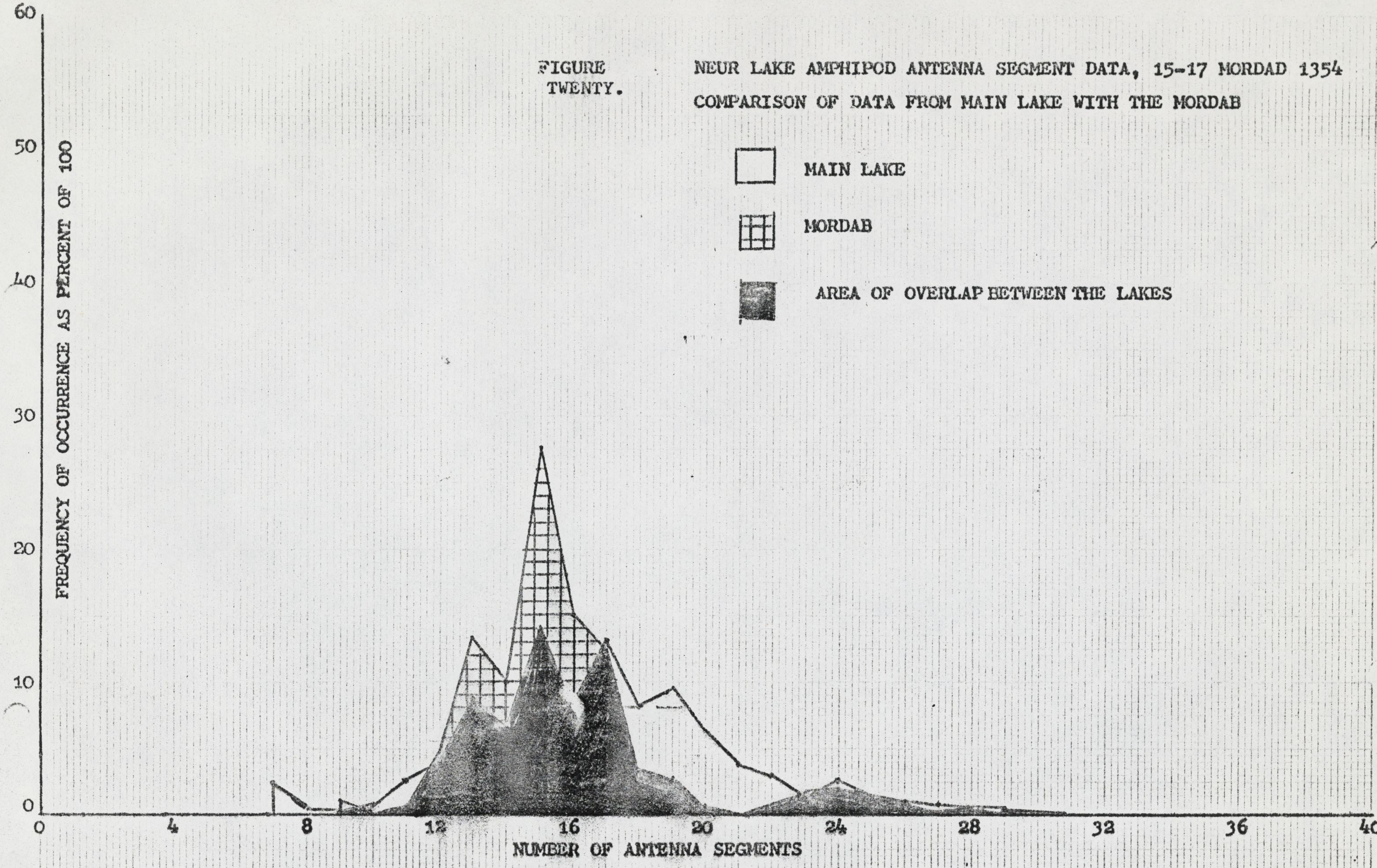
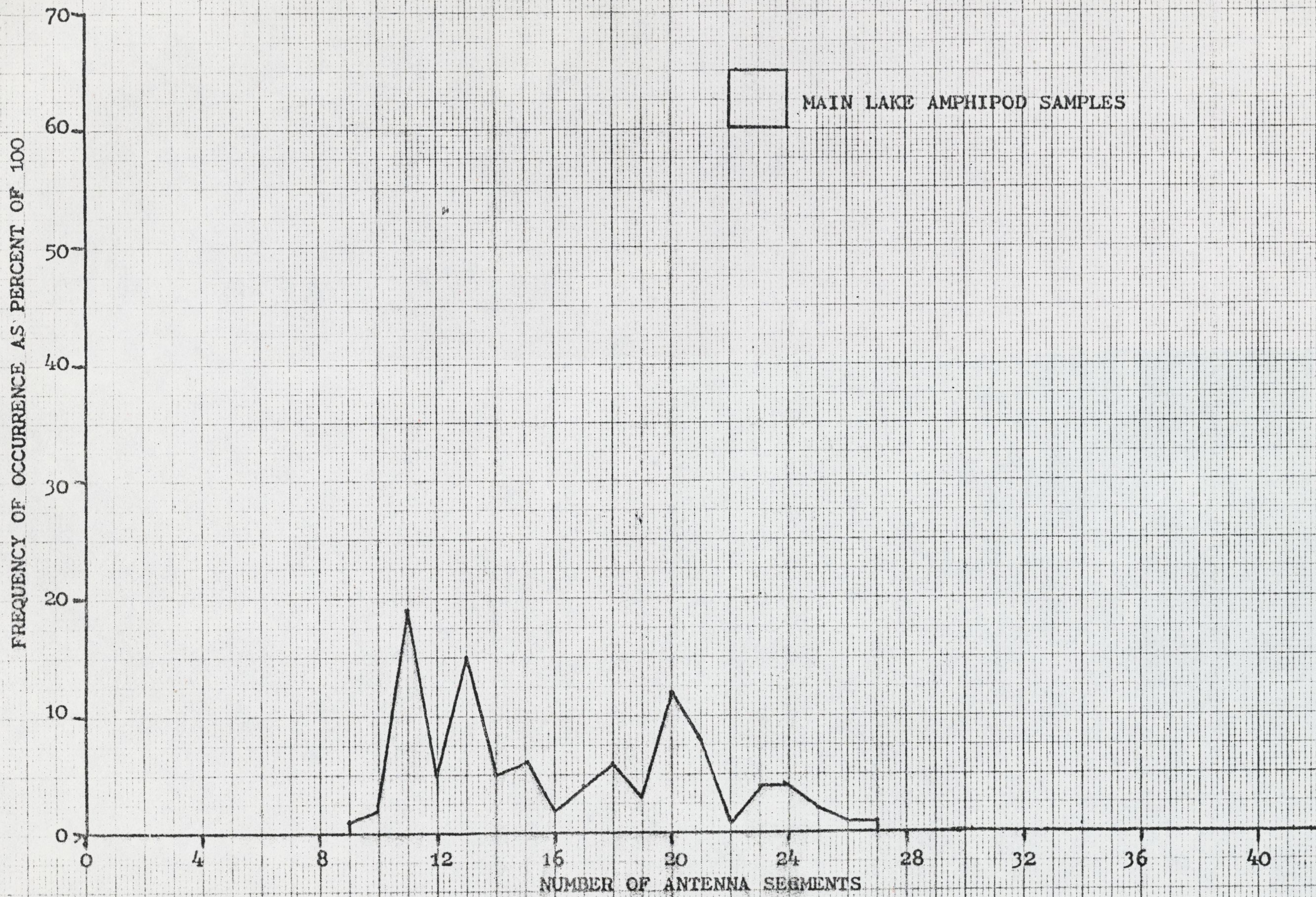


FIGURE TWENTY.
NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA, 15-17 MORDAD 1354
COMPARISON OF DATA FROM MAIN LAKE WITH THE MORDAB
MAIN LAKE
MORDAB
AREA OF OVERLAP BETWEEN THE LAKES
FREQUENCY OF OCCURRENCE AS PERCENT OF 100
60
50
40
30
20
10
0
0
4
8
12
16
20
24
28
32
36
40
NUMBER OF ANTENNA SEGMENTS

FIGURE TWENTY A. NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA, 6 AZAR 1354



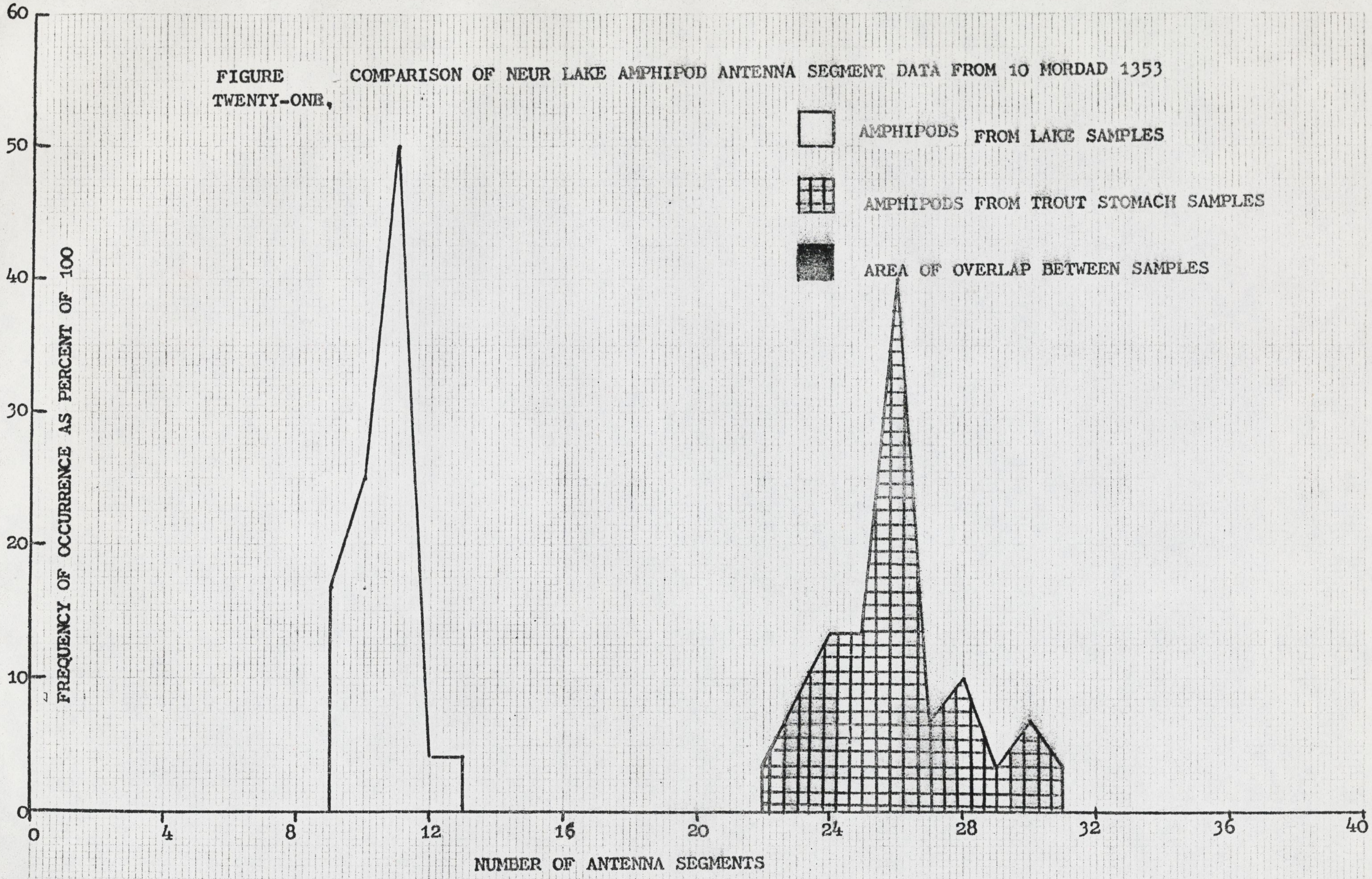


FIGURE TWENTY-ONE, COMPARISON OF NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA FROM 10 MORDAD 1353

FIGURE TWENTY-TWO. COMPARISON OF NEUR LAKE AMPHIPOD ANTENNA SEGMENT DATA FROM 25 ORDIBEHESHT 1352 AND 25 ORDIBEHESHT 1353.

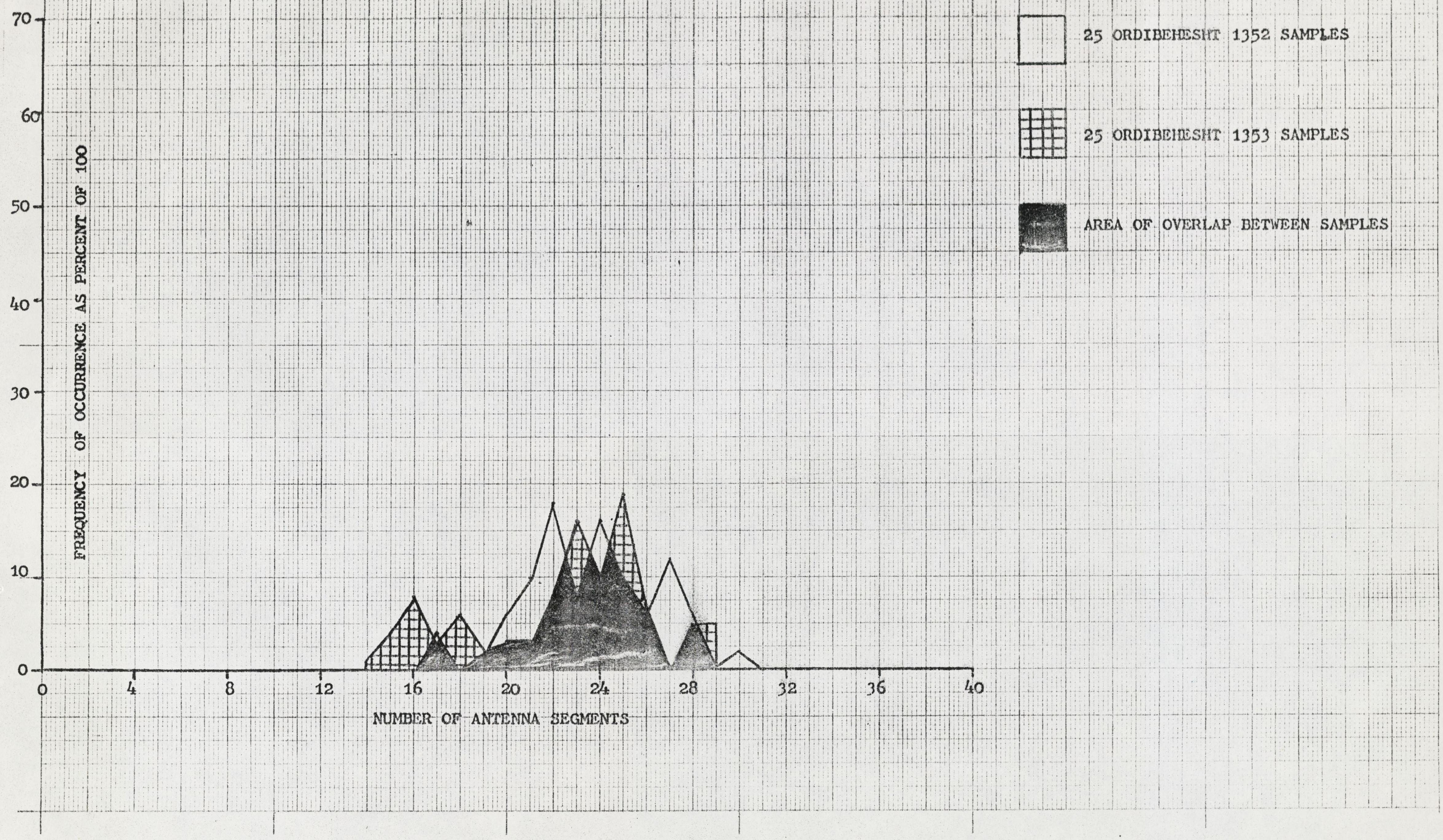
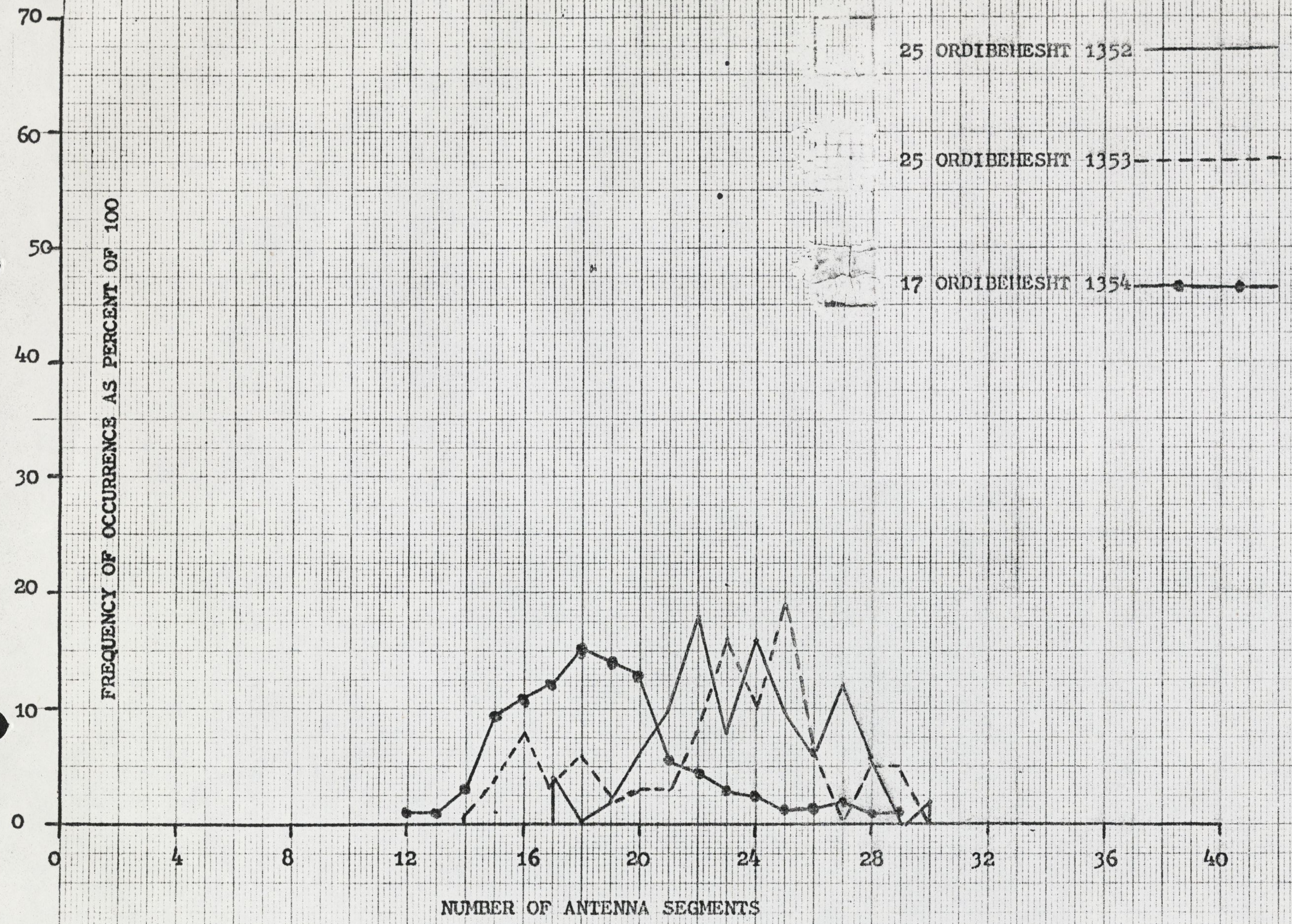
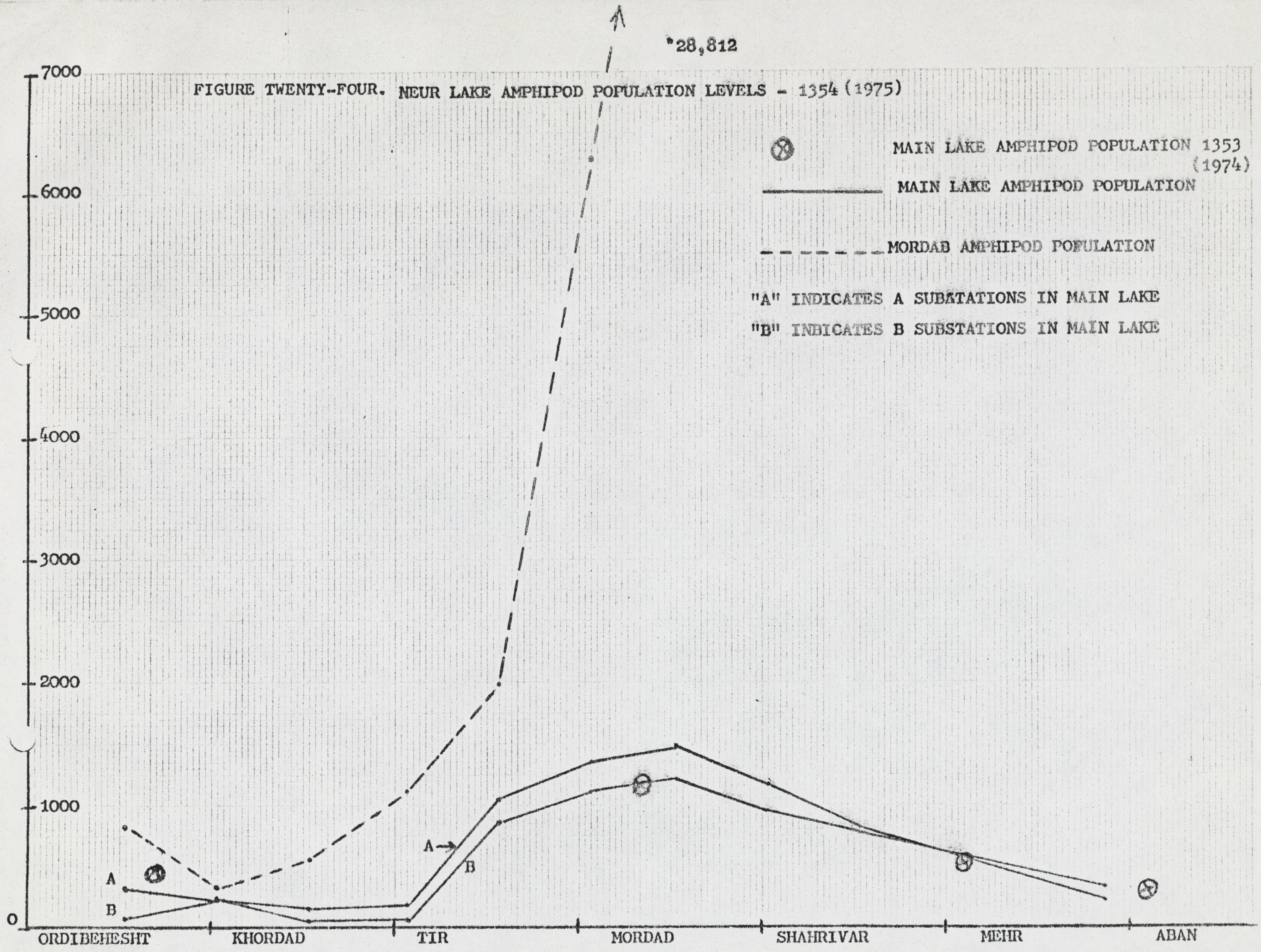


FIGURE TWENTY-THREE COMPARISON OF NEUR LAKE AMPHIPOD POPULATION STRUCTURE FROM THE MONTH OF ORDIBEHESHT 1352, 1353, & 1354




*28,812
7000
6000
5000
4000
3000
2000
1000
0
FIGURE TWENTY-FOUR. NEUR LAKE AMPHIPOD POPULATION LEVELS - 1354 (1975)
MAIN LAKE AMPHIPOD POPULATION 1353 (1974)
MAIN LAKE AMPHIPOD POPULATION
MORDAB AMPHIPOD POPULATION
"A" INDICATES A SUBATATIONS IN MAIN LAKE
"B" INDICATES B SUBSTATIONS IN MAIN LAKE
A
B
A
B
ORDIBEHESHT
KHORDAD
TIR
MORDAD
SHAHRIVAR
MEHR
ABAN