RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 2846
(D.c.5)

ICNAF Res.Doc. 72/101

ANNUAL MEETING - JUNE 1972

GRID vs RANDOM SAMPLING FOR ICHTHYOPLANKTON

by

J. A. Posgay

National Marine Fisheries Service

Woods Hole, Massachusetts USA

Introduction

The USA and the USSR conducted a joint experiment in May 1969 to compare the results, on estimates of abundance of fish eggs and larvae, of collecting samples on a traditional grid design with samples collected on a stratified random design. The vessels involved were Prognoz of AtlantNIRO, Kaliningrad, USSR and Albatross IV of the National Marine Fisheries Service, Woods Hole, Massachusetts. Originally, we intended to make two combined cruises, one in April and the other in May, but an accident to Albatross IV forced us to abort the April cruise.

Methods

Both ships used a 60 cm Bongo sampler with #505 mesh gauze on both sides. The tows were double oblique to within five meters of the bottom or 200 meters, whichever was less, at three knots. The wire was payed out at 30 meters per minute and hauled back at 10 meters per minute.

The samples were retained on each ship for later sorting at their respective laboratories. The USA randomly selected one side only to be sorted while the USSR sorted the catches of both nets. After sorting, the USSR biologists sent copies of their results to us and we sent copies of ours to them. For this analysis,

I randomly selected the catch of one net from each of the USSR tows to be compared with the USA tows.

Sampling Design

We selected the eastern and southern parts of Georges Bank between the 60 m and 200 m isobaths as the sampling area because past experience led us to expect an abundance of eggs and larvae there at that time of year. The area was divided into six strata, each 800 square miles (Figure 1), and then each stratum was further divided into 16 substrata each 50 square miles. The grid stations were located in the center of these substrata. Each of the substrata was then divided into 50 blocks and one of these was randomly selected for that set of samples. The order in which these stations were to be occupied within strata was also randomized. (Figure 2)

Both ships were to occupy their first stations in each stratum at approximately the same time of day, complete as many as they could in the next 24 hours, and then proceed to the next stratum. Prognoz occupied the grid stations while Albatross IV occupied the random stations.

Results

Prognoz completed 95 of her 96 stations while Albatross IV only completed 76 because of the extra travel time required by the random design. The number of stations occupied by each stratum is given below.

Strata	1	2	3	4	5	6
Grid Stations	16	16	15	16	16	16
Random Stations	11	14	11	14	13	13

Most of the larvae taken were either haddock (Table 1) or yellowtail flounder (Table 2). All species of larvae combined are given in Table 3. Because of some identification problems, I decided to combine all species of eggs for this analysis

(Table 4). The mean catch per 100 cubic meters for each of these categories in each stratum for both designs is shown below.

Category	Haddock larvae		Y-tail larvae		All larvae		All eggs	
Design	G	R	G	R	G	R	G	R
Str. 1	24.4	49.3	5.1	7.6	43.3	72.5	151.2	153.6
Str. 2	20.7	36.3	17.2	38.7	47.8	94.9	102.1	242.2
Str. 3	15.5	18.5	18.9	27.4	42.8	53.9	87.9	91.6
Str. 4	5.3	3.2	4.5	0.9	13.4	6.7	237.8	286.2
Str. 5	0.1	0.2	0.5	0.1	2.0	1.6	526.4	461.7
Str. 6	0.0	0.1	0.0	0.0	0.6	0.7	196.6	57.0

Analysis

The proper statistical methods to be used in analyzing plankton data are still a matter of some discussion among workers in the field. The classic parametric methods require that the frequency distribution of the catches per tow be approximately normal. A cursory examination of the data in Tables 1-4 shows that they are not normally distributed. A logarithmic transformation, the usual method of improving normality, was tried on parts of the data without success. I therefore decided to use one of the non-parametric (distribution-free) tests, the Mann-Whitney U test (Siegal, 1956).

This procedure tests the null hypothesis that all of the individual samples in two groups of independently collected samples were drawn from the same population. Tables are available which enable you to accept or reject the null hypothesis at different levels of probability by comparing the observed U value with the tabulated critical values. If the observed U is smaller than the critical value, we conclude that there is a significant difference between the two groups of data. The table below gives the observed U value for each category by stratum and the

critical values for each stratum at the 0.05 level of probability.

Category	Haddock larvae	Y-tail larvae	All larvae	All eggs	Critical value
Str. 1	61	73	69	66	47
Str. 2	101	111	93	80	64
Str. 3	80	73	74	78	44
Str. 4	87	96	106	95	64
Str. 5	-	-	98	93	59
Str. 6	-	-	77	84	59

None of the observed values are even close to the critical values and we therefore conclude that there is no significant difference between the results of collecting on a grid design and the results of collecting on a random design.

References

Siegal, S. 1956. Nonparametric Statistics, McGraw-Hill Book Co., New York.

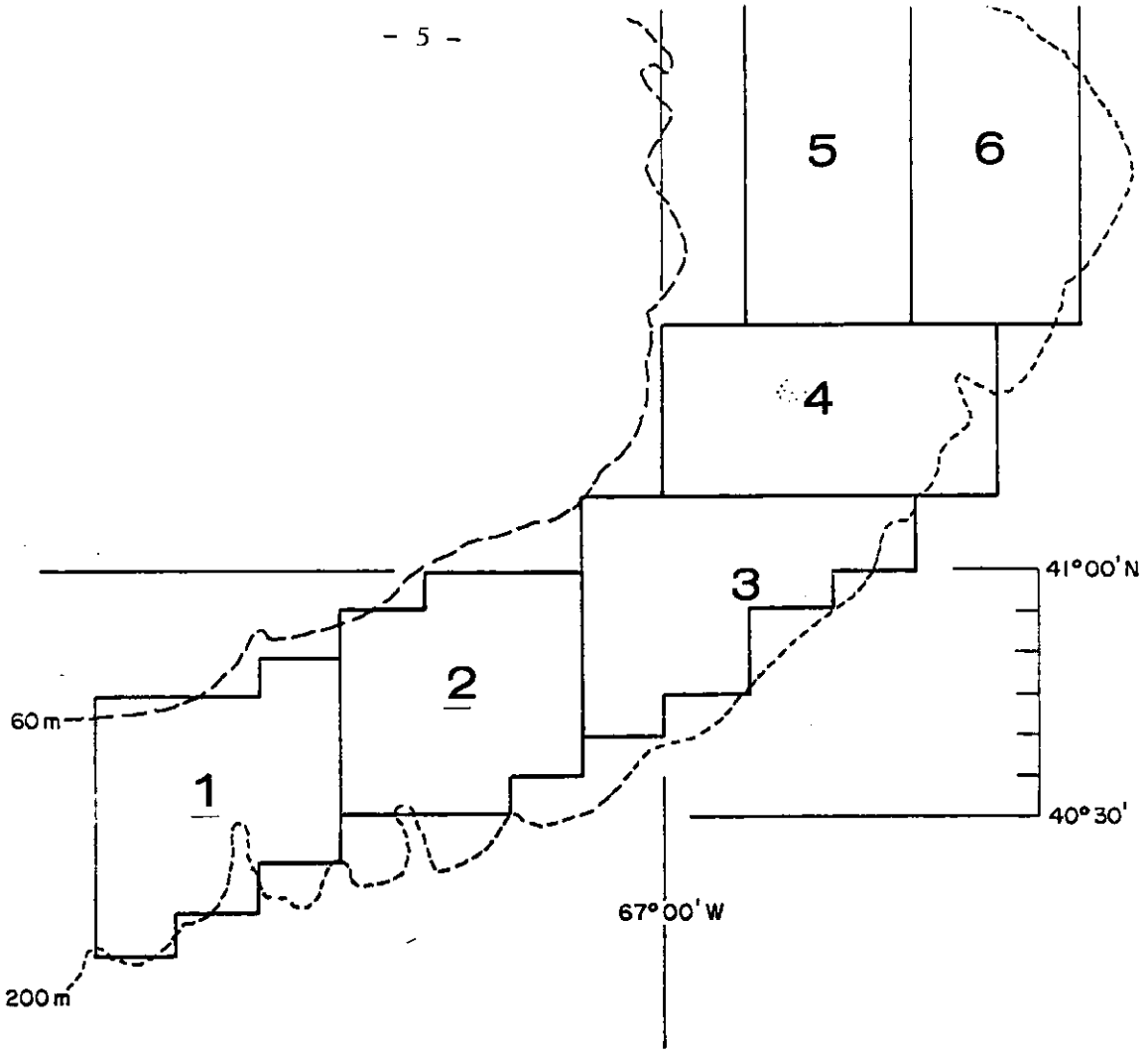

Figure 1 -- Sampling strata on Georges Bank for the grid vs. random sampling experiment.

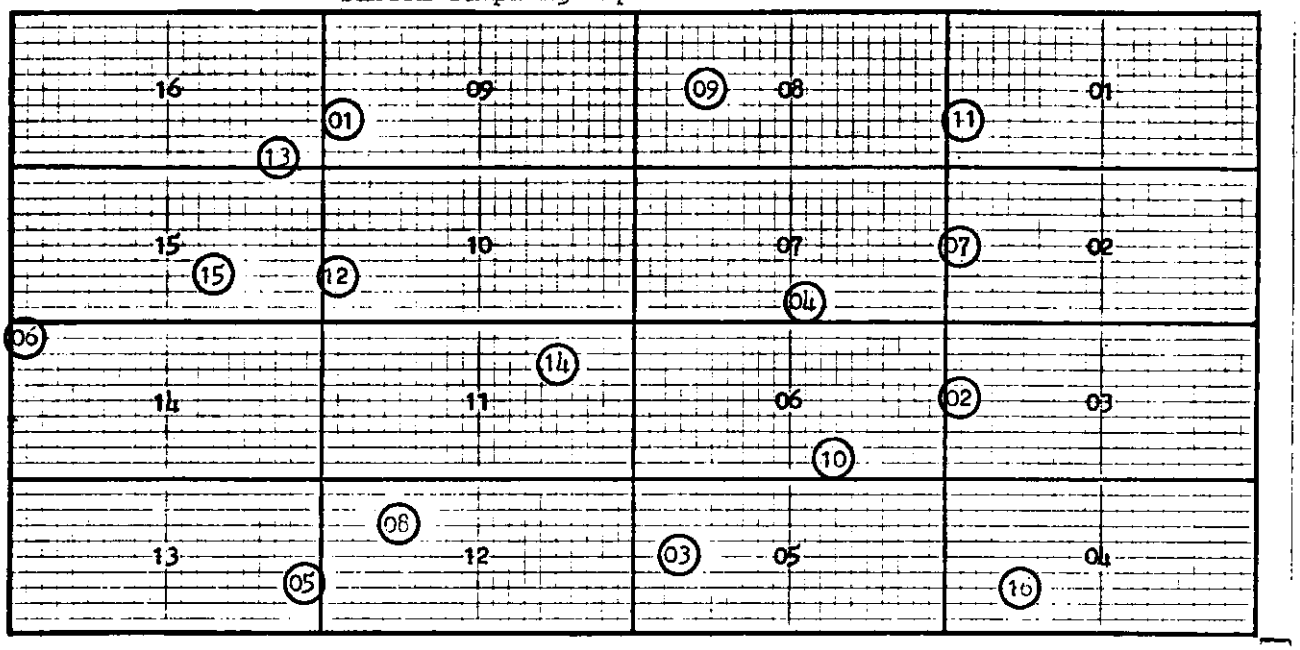

Figure 2 -- Sampling design for Stratum 4. The circled numbers show the random stations and the order in which they were occupied. The grid stations were also occupied in order.

Table 1. -- Catches of haddock larvae in numbers per 100 cubic meters on the grid design and on the random design.

TOW	GRID	RANDOM	TOW	GRID	RANDOM	TOW	GRID	RANDOM
101	131.2	4.5	301	31.2	67.1	501	0.8	0.0
102	63.8	81.0	302	37.9	7.3	502	0.0	0.3
103	16.1	44.2	303	63.9	0.3	503	0.0	0.3
104	7.5	74.5	304	6.8	55.8	504	0.0	0.0
105	0.5	0.0	305	0.7	0.0	505	0.0	0.0
106	1.1	5.1	306	0.0	0.0	506	0.0	0.0
107	0.0	34.3	307	3.0	45.4	507	0.0	0.8
108	2.3	222.0	308	18.2	1.4	508	0.0	0.0
109	6.2	20.7	309	10.4	1.0	509	0.0	0.0
110	46.8	45.6	310	24.5	17.1	510	0.0	0.0
111	37.0	10.1	311	16.0	7.7	511	0.0	0.0
112	34.2	-	312	18.8	-	512	0.0	1.2
113	19.7	-	313	1.4	-	513	0.0	0.0
114	17.5	-	314	0.0	-	514	0.0	-
115	4.8	-	315	0.0	-	515	0.0	-
116	1.5	-	316	-	-	516	0.5	-
201	1.1	96.8	401	0.0	0.0	601	0.0	0.0
202	32.6	20.8	402	0.0	0.0	602	0.0	0.2
203	24.0	124.1	403	0.0	0.0	603	0.0	0.0
204	44.3	74.8	404	0.2	0.0	604	0.0	0.0
205	20.6	2.8	405	0.0	27.0	605	0.0	0.0
206	25.5	4.7	406	0.0	3.1	606	0.0	0.3
207	43.6	2.6	407	0.0	0.0	607	0.0	0.0
208	26.4	0.0	408	5.6	3.1	608	0.0	0.0
209	18.8	8.6	409	1.0	1.6	609	0.0	0.0
210	5.6	34.5	410	9.6	0.0	610	0.0	0.7
211	3.3	1.9	411	16.8	0.0	611	0.0	0.0
212	0.0	0.0	412	2.5	4.7	612	0.0	0.0
213	0.0	38.8	413	39.0	0.9	613	0.0	0.0
214	0.9	98.5	414	4.0	3.7	614	0.0	-
215	53.1	-	415	4.2	-	615	0.0	-
216	31.3	-	416	1.4	-	616	0.0	-

Table 2. -- Catches of yellowtail flounder larvae in numbers per 100 cubic meters on the grid design and on the random design.

TOW	GRID	RANDOM	TOW	GRID	RANDOM	TOW	GRID	RANDOM
101	29.5	0.0	301	34.9	148.3	501	3.1	0.0
102	7.0	24.7	302	59.1	4.3	502	0.0	0.6
103	4.2	9.2	303	90.1	2.9	503	0.0	0.0
104	3.6	5.3	304	6.4	89.9	504	0.0	0.0
105	0.0	0.0	305	0.3	0.0	505	0.0	0.0
106	0.0	1.6	306	0.0	0.0	506	0.0	0.0
107	0.0	1.6	307	0.7	38.6	507	0.0	0.0
108	0.0	28.0	308	26.0	0.4	508	0.0	0.0
109	1.9	2.6	309	26.6	2.3	509	0.0	0.0
110	14.1	6.0	310	36.3	11.1	510	0.0	0.0
111	6.9	4.8	311	2.5	4.1	511	0.0	0.0
112	1.8	-	312	0.0	-	512	0.0	0.4
113	1.5	-	313	0.3	-	513	0.0	0.0
114	5.2	-	314	0.0	-	514	0.0	-
115	5.3	-	315	0.0	-	515	0.0	-
116	0.0	-	316	-	-	516	0.0	-
201	0.0	83.2	401	0.0	0.0	601	0.0	0.0
202	10.3	18.5	402	0.0	0.0	602	0.0	0.0
203	22.6	108.1	403	0.0	0.0	603	0.0	0.0
204	62.8	61.5	404	0.2	0.0	604	0.0	0.0
205	11.1	2.8	405	0.0	3.3	605	0.0	0.0
206	8.5	20.7	406	0.0	3.6	606	0.0	0.0
207	25.9	2.9	407	0.0	0.0	607	0.0	0.0
208	38.6	0.3	408	0.0	0.0	608	0.0	0.0
209	16.1	4.0	409	0.3	0.0	609	0.0	0.0
210	1.6	48.7	410	1.2	0.0	610	0.0	0.0
211	2.4	0.3	411	3.3	0.0	611	0.0	0.0
212	0.0	0.0	412	0.0	3.0	612	0.0	0.0
213	0.0	94.8	413	30.3	2.8	613	0.0	0.0
214	15.4	116.6	414	3.2	0.4	614	0.0	-
215	28.6	-	415	3.0	-	615	0.0	-
216	32.1	-	416	30.2	-	616	0.0	-

Table 3. -- Catches of fish larvae, all species combined, in numbers per 100 cubic meters on the grid design and on the random design.

TOW	GRID	RANDOM	TOW	GRID	RANDOM	TOW	GRID	RANDOM
101	197.7	3.4	301	80.3	266.0	501	10.4	6.3
102	101.2	129.9	302	106.7	14.9	502	3.4	1.5
103	32.5	70.2	303	189.5	4.0	503	2.4	3.1
104	14.6	88.8	304	15.7	151.3	504	5.1	0.0
105	1.2	0.3	305	2.2	2.0	505	0.5	1.0
106	2.0	11.0	306	3.7	0.0	506	0.5	0.4
107	0.9	55.5	307	5.9	96.9	507	0.0	1.2
108	3.9	313.8	308	45.4	2.5	508	0.0	0.0
109	29.2	39.9	309	47.1	4.1	509	0.0	0.0
110	83.5	63.7	310	72.5	34.7	510	0.0	0.0
111	63.0	20.6	311	41.5	16.4	511	0.8	0.0
112	76.7	-	312	21.7	-	512	0.5	6.6
113	29.3	-	313	3.6	-	513	0.6	0.8
114	38.2	-	314	0.9	-	514	0.0	-
115	16.0	-	315	6.0	-	515	1.4	-
116	2.6	-	316	-	-	516	6.9	-
201	1.4	199.0	401	0.6	2.3	601	1.4	1.1
202	56.7	50.0	402	0.0	0.3	602	2.0	1.0
203	57.7	293.1	403	0.2	0.9	603	1.2	0.2
204	130.2	161.2	404	0.5	0.9	604	3.3	0.5
205	58.8	10.6	405	0.3	44.1	605	0.3	0.7
206	51.0	28.3	406	0.0	9.2	606	1.0	1.8
207	79.4	7.8	407	0.0	0.3	607	0.0	0.6
208	75.3	0.6	408	6.8	4.7	608	0.0	0.0
209	41.3	19.1	409	5.5	2.9	609	0.6	0.0
210	10.0	137.2	410	15.3	0.3	610	0.0	0.7
211	8.4	3.5	411	27.1	0.3	611	0.0	0.3
212	0.3	9.8	412	8.2	13.3	612	0.0	0.3
213	0.3	154.4	413	85.2	6.6	613	0.0	1.9
214	21.6	253.6	414	12.5	7.4	614	0.0	-
215	96.8	-	415	14.7	-	615	0.0	-
216	75.4	-	416	37.0	-	616	0.0	-

Table 4. -- Catches of fish eggs, all species combined, in numbers per 100 cubic meters on the grid design and on the random design.

TOW	GRID	RANDOM	TOW	GRID	RANDOM	TOW	GRID	RANDOM
101	254.3	11.2	301	291,8	199.0	501	938.3	855.1
102	146.8	173.9	302	116.0	13.5	502	1173.9	299.6
103	147.1	150.7	303	76.3	29.5	503	1330.6	442.1
104	149.3	137.4	304	33.0	116.9	504	578.0	206.9
105	53.1	83.9	305	26.3	16.8	505	636.6	142.0
106	63.6	148.4	306	36.3	33.6	506	659.1	575.2
107	5.0	396.4	307	17.6	85.6	507	313.1	1146.7
108	108.6	210.0	308	82.7	54.4	508	44.8	322.3
109	90.8	156.6	309	70.6	278.5	509	1.1	304.3
110	66.6	152.3	310	107.4	43.9	510	0.7	36.6
111	216.2	68.6	311	287.0	135.5	511	13.2	23.6
112	798.1	-	312	106.0	-	512	502.1	1108.0
113	217.9	-	313	55.2	-	513	282.0	539.8
114	83.3	-	314	9.1	-	514	667.5	-
115	27.1	-	315	3.9	-	515	859.0	-
116	7.0	-	316	-	-	516	422.6	-
201	5.2	241.9	401	31.4	1289.8	601	64.0	9.5
202	55.8	114.9	402	9.9	15.1	602	296.2	0.6
203	90.2	186.6	403	1.0	17.5	603	510.6	5.4
204	290.4	94.9	404	0.2	13.1	604	907.2	225.5
205	320.7	98.9	405	1.4	195.4	605	791.1	343.5
206	216.0	74.3	406	6.5	764.5	606	182.0	11.4
207	164.1	64.5	407	15.1	91.6	607	8.1	15.4
208	52.5	18.8	408	150.6	125.2	608	1.3	39.2
209	101.5	508.1	409	885,5	357.8	609	14.2	31.5
210	58.6	1675.4	410	326.8	15.8	610	14.2	11.1
211	63.1	24.7	411	205.2	47.7	611	8.0	12.3
212	16.1	24.5	412	97.9	309.8	612	23.7	26.2
213	9.2	102.6	413	346.0	657.4	613	216.2	9.6
214	14.8	160.4	414	437.7	105.7	614	104.9	-
215	96.5	-	415	674.1	-	615	2.3	-
216	79.4	-	416	615.6	-	616	1.8	-