

Grid versus Random Sampling for Ichthyoplankton

J. A. Posgay
 National Marine Fisheries Service, Northeast Fisheries Center
 Woods Hole, Massachusetts 02543, USA

Abstract

The results of a two-ship ichthyoplankton survey on Georges Bank, one ship sampling systematically on a grid design and the other on a stratified random design, are used to demonstrate that there is no statistically significant difference in the catches of fish eggs and larvae within strata.

Introduction

In May 1969, USA and USSR biologists conducted a joint experiment on the eastern and southern parts of Georges Bank to compare the effects on abundance estimates of fish eggs and larvae of sampling on a systematic grid design with sampling on a stratified random design. The results of that experiment are presented and analyzed in this paper.

Materials and Methods

The eastern and southern parts of Georges Bank between the 60 m and 200 m isobaths were selected as the sampling area because an abundance of fish eggs and larvae was expected from past experience to be encountered there at the time of the survey. The area was divided into six strata, each 2,100 km² (Fig. 1). Each stratum was further subdivided into 16 substrata,

each 130 km². The grid stations were located at the center of these substrata. Each of the substrata was then divided equally into 50 smaller units and one of these was randomly selected as a sampling location. The order in which these random stations were occupied within strata was also randomized. Figure 2 indicates, for example, the location of grid and random sampling stations in Stratum 2.

The research vessels involved were *Albatross IV* of the National Marine Fisheries Service, Woods Hole, USA, and *Prognoz* of the Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), Kaliningrad, USSR. Both ships occupied their first stations in each stratum at approximately the same time of day. They completed as many stations as possible in the next 24 hours and then proceeded to the

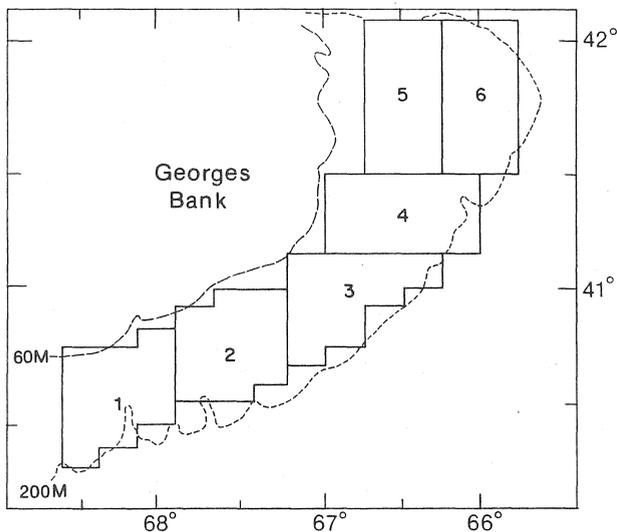


Fig. 1. Location of the strata on Georges Bank where the ichthyoplankton sampling experiment was conducted in May 1969.

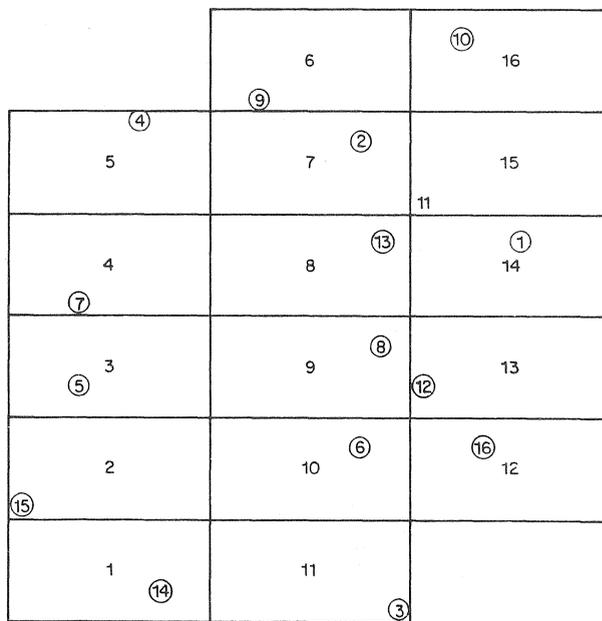


Fig. 2. Sampling locations within Strata 2 of the Georges Bank ichthyoplankton sampling experiment in May 1969.

next stratum. *Albatross IV* occupied the random stations and *Prognoz* the grid stations.

Each vessel used the 61-cm Bongo sampler (Posgay and Marak, 1980) equipped with calibrated flowmeters and 0.505-mm mesh nylon nets. The tows were double oblique to within 5 m of the bottom or 200 m. At a towing speed of 3 knots, the sampler attached to a wire cable was set at 30 m per minute and hauled back at 10 m per minute.

The ichthyoplankton samples were retained on each ship for later sorting at the respective laboratories. USA biologists randomly selected samples from one net only of the sampler to be sorted whereas USSR biologists sorted the catches of both nets. After sorting, the results were exchanged between laboratories. For comparison with the USA stratified random catches, the catch of one net was randomly selected from each of the USSR grid stations. Flowmeter readings were used to convert all catches to numbers per 100 m³ of water filtered.

Results

Prognoz completed 95 of the 96 grid stations constituting the experiment, but *Albatross IV* completed only 76 stations because of the additional travel time required by the random design. The numbers of stations occupied in the various strata were as follows:

| Type of station | Number of stations by stratum | | | | | |
|-----------------|-------------------------------|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Grid | 16 | 16 | 15 | 16 | 16 | 16 |
| Random | 11 | 14 | 11 | 14 | 13 | 13 |

Most of the fish larvae taken were haddock and yellowtail flounder, and the results for these species were kept separate for the analysis. However, due to the difficulty of identifying cod and haddock eggs in the early stages of development, the numbers of fish eggs of all species were combined for each sample analyzed. The numbers per 100 m³ for all tows in

TABLE 1. Numbers of haddock larvae, yellowtail flounder larvae, all fish larvae, and all fish eggs caught per 100 m³ of water filtered in each tow at the grid and random stations in Stratum 2 on Georges Bank in May 1969.

| Tow No. | Haddock | | Yellowtail | | All larvae | | Fish eggs | |
|---------|---------|-------|------------|-------|------------|-------|-----------|--------|
| | Grid | Rand. | Grid | Rand. | Grid | Rand. | Grid | Rand. |
| 1 | 1.1 | 96.8 | 0.0 | 83.2 | 1.4 | 199.0 | 5.2 | 241.9 |
| 2 | 32.6 | 20.8 | 10.3 | 18.5 | 56.7 | 50.0 | 55.8 | 114.9 |
| 3 | 24.0 | 124.1 | 22.6 | 108.1 | 57.7 | 293.1 | 90.2 | 186.6 |
| 4 | 44.3 | 74.8 | 62.8 | 61.5 | 130.2 | 161.2 | 290.4 | 94.9 |
| 5 | 20.6 | 2.8 | 11.1 | 2.8 | 58.8 | 10.6 | 320.7 | 98.9 |
| 6 | 25.5 | 4.7 | 8.5 | 20.7 | 51.0 | 28.3 | 216.0 | 74.3 |
| 7 | 43.6 | 2.6 | 25.9 | 2.9 | 79.4 | 7.8 | 164.1 | 64.5 |
| 8 | 26.4 | 0.0 | 38.6 | 0.3 | 75.3 | 0.6 | 52.5 | 18.8 |
| 9 | 18.8 | 8.6 | 16.1 | 4.0 | 41.3 | 19.1 | 101.5 | 508.1 |
| 10 | 5.6 | 34.5 | 1.6 | 48.7 | 10.0 | 137.2 | 58.6 | 1675.4 |
| 11 | 3.3 | 1.9 | 2.4 | 0.3 | 8.4 | 3.5 | 63.1 | 24.7 |
| 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 9.8 | 16.1 | 24.5 |
| 13 | 0.0 | 38.8 | 0.0 | 94.8 | 0.3 | 154.4 | 9.2 | 102.6 |
| 14 | 0.9 | 98.5 | 15.4 | 116.6 | 21.6 | 253.6 | 14.8 | 160.4 |
| 15 | 53.1 | — | 28.6 | — | 96.8 | — | 96.5 | — |
| 16 | 31.3 | — | 32.1 | — | 75.4 | — | 79.4 | — |

TABLE 2. Mean numbers of fish larvae and eggs caught per 100 m³ of water filtered at the grid and random stations by stratum on Georges Bank in May 1969.

| Stratum No. | Haddock | | Yellowtail | | All larvae | | Fish eggs | |
|-------------|---------|-------|------------|-------|------------|-------|-----------|-------|
| | Grid | Rand. | Grid | Rand. | Grid | Rand. | Grid | Rand. |
| 1 | 24.4 | 49.3 | 5.1 | 7.6 | 43.3 | 72.5 | 151.2 | 153.6 |
| 2 | 20.7 | 36.3 | 17.2 | 38.7 | 47.8 | 94.9 | 102.1 | 242.2 |
| 3 | 15.5 | 18.5 | 18.9 | 27.4 | 42.8 | 53.9 | 87.9 | 91.6 |
| 4 | 5.3 | 3.2 | 4.5 | 0.9 | 13.4 | 6.7 | 237.8 | 286.2 |
| 5 | 0.1 | 0.2 | 0.5 | 0.1 | 2.0 | 1.6 | 526.4 | 461.7 |
| 6 | 0.0 | 0.1 | 0.0 | 0.0 | 0.6 | 0.7 | 196.6 | 57.0 |

Stratum 2 are presented as an example in Table 1. The complete data for all tows in all strata were reported by Posgay (MS 1972) and will not be repeated here. The mean catches per 100 m³ for three categories of fish larvae and for all fish eggs in each stratum are given in Table 2.

A distribution-free test, the Kruskal-Wallis One-way Analysis of Variance by Ranks, was used to test the

TABLE 3. Results of the Kruskal-Wallis tests: probabilities that the observed differences in catches for the grid and random sampling designs occurred by chance.

| Stratum | Haddock larvae | Yellowtail larvae | All fish larvae | All fish eggs |
|---------|----------------|-------------------|-----------------|---------------|
| 1 | 0.19 | 0.48 | 0.36 | 0.28 |
| 2 | 0.66 | 0.31 | 0.45 | 0.18 |
| 3 | 0.92 | 0.64 | 0.67 | 0.82 |
| 4 | 0.47 | 0.51 | 0.80 | 0.91 |
| 5 | * | * | 0.79 | 0.64 |
| 6 | * | * | 0.24 | 0.40 |

* Too few positive tows to give meaningful results.

null hypothesis that all of the individual samples in the two groups of independently-collected samples were drawn from the same population (Siegel, 1956). The results of the tests, expressed as the probability that the observed differences occurred by chance, are given in Table 3. None of the 20 tests gave a probability less than 0.05, and only two tests gave probabilities less than 0.20, whereas 10 were greater than 0.50. Therefore, it is concluded that there is no significant difference between estimates of abundance of ichthyoplankton collected on the basis of a grid design and those collected by using a stratified random design.

References

- POSGAY, J. A. MS 1972. Grid vs random sampling for ichthyoplankton. *ICNAF Res. Doc.*, No. 101, Serial No. 2846.
- POSGAY, J. A., and R. R. MARAK. 1980. The MARMAP Bongo Zooplankton Samplers. *J. Northw. Atl. Fish. Sci.*, 1: 91-99.
- SIEGEL, S. 1956. *Nonparametric statistics for the behavioral sciences.* McGraw-Hill Book Co., New York, 312 p.

