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The Canada-USSR Juvenile Silver Hake (*Merluccius bilinearis*) Surveys on the Scotian Shelf: Abundance Indices, Distribution, and Comparison with Independent Estimates of Juvenile Abundance, 1978-83

by

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INTRODUCTION

Canada and the U.S.S.R. have conducted joint midwater trawl surveys of juvenile (0-group) silver hake on the Scotian Shelf from 1978 to the present. The purpose of the surveys was to provide 0-group abundance estimates using gear and methods appropriate for pelagic juveniles. Standard groundfish surveys in the area are conducted with ground trawls and have not provided adequate data on juvenile silver hake abundance due to diel variations in the availability of fish to the survey gear (Koeller 1981). Ground trawl surveys also have a limited capability for predicting recruitment due to the short period of time between recruitment to the survey and to the fishery. Juvenile surveys for 0-group fish however, could be useful for projections of recruitment to the fishery and in developing Sequential Population Analyses (SPA).

This paper presents data on the distribution and abundance of 0-group silver hake from 1978-1983. Abundance indices are also compared with indices derived from another source.

METHODS

The surveys from which data are presented are listed in Table 1. Juvenile silver hake surveys began in 1978 using the 13.6 m Soviet Juvenile Trawl, fished as near to the bottom as possible for 30 minutes. Operations were conducted 24 hours per day. Vertical distribution experiments conducted in 1980 indicated that 0-group silver hake were

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unavailable to the trawl by day but became available throughout the water column by night (Koeller 1981). Consequently the tow type was changed for the 1981 survey to a 3-step oblique tow of 30 minutes duration (10 minutes each near bottom, midwater and near surface), with operations conducted only during hours of darkness. The trawl type was also changed for the 1981 survey to the International Young Gadoid Pelagic Trawl (IYGPT). General descriptions of the Soviet Juvenile Trawl and the IYGPT trawls are given in Table 2. Both trawls were designed for 0-group surveys and have roughly the same dimensions. A headline transducer was used to determine trawl depth during all years except 1978 when the near bottom tow was approximated from warp out.

All surveys were conducted using Soviet vessels and fishing gear except during 1981 when the Lady Hammond completed the western part of the survey area using a Canadian built IYGPT with different rigging and doors. A comparative fishing experiment was conducted during this survey to determine relative fishing power of the two vessels and gears. The vessels fished side-by-side during all sets using the three step tow type. Results from 15 comparative night sets indicated a ratio of 0.667 for Eklyptika:Lady Hammond 0-group silver hake catches. Consequently, all Lady Hammond catches used in the calculation of the abundance index for 1981 were multiplied by that factor.

All surveys were conducted in the fall after most silver hake spawning had occurred (O'Boyle et. al. 1984). However, relatively large numbers of small juveniles, some still with yolk sac present, were observed during the 1978-80 surveys, which were initiated in early October. To ensure that all 0-group fish were metamorphosed and available to the gear the start of subsequent cruises was delayed until mid-October. Isaac-Kidd midwater trawl tows during the 1981 survey provided corroboration that larvae were no longer present in the water column during the mid-October period.

A stratified random design following the Canadian groundfish survey stratification scheme (Figure 1) was used for all surveys. In 1979, the same stations selected for the 1978 survey were used. New stations were selected for each subsequent survey.

The 0-group abundance index was calculated as the stratified mean catch per tow for strata 60-78, using the standard formula (Smith and Somerton 1981). These strata contained the main 0-group concentrations during years when wider coverage was achieved, and they received almost complete coverage during all years.

During the surveys all silver hake were separated from the catch and counted. The total catch of 0-group fish or a representative subsample was measured to the nearest centimeter in 1978-79 and to the millimeter above for all subsequent cruises. Older fish were measured to the nearest centimeter at all times. 0-group fish were easily identifiable from older fish because of large size differences between groups, i.e. upper range of 0-group and lower range of 1-group were separated by several centimeters. The maximum length of an 0-group fish was taken to be 80, 80, 60, 100, 60 and 100 mm for the 1978 to 1983 data, respectively. These lengths were determined by examination of length-frequency distributions in each year.

RESULTS AND DISCUSSION

Distribution of 0-group silver hake

The distribution of 0-group silver hake catches made during the juvenile surveys conducted from 1978 to 1983 are shown on Figure 2. As illustrated by the distribution of catches in 1978 and 1979, the centre of 0-group silver hake concentration generally falls within strata 60-66 and 70-78. Sampling was largely restricted to these strata during subsequent years. In general, silver hake juveniles were evenly distributed throughout the surveyed area in years of high abundance (1981, 1983). Our results contrast with those of Noskov et al. (1979) who found that the centre of the distribution of silver hake larvae in 1978 was more to the east, on Emerald and Sable Island Bank. Subsequent captures of juvenile silver hake further to the west may represent the passive displacement of larvae by the Nova Scotia current.

0-group silver hake abundance indices

The stratified and unstratified (simple mean) abundance indices for 0-group silver hake for all surveys are given in Table 3. Indices for 1978-80 are suspect since surveys conducted during those years used a near

bottom tow with operations conducted 24 hours per day. Results from vertical distribution experiments (Koeller 1981) indicated that with this method, silver hake are caught mainly around dawn and dusk when the fish migrate past those depths where the trawl is fished. Silver hake juveniles appear to reside on the bottom by day where they are largely unavailable to midwater gear. The absence of a headline transducer during 1978 may also have influenced survey results since the actual fishing depth was unknown and the trawl may have contacted bottom on occasion. This is corroborated by several large catches made by daylight during this survey (Koeller 1981). The use of the same set of random station in 1978 and 1979 and the earlier survey dates in 1978-80 may also have resulted in biased indices.

Preliminary results from experiments conducted since 1980 indicated that the difference in availability between day and night is less dramatic during years of high abundance, possibly because fish are distributed further off bottom during these years due to competition for space. Therefore, it is possible that the changes in the index shown from 1978 to 1980 are roughly related to actual abundance changes and they are included for this reason, as well as for comparative purposes.

The appropriateness of the change in methodology to the three-step oblique, night only tow type in 1981 is reflected in the substantial increase in precision in that year and the continuing high precision in subsequent years. In fact the 1983 and 1981 surveys had the highest and second highest level of precision despite having the highest and third highest abundance, respectively, of the six year series.

RELATIONSHIP WITH ADULT SURVEYS

Comparison of 1-group abundance from the July groundtrawl research surveys with the 0-group index from the juvenile surveys (Table 4 and Figure 3) indicates relatively good agreement between these two recruitment indices. The exception is the 1982 index. Comparisons of abundance indices derived from the March and October groundtrawl surveys and sequential population analysis should be made to fully evaluate the usefullness of the 0-group survey for assessment purposes.

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Table 1. Juvenile silver hake cruises for which distribution and 0-group abundance are presented.

Year	Dates	Cruise #	Strata Covered	# of Sets (Strata 60-78)	Trawl	Tow Type
1978	27 Sept.-16 Oct.	VY03	47-81	55	Soviet 13.6	Near bottom, 24 hr.
1979	2-29 Oct.	VN04	47-80	55	Soviet 13.6	Near bottom, 24 hr.
1980	26 Sept.-3 Nov.	HO3	60-78	100	Soviet 13.6	Near bottom, 24 hr.
1981	26 Oct.-13 Nov.	HO66	70-81	77	IYGPT	3 step, night only
	15 Oct.-12 Nov.	EK03	52-78		IYGPT	3 step, night only
1982	15 Oct.-15 Nov.	EK05	60-78	61	IYGPT	3 step, night only
1983	28 Oct.-23 Nov.	LK02	60-78	64	IYGPT	3 step, night only

Table 2. Specifications for Soviet 13.6 m juvenile trawl and IYGPT trawl fished on Soviet vessels during juvenile silver hake surveys.

	13.6 m	IGYPT
Overall length	33 m	38 m
Footrope length (wing to wing)	24 m	28 m
Headrope length (wing to wing)	24 m	28 m
Vertical opening	3-6 m	approx. 7 m
Door type	Oval biplane	Oval biplane
Door area	3.5 m^2	3.5 m^2
Mesh size in wings	40, 80 mm	50 mm
Mesh size in body from bellies to lengthening piece	40, 30, 20, 16 mm	50, 40, 20 mm
Codend mesh size	60 mm	60 mm
Liners	20, 5 mm	20, 5 mm
Length of codend	13 m	13 m

Table 3. O-group silver hake abundance indices, strata 60-78.

		Unstratified (simple mean)			Stratified		
Year	n	$\bar{x}$	s.d.	c.v(%)	$\bar{x}$	s.e.	s.e(%) $\bar{x}$
1978	55	166.11	443.64	267	235.57	98.37	42
1979	55	180.67	849.03	470	56.42	20.98	37
1980	100	26.83	57.55	214	26.03	5.36	21
1981	77	610.71	614.27	101	578.34	70.63	12
1982	61	7.26	9.96	137	8.74	1.40	16
1983	64	223.63	238.72	107	225.6	23.37	10

1978-80 - near bottom tows (day and night), Soviet juvenile trawl

1981-82 - near bottom, midwater, near surface (night only), IYGPT

1982 - strata 71 - not sampled

Table 4. Comparison of recruitment indicies derived from Canadian summer groundfish surveys (total numbers, age 1, thousands of fish) and juvenile surveys (stratified mean catch per tow, 0-group).

Year Class	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1-group	28271	70044	30601	12226	22689	3770	13636	44392	7454	16750	84743	57165	-
0-group	-	-	-	-	-	-	-	237.57	56.42	26.03	578.34	8.74	225.60

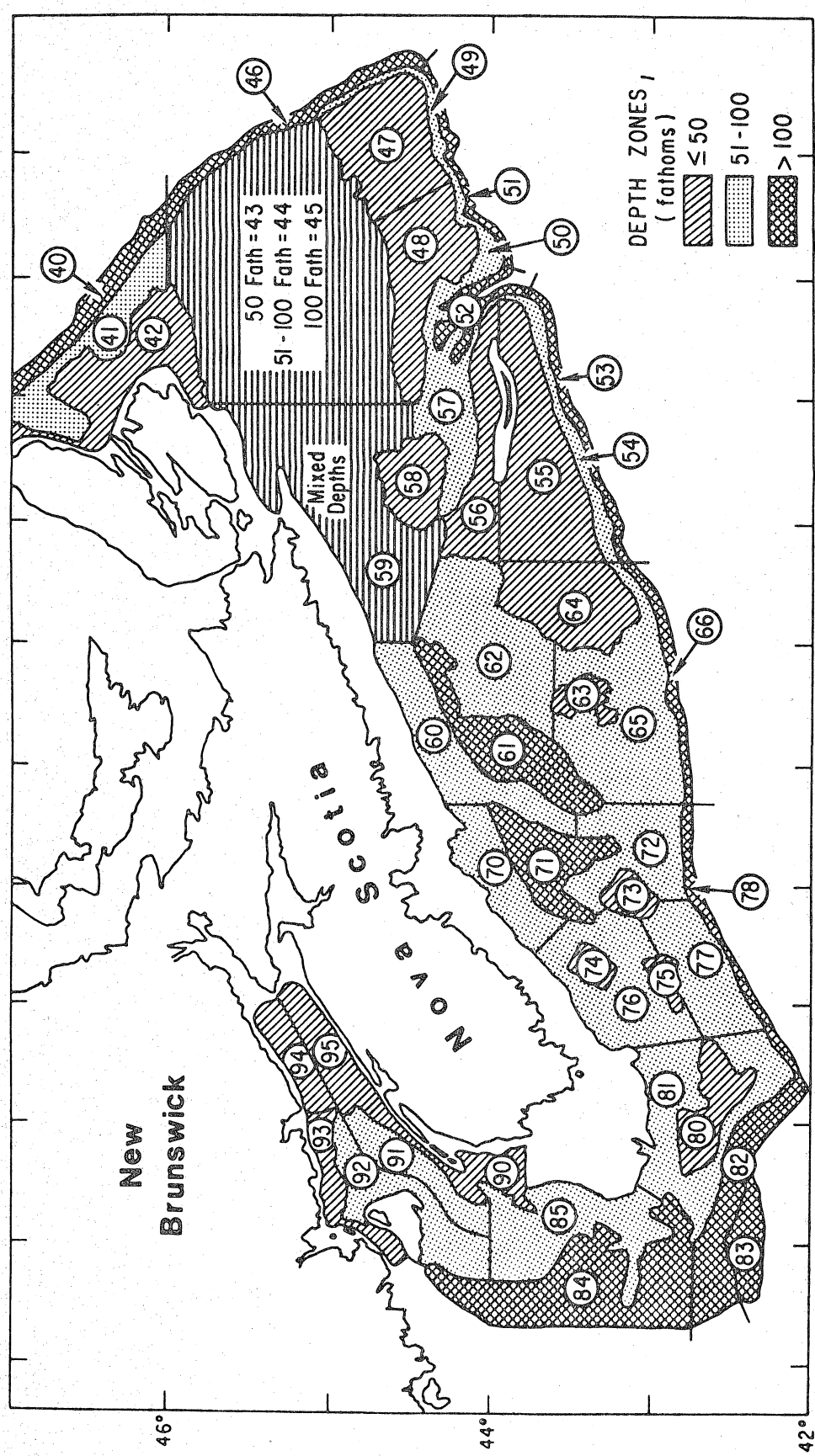

Figure 1. Canadian stratification scheme of the Scotian Shelf. The Canada-USSR silver hake survey included strata 60-66; 70-78.

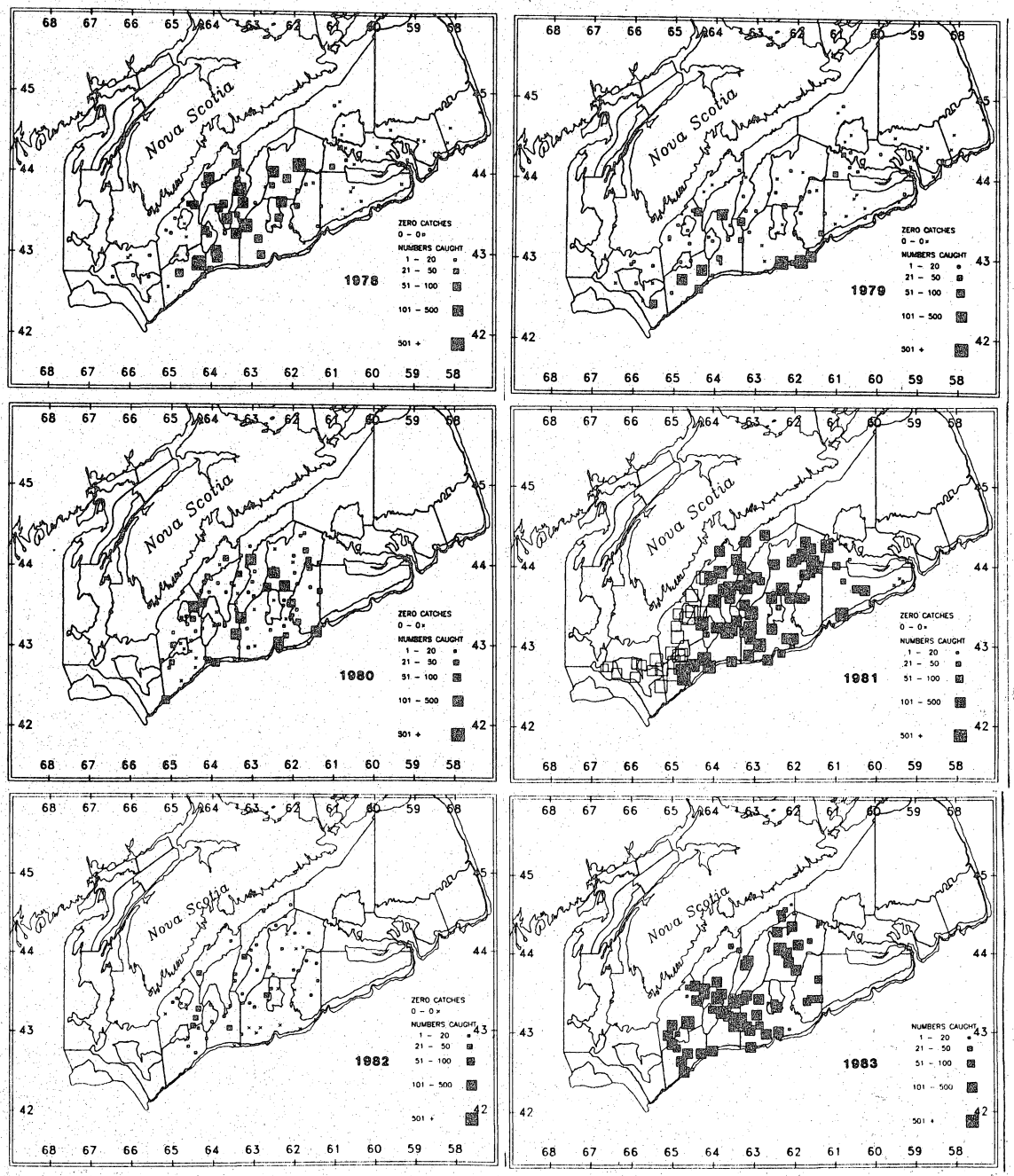

Figure 2. Distributions of catches of 0-group silver hake on the Scotian Shelf (strata 60-66; 70-78), 1978-1983. In 1981, the open squares denote Lady Hammond catches. All sets in 1983 resulted in the capture of 0-group silver hake.

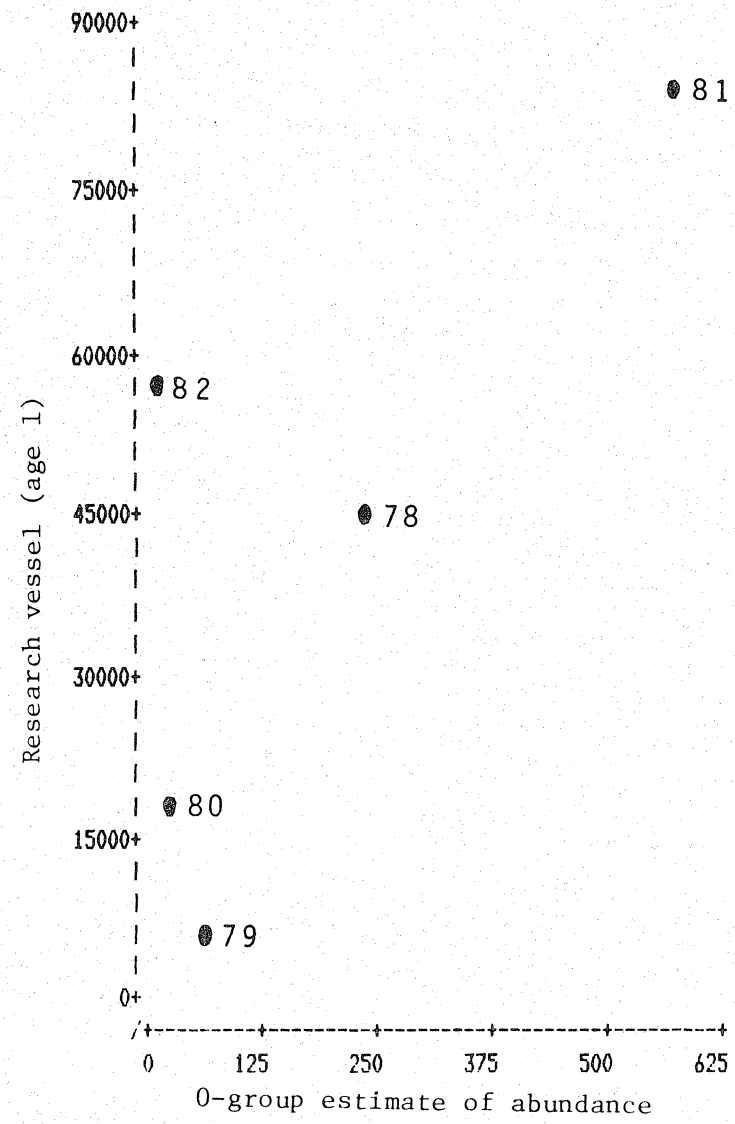

Figure 3. Comparison of recruitment indices from summer groundfish otter trawl surveys (research vessel age 1) and midwater trawl juvenile surveys (0 group estimate of abundance).