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Comparisons of abundance indices from research vessel surveys and commercial statistics for cod and haddock in ICNAF Subarea 4

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INTRODUCTION

On recommending that an ICNAF Working Group on Co-ordinated Groundfish Surveys be established, the Standing Committee on Research and Statistics emphasized that determination of accuracy of abundance indices derived from research vessel surveys should be one of its first tasks. Obviously, future survey planning decisions should be based on a realistic assessment of the abilities of surveys to provide the type of information required.

To this end, a number of comparisons of survey and commercial abundance indices for cod and haddock in ICNAF Subarea 4 are brought together here. Very little analysis has been possible on these data because of time limitations and this report should be considered preliminary.

DIV. 4X COD

The U.S. National Marine Fisheries Service has surveyed most of ICNAF Div. 4X at least once a year since 1965. These surveys by the research vessel *Albatross IV* using a stratified random sampling design extended as far as the mouth of the Bay of Fundy and included LaHave and Roseway Banks. Stratified mean catch of cod in pounds per tow, calculated after \log_e transformation of the data, is used here as an index of cod abundance (Table 1). The strata considered (numbers 31-35, 41, 42) cover most of Div. 4X but exclude the inner Bay of Fundy, inshore southwestern Nova Scotia, and depths greater than 100 fathoms. These indices are therefore estimates of abundance of the offshore cod stock in Div. 4X.

Halliday (Report on 4X cod to Assessment Subcommittee Midterm Meeting, 1971) has taken the catch per hour of Canadian side otter trawlers of 151-500 gross tons which caught predominantly cod in "unit areas" N,O,P of Div. 4X as being the best available index of abundance of the offshore cod stock (Table 1). This area includes deep waters of the Fundian Channel and eastern Gulf of Maine while excluding the region between northern Brown's Bank and the Bay of Fundy. Thus the areas from which survey and commercial data come do not coincide exactly. However, both include the major areas of cod concentration on Brown's and LaHave Banks.

Expressing the abundance estimates as percentages of the mean values facilitates comparison of trends (Fig. 1). Both survey and commercial indices show that cod abundance has declined progressively during the period 1965-69.

There is considerable seasonal variation in availability of cod to the commercial fishery. The value best representing cod abundance in a particular year is probably the annual average of monthly catch per unit effort values. Insufficient survey data are at hand to describe seasonal variation in availability to survey operations. Differences in fishing practices between commercial fishermen and scientists on trawling surveys probably make the degree, if not the nature, of seasonal availability changes quite different. Nevertheless, the correlation coefficient (r) of survey indices with their corresponding commercial quarterly indices is statistically significant ($r = 0.74$, d. of f. = 8) there being only a 1.5% probability (P) of as high a value occurring by chance. Fall survey indices and 4th quarter commercial indices have a correlation of 0.77 ($P = 14\%$, d. of f. = 3). Fall survey indices and annual commercial indices have a correlation of 0.83 ($P = 8\%$, d. of f. = 3). Thus there is moderately good agreement between the two data series.

DIV. 4X HADDOCK

Survey and commercial data on Div. 4X haddock abundance are available in an identical form to that described above for Div. 4X cod (Table 2). Both survey and commercial indices indicate that abundance was lower in the latter part of 1968 and in 1969 than in earlier years (Fig. 2). However, the correlation between survey indices and their corresponding commercial quarterly indices is only 0.32 ($P = 38\%$, d. of f. = 8). Fall indices for the two data sets give $r = 0.76$ ($P = 14\%$, d. of f. = 3). Fall survey indices and annual commercial indices give $r = 0.70$ ($P = 19\%$, d. of f. = 3). Thus, although fall survey indices are in fair agreement with both fall and annual commercial indices, overall agreement between the two data series is poor.

DIV. 4T COD

The Groundfish Investigation of the St. Andrews Biological Station of the Fisheries Research Board of Canada has undertaken annual fall (September-October) cod surveys in the southern Gulf of St. Lawrence (ICNAF Div. 4T) since 1957. On these surveys, 13 fixed stations were normally occupied, two half-hour otter trawl tows being made at each station, the station locations being originally chosen to coincide with popular areas for commercial fishing. Those surveys undertaken in 1957-65 have been analyzed to provide abundance indices for the "summer" concentrations of the Div. 4T-4VN cod stock (Paloheimo and Kohler, 1968). In this case, survey catches, which were taken using otter trawls with small mesh codend liners, were adjusted using selection ogives for the mesh sizes which were currently used by the commercial fleet. Thus, survey indices are expressed as pounds per tow of commercial sized cod (Table 3). Catches per trip by Gloucester class otter trawlers (26-50 gross tons) in August to October inclusive provide suitable commercial abundance indices for comparison (Table 3). Variations in the two series

are almost identical (Fig. 3). The largest discrepancy lies in the 1957 values. However, the survey in that year was undertaken by a different vessel from those in following years, and the 1957 abundance index was adjusted on the basis of results from comparative fishing experiments between the two vessels. The discrepancy between survey and commercial values in 1957 may reflect errors in this adjustment. Even including the 1957 value the correlation coefficient between the two series is 0.90 which is highly significant ($P < 0.1\%$, d. of f. = 7).

DIV. 4W HADDOCK

Summer survey cruises in ICNAF Div. 4W in 1958-60 by the St. Andrews Biological Station to investigate the distribution of haddock have been used to obtain abundance indices of haddock at ages 1-3 (Halliday, ICNAF Res. Doc. 70/75). Abundance indices at ages 1-3 were found to be significantly correlated with abundance at age 4 estimated from the commercial fishery for the 1954-59 year-classes ($r = 0.83$, $P = 4\%$, d. of f. = 4), when both data sets were transformed to \log_e scale. The relationship is described by the equation:

$$\log_e Y = 1.4457 + 0.5785 \log_e X$$

where Y is abundance at age 4 and X is mean abundance at ages 1-3, in millions of fish (Fig. 4).

DISCUSSION

The extent of agreement between abundance indices from research vessel surveys and commercial statistics encourages the view that surveys can provide useful data on abundance of groundfish species. More detailed analysis of these data may well demonstrate closer agreement between commercial and survey indices than is shown here for Div. 4X cod and haddock. The survey index reflects not only the abundance of commercial sized fish but also the abundance of pre-recruits which may form a substantial proportion of the standing stock. Thus, the poor agreement between survey and commercial abundance indices for Div. 4X haddock may result in large part from the influence of pre-recruits on survey indices. Certainly, the period in question, 1965-69, was one when pre-recruit haddock abundance fluctuated considerably, the very abundant 1963 year-class being followed by a series of very poor year-classes (Grosslein, ICNAF Res. Doc. 69/89). Variations in year-class strength of Div. 4X cod (Halliday, report on 4X cod to Assessments Subcommittee Midterm Meeting, 1971) indicate that there were also considerable fluctuations in abundance of pre-recruit cod during 1965-69. However, these were probably less marked than variations in pre-recruit haddock abundance, and this, in combination with the relative unavailability of young cod to otter trawls, resulted in better agreement between survey and commercial indices for cod. Agreement between survey and commercial abundance indices for Div. 4T cod is excellent after the influence of pre-recruits on survey indices is removed.

TABLE 1. ICNAF Div. 4X cod abundance indices from U.S.A. research vessel *Albatross IV* and Canadian commercial otter trawlers

Year	Qtr	Season	Survey index \log_e (lb/tow)	Commercial index metric tons/hour	
				Quarterly	Annual
1965	1	Winter	-	.307	
	2	Spring	-	.355	
	3	Summer	2.66	.376	
	4	Fall	3.25	.333	.343
1966	1	Winter	-	.362	
	2	Spring	3.28	.433	
	3	Summer	-	.263	
	4	Fall	2.71	.225	.321
1967	1	Winter	-	.362	
	2	Spring	-	.381	
	3	Summer	-	.273	
	4	Fall	2.16	.265	.320
1968	1	Winter	-	.332	
	2	Spring	2.47	.317	
	3	Summer	-	.270	
	4	Fall	1.86	.240	.290
1969	1	Winter	-	.302	
	2	Spring	1.86	.307	
	3	Summer	1.88	.192	
	4	Fall	1.74	.137	.235

TABLE 2. ICNAF Div. 4X haddock abundance indices from U.S.A. research vessel *Albatross IV* and Canadian commercial otter trawlers.

Year	Qtr	Season	Survey index \log_e (lb/tow)	Commercial index metric tons/hour	
				Quarterly	Annual
1965	1	Winter	-	.306	
	2	Spring	-	.400	
	3	Summer	2.78	.250	
	4	Fall	3.61	.237	.298
1966	1	Winter	-	.391	
	2	Spring	3.72	.390	
	3	Summer	-	.279	
	4	Fall	3.22	.228	.322
1967	1	Winter	-	.370	
	2	Spring	-	.397	
	3	Summer	-	.236	
	4	Fall	3.87	.212	.304
1968	1	Winter	-	.423	
	2	Spring	3.13	.296	
	3	Summer	-	.248	
	4	Fall	2.93	.148	.279
1969	1	Winter	-	.352	
	2	Spring	2.53	.286	
	3	Summer	2.96	.215	
	4	Fall	2.68	.162	.254

TABLE 3. ICNAF Div. 4T cod abundance indices from Canadian research vessel surveys and Canadian commercial otter trawlers

Year	Survey index lb./tow	Commercial index 1000 lb./trip
1957	393	14.3
1958	227	11.5
1959	250	12.8
1960	119	7.8
1961	136	8.6
1962	178	11.5
1963	159	9.6
1964	140	8.6
1965	111	6.2

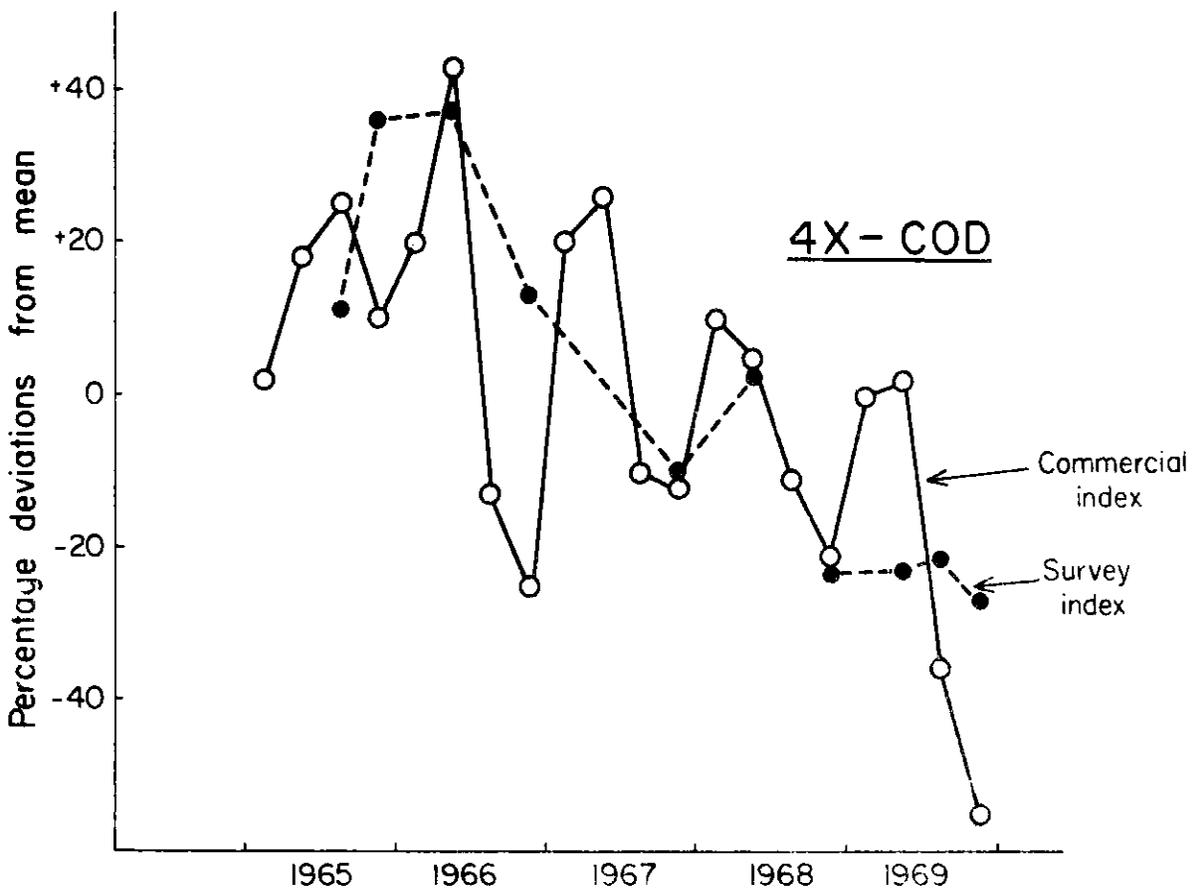


FIG. 1

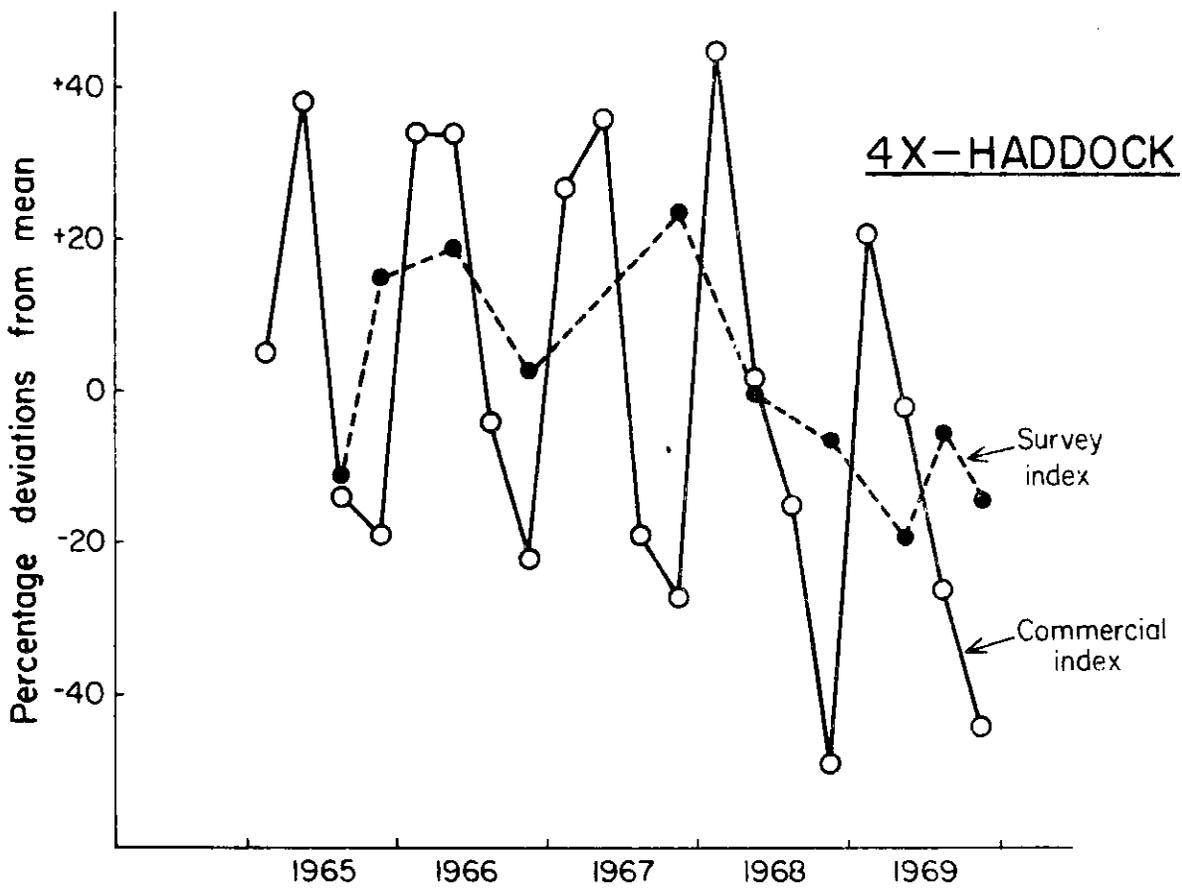


FIG. 2

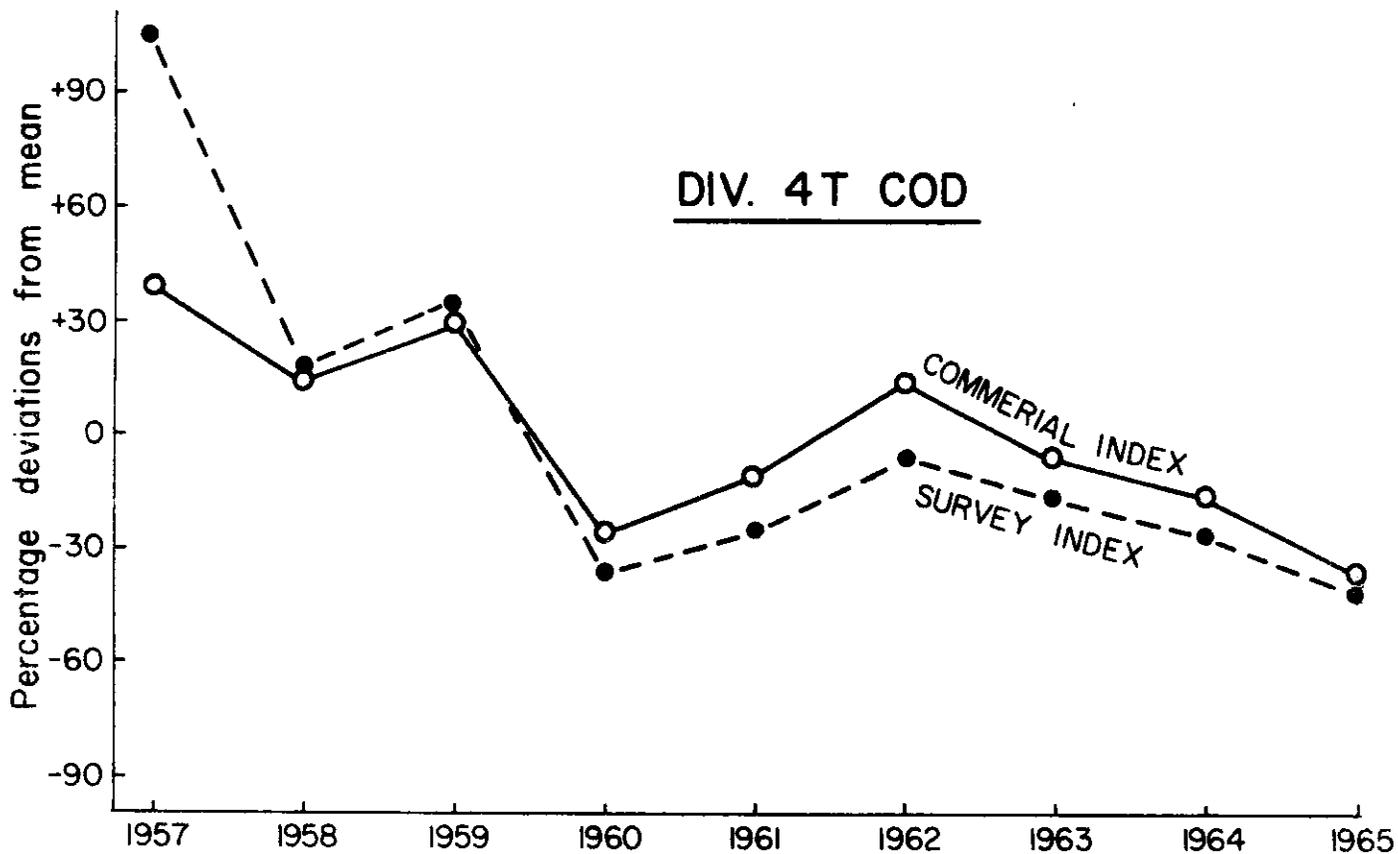


FIG. 3

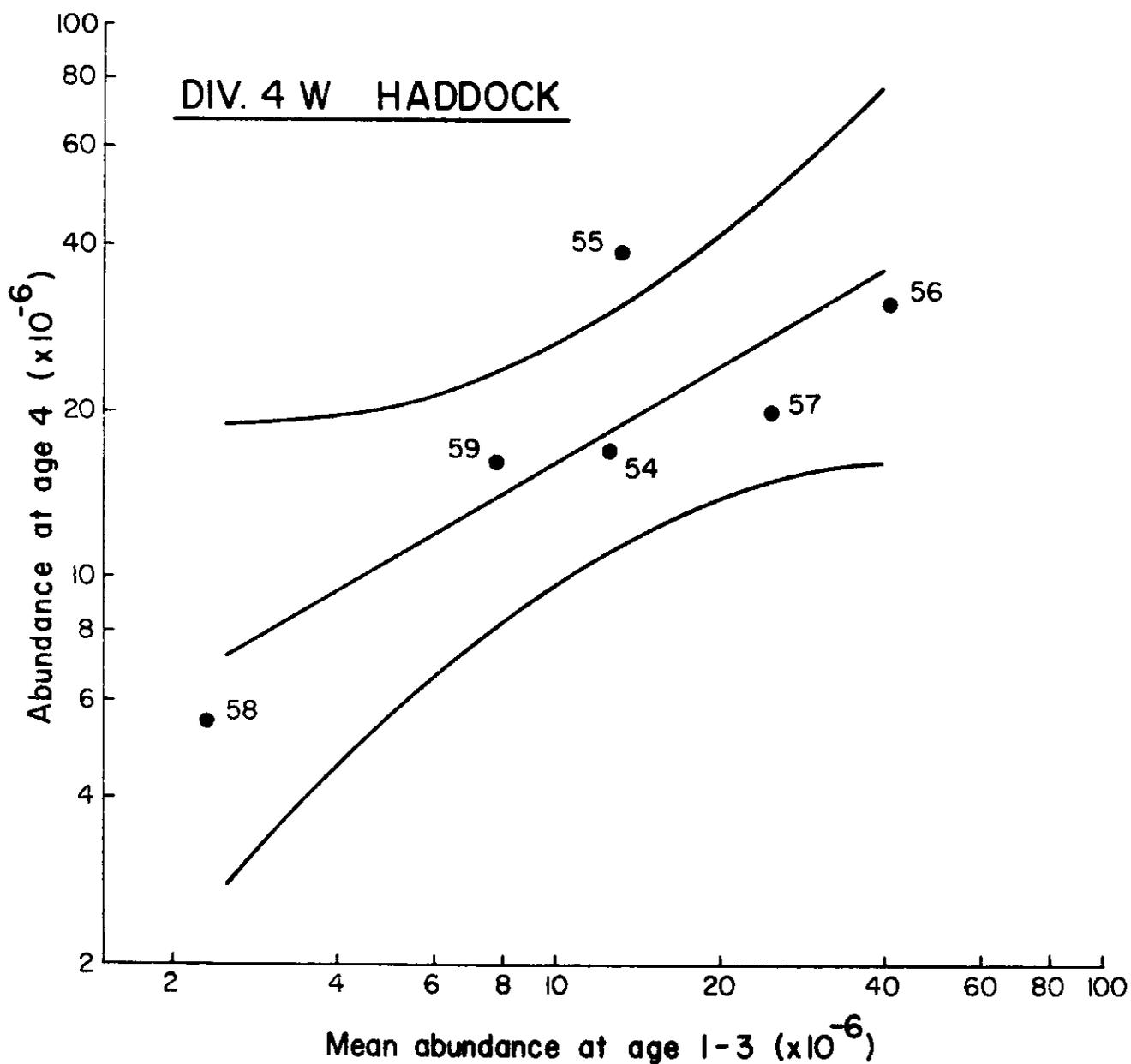


FIG. 4