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Relative Strength of the 1998 year-class, from nearshore surveys of demersal age 0 Atlantic cod in 3KL and in Newman Sound, Bonavista Bay.

By

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Abstract

Recruitment of age 0 Atlantic cod to the nearshore in 3KL in 1997 was the highest on record during the annual Fleming survey in the 1990's (Methven et al. 1998). This survey was not conducted in 1998. In its absence, we conducted a qualitative assessment of the strength of the 1997 and 1998 year-classes based on abundance of demersal age 0 and age 1 Atlantic cod in the nearshore in Newman Sound, Bonavista Bay in the summer and fall 1998. Three years of data from Newman Sound were available- 1995, 1996, and 1998. We compared abundances of age 0 and age 1 Atlantic cod in Newman Sound in 1998 to those in previous years and with those reported during the Fleming surveys (1992-97). The sampling techniques used during both surveys were identical and data were available for the same times in the fall for use in interannual comparisons (early to mid-October). Therefore, abundance data from the two surveys were comparable, albeit at different spatial scales. We observed good correspondence of abundance trends for both age groups between the surveys in 1995 and 1996. In both data sets, 1996 showed the lowest age 0 abundance among years. The Fleming survey results for 1997 predicted that age 1 abundance in 1998 would be higher than in previous years this decade. High age 1 abundance in 1998 compared to previous years in Newman Sound supported this prediction. Age 0 Atlantic cod abundance in 1998 was over double that in 1995 and a full order of magnitude higher than in 1996. We suggest that the 1998 year class will be stronger than either the 1995 or 1996 year-classes. Analysis of length frequency data collected from July to November in Newman Sound indicated that age 0 Atlantic cod settled in the nearshore in two distinct recruitment pulses in 1998 - the first arriving in early August, the second in late September. In both 1995 and 1996, only the second of these pulses was evident. The implications of each of these pulses on overall recruitment to subsequent age groups remains to be identified.

Résumé

Le recrutement de morues de l'Atlantique d'âge 0 dans la zone côtière de 3KL en 1997 a été le plus élevé jamais noté pendant les relevés annuels Fleming des années 1990 (Methven et coll., 1998). Ce relevé n'a pas été effectué en 1998. Nous avons cependant réalisé une évaluation qualitative de l'importance des classes d'âge de 1997 et 1998 fondée sur l'abondance des morues démersales d'âges 0 et 1 à proximité des côtes du détroit Newman, baie Bonavista, à l'été et à l'automne de 1998. Trois années de données pour le détroit Newman existaient pour les années 1995, 1996 et 1998. Nous avons comparé l'abondance des morues d'âges 0 et du détroit Newman en 1998 à celles des années antérieures et à celles des relevés Fleming (1992-1997). Les mêmes techniques d'échantillonnage ont été utilisées pour les deux relevés et comme nous disposions de données pour les mêmes périodes en automne, elles pouvaient servir à des comparaisons interannuelles (début à mi-octobre). Par conséquent, les données sur l'abondance des deux relevés étaient comparables, bien qu'à des échelles spatiales différentes. Nous avons noté une bonne correspondance entre les allures de l'abondance des deux groupes d'âges des relevés de 1995 et de 1996. Pour les deux ensembles de données, l'abondance du groupe d'âge 0 était la plus faible en 1996. Le relevé Fleming de 1997 indiquait que l'abondance du groupe d'âge 1 en 1998 serait plus élevée que celle des années précédentes de la décennie. L'abondance élevée du groupe d'âge 1 en 1998 était semblable à celles des années précédentes dans le détroit Newman et appuyait la prévision. L'abondance du groupe d'âge 0 en 1998 était plus que le double de celle de 1995 et un ordre de grandeur supérieure à celle de 1996. Nous pensons que la classe d'âge de 1998 sera plus importante que celles de 1995 ou de 1996. L'analyse des données de fréquences de longueurs obtenues de juillet à novembre dans le détroit Newman montre que les morues du groupe d'âge 0 se sont déplacées vers le fond à proximité des côtes en deux vagues de recrutement successives en 1998 - la première au début d'août et la seconde à la fin de septembre. En 1995 et en 1996, seule la seconde vague était visible. L'effet de chacune de ces vagues sur le recrutement général des groupes d'âges suivants demeure à préciser.

Introduction

It has been shown, at least for the 1990's, that age 0 and age 1 Atlantic cod in 3KL (Northeast Newfoundland Shelf) are distributed predominantly in inshore waters (Dalley & Anderson 1997). Within these inshore waters during autumn, age 0 cod are most common in shallow water in the nearshore (<10 m deep - Methven & Schneider 1998, Gregory et al. submitted). The Fleming surveys (1959 - 64, Lear et al. 1980; 1992-97, e.g., Methven et al. 1998) have historically sampled nearshore abundances of age 0-2 Atlantic cod, with the objective of assessing relative year-class strength. These surveys have generally been successful at predicting the relative strength of adjacent cohorts through the first years of life.

The 1997 Fleming survey (Methven et al. 1998) reported the highest abundance of age 0 cod in the nearshore since the survey was reinitiated in 1992. The Fleming survey was not conducted in 1998. Consequently, the success (or failure) of the 1997 year-class could not be assessed directly. Similarly, the strength of the 1998 year-class could not be evaluated relative to the long-term Fleming time series.

In Fall 1995, an investigation of the adundance of age 0 cod and their association with nearshore habitat types was initiated in Newman Sound, Bonavista Bay (Gotceitas et al. 1996). The 1995 study was followed by a similar effort in 1996 (Gregory et al. 1997) and again in 1998. These studies showed that the nearshore of Newman Sound represents a significant nursery area for juvenile cod. The Newman Sound work was conducted using the same gear, used in the same way, at the same time of year as the Fleming surveys. Therefore, the abundance data of the two surveys during the period of study were comparable, albeit at different spatial scales.

In this study, we conducted a qualitative assessment of the relative strength of the 1998 year-class based on abundance of demersal age 0 and age 1 Atlantic cod in the nearshore in Newman Sound, Bonavista Bay in summer and fall 1998. We compared abundances of age 0 and age 1 Atlantic cod in Newman Sound in 1998 to previous years (1995 & 96), linking interannual abundance trends to those demonstrated in the Fleming surveys (1992 - 97). We show that the interannual trends between the Newman Sound data and the larger scale Fleming survey were consistent. Comparisons between the data sets showed: 1. the 1998 year-class was relatively stronger than the 1995 and 1996 year-classes and, 2. age 1 abundance (1997 year-class) was higher than previous years, which supports the predictions of the 1997 Fleming survey (Methven et al. 1998).

Methods

Fleming survey sites (Fig. 1) have been described in previous reports (e.g., Methven et al. 1998). In the 1990's, the Fleming survey was conducted at between 37 - 45 nearshore sites extending from St. Mary's Bay in the south to Notre Dame Bay in the north from 19 September to 27 October. In Bonavista Bay, sampling has generally been conducted 5 - 9 October (18 October in 1997).

Newman Sound sites (Fig. 2), described in Gregory et al. (1997), were selected on the basis of gear accessibility, similar to those of the Fleming survey (Lear et al. 1980). To maintain consistency within years, we have presented data from four of these sites, which were in common among field programs in 1995, 1996, and 1998. For comparison with the Fleming survey data, we analyzed data from Newman Sound which had been collected 1 - 15 October in these years. In order to investigate seasonal growth and timing of recruitment pulses, we examined data from these sites September to November, 1995 and July to November in 1996 and 1998.

Both the Fleming survey and Newman Sound studies used the same gear and sampling methods. Fish samples were collected using a 25 m beach seine -- wings and belly 19 mm stretch mesh, codend 9 mm stretch mesh bag; 24.4 m headrope, 26.2 m footrope; 75 cm long and 25 mm diameter aluminum poles on each wing served to maintain the spread between the headrope and footrope. The net was deployed from a 6 m boat at a distance of 55 m from the shore, and then retrieved by two individuals standing 16 m apart on the shore. The seine was pulled along the bottom and sampled the lowest 2 m of the water column. As described above, the net samples approximately 880 m^2 of the bottom. Previous work (Ings, unpublished data) has indicated that less than 5% of all fish enclosed by the net are missed or escape when the seine is deployed in this manner.

All fish collected were identified and counted. Juvenile cod were also aged, based on previously established age-length relationships (i.e., length group [LG]) in Newfoundland waters (LG0 - age 0: $\leq$ 10 cm SL [standard length], age 1: 10 to 20 cm SL, and age 2: 20 to 30 cm SL - Dalley & Anderson 1997).

Results and Discussion

We observed good correspondence of abundance trends in 1995 and 1996, for both age groups between the two surveys. In both data sets, 1996 showed the lowest age 0 abundance among years (Fig. 3). Newman Sound abundance in 1996 was 26% of that in 1995; Fleming survey abundance in 1996 was 51% of that in 1995. Similarly, age 1 abundance was higher in 1996 than it had been in 1995 in both the Fleming survey (2.0 times higher) and in Newman Sound (2.4 times higher) data sets (Fig. 4). The 1997 Fleming report predicted that age 1 abundance in 1998 would be higher than in previous years. Age 1 abundance observed in Newman Sound in 1998 supported this prediction (Fig. 4). Age 0 Atlantic cod abundance in 1998 was the highest in the Newman Sound data set and was over an order of magnitude higher than that in 1996 (the lowest recorded year in both data sets). These results suggest that the 1998 year class will be strong relative to 1995 or 1996 year-classes.

Analysis of length frequency data from age 0 Atlantic cod collected July to November in Newman Sound indicated that age 0 Atlantic cod settled in the nearshore in two distinct recruitment pulses in 1998 - the first arriving in early August, the second in late September (Fig. 5). In 1998, age 0 Atlantic cod recruited to the nearshore of Newman Sound in two distinct pulses - the first in early August, the second in September - early October. The first pulse was the strongest. In 1995 and 1996, recruitment was limited to one pulse in late September - early October (1996 - Fig. 6).

Abundance of age 1 Atlantic cod was significantly correlated ($p < 0.0095$) with age 0 abundance measured in the previous year, throughout the Fleming survey (Table 1, Fig. 7). It is premature to determine this relationship for Newman Sound. However, the results from the sound for the 1995 year class were within the range determined by the Fleming data (Fig. 7).

Abundance of age 2 Atlantic cod was significantly correlated ($p < 0.0020$) with age 1 abundance measured in the previous year in the Fleming survey data (Table 1, Fig. 7). In the Newman Sound data, the result for the 1994 year class (i.e., age 2 in 1996 compared to age 1 in 1995) was within the range shown by Fleming survey data set (Fig. 7).

In Newman Sound, there was only one recruitment pulse in both 1995 and 1996. In contrast, there were two pulses in 1998 - a year of comparatively high age 0 abundance. Although the purposes of this study did not include assessing the contribution of the first recruitment pulse relative to the second in determining year-class strength, this result remains compelling. The role of multiple age 0 recruitment pulses should be explored further to fully understand recruitment from age 0 nearshore nursery areas. Specifically, the parental origin of these pulses has yet to be determined.

We predict that the 1998 year class will be strong relative to the 1995 and 1996 year classes. The abundance of age 1 Atlantic cod in Newman Sound relative to previous years supported the predictions by Methven et al. (1998) that the 1997 year-class will be strong relative to 1995 and 1996.

References

Dalley, E.L. and J.T. Anderson. 1997. Distribution and abundance of demersal juvenile cod (Gadus morhua) in inshore and offshore areas of northeast Newfoundland (NAFO Divisions 3KL) in the early 1990's. Can. J. Fish. Aquat. Sci. 54(Suppl.1):168-176.

Gotceitas, V., R.S. Gregory, and S. Fraser. 1996. Distribution of habitat types and fish in the nearshore environment of inner Newman Sound, Terra Nova National Park, Newfoundland, Canada. Memorial University of Newfoundland. 1995-96 Annual Progress Report to Terra Nova National Park, Project No. MEM95-001.

Gregory, R.S., S. Fraser, J.T. Anderson, and J.A. Brown. Submitted. Diel and spatial distribution of juvenile Atlantic cod in inshore and nearshore coastal waters of Newfoundland. J. Fish Biol.

Gregory, R.S., V. Gotceitas, S. Fraser, P. Lundrigan, and J.A. Brown. 1997. Temporal and spatial survey of the fish community and its distribution among nearshore habitat types in the marine environment in the vicinity of Terra Nova National Park. Final Report to Canadian Heritage-Parks Canada.

Lear, W.H., A.M. Fleming, and R. Wells. 1980. Results of small cod surveys in eastern Newfoundland during 1959-64. NAFO SCR Doc. 80/IX/144, N0218 11 p.

Methven, D.A., and D.C. Schneider. 1998. Gear-independent patterns of variation in catch of juvenile Atlantic cod (*Gadus morhua*) in coastal habitats. Canadian Journal of Fisheries and Aquatic Sciences 55: 1430-1442.

Methven, D.A., D. C. Schneider, and D.W. Ings. 1998. Results of the 1997 Fleming Survey of demersal juvenile cod in the coastal zone of eastern Newfoundland. Memorial University, St. John's 26 p.

Table 1. Relationship between abundance of length groups (LG0 ~age 0, LG1 ~age 1, LG2 ~age 2) for Fleming survey data collected 1959-64 and 1992-97. (a gamma error structure was assumed).

Equation	Slope deviance	Deg. free.	Probability
LG1 = 0.876 LG0 -1.129	6.730	1	0.0095
LG2 = 0.023 LG1 + 0.526	9.539	1	0.0020

Figures

Figure 1. Fleming survey sites 1959-64 and 1991-97 (Lear et al. 1980; Methven et al. 1998).

Figure 2. "Fleming seine" sites and nearshore habitat in Newman Sound, Bonavista Bay, July to November 1995-98.

Figure 3. Mean age 0 Atlantic cod abundance (mean set^{-1}) caught by beach seine in the Fleming survey 1959-64 and 1992-97, St. Mary's Bay to Notre Dame Bay (upper panel) and in Newman Sound Bonavista Bay, 1995-98 (lower panel). Vertical bars are 95% confidence intervals estimated by randomized data resampling.

Figure 4. Mean age 1 Atlantic cod abundance (mean set^{-1}) caught by beach seine in the Fleming survey 1959-64 and 1992-97, St. Mary's Bay to Notre Dame Bay (upper panel) and in Newman Sound Bonavista Bay, 1995-98 (lower panel). Vertical bars are 95% confidence intervals estimated by randomized data resampling.

Figure 5. Length frequency of age 0 Atlantic cod caught by nearshore beach seining in Newman Sound, Bonavista Bay, July - November 1998.

Figure 6. Length frequency of age 0 Atlantic cod caught by nearshore beach seining in Newman Sound, Bonavista Bay, July - November 1996.

Figure 7. Scatter plot of mean catch of age 1 against age 0 Atlantic cod mean catch the previous year (upper panel) and age 2 against age 1 mean catch the previous year (lower panel) in the Fleming survey (closed circles) and Newman Sound (open circles) data sets.

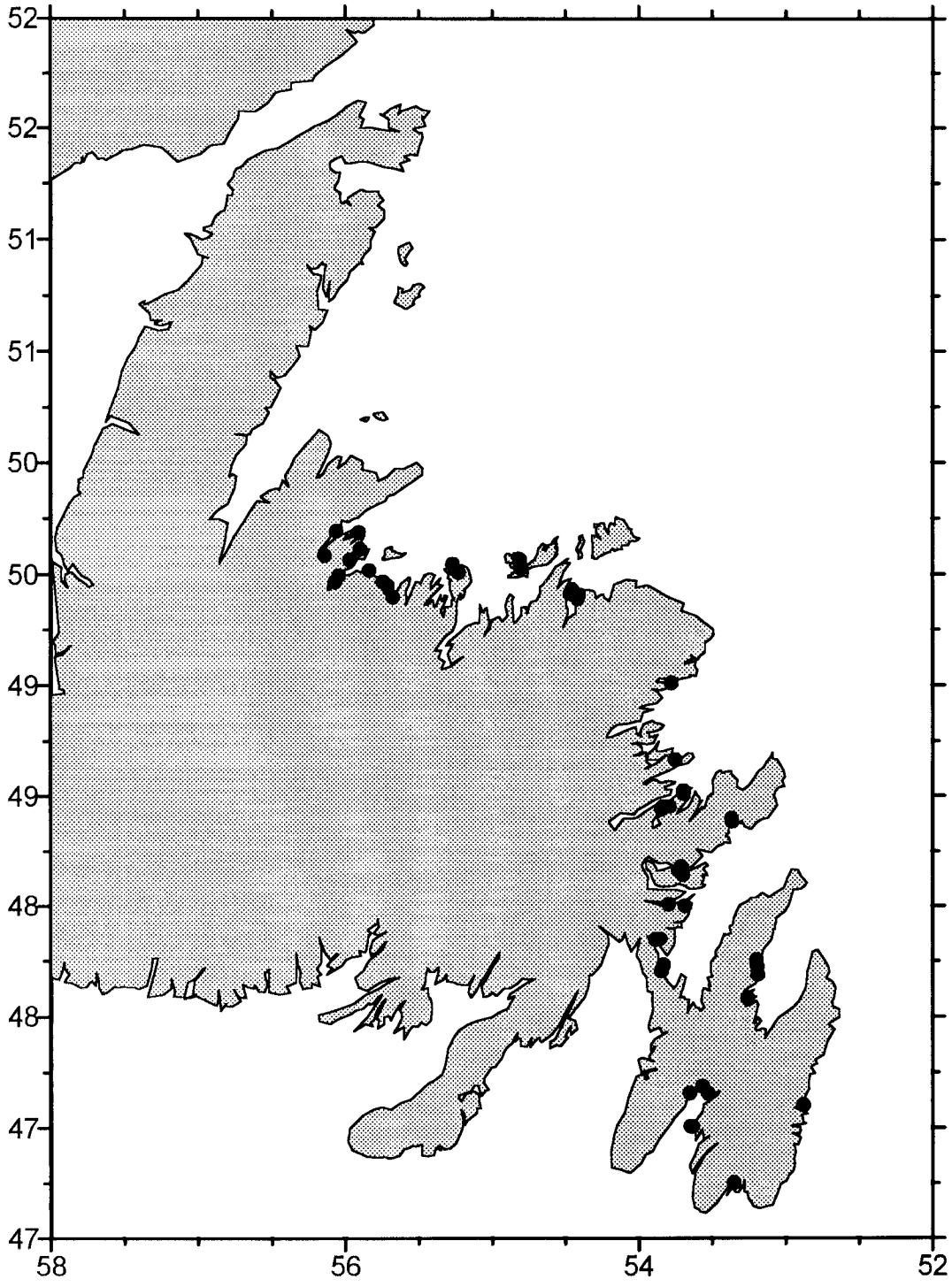
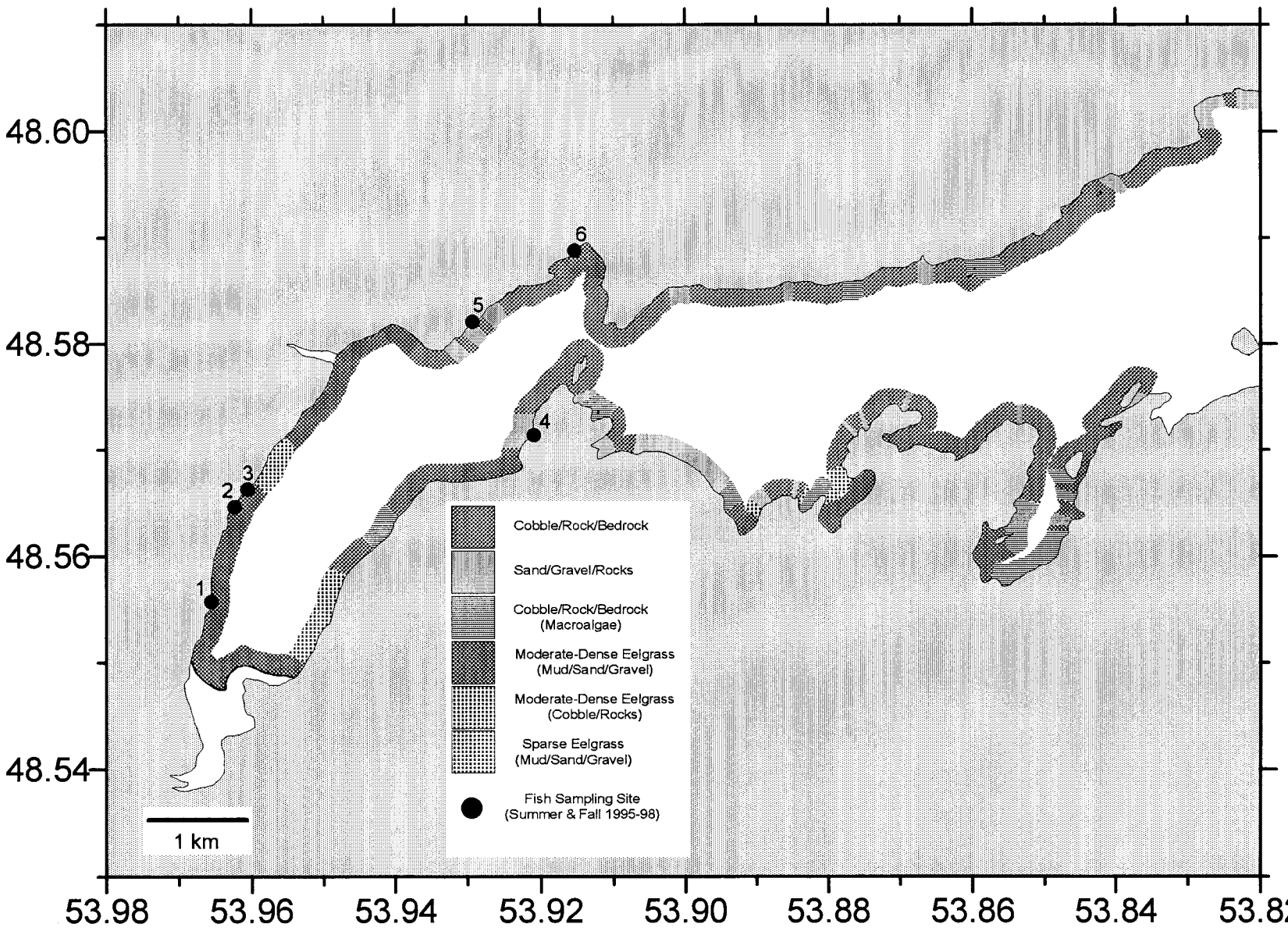


Figure 1. Fleming survey sites, 1959-64 & 1991-97 (Lear et al. 1980; Methven et al. 1998).



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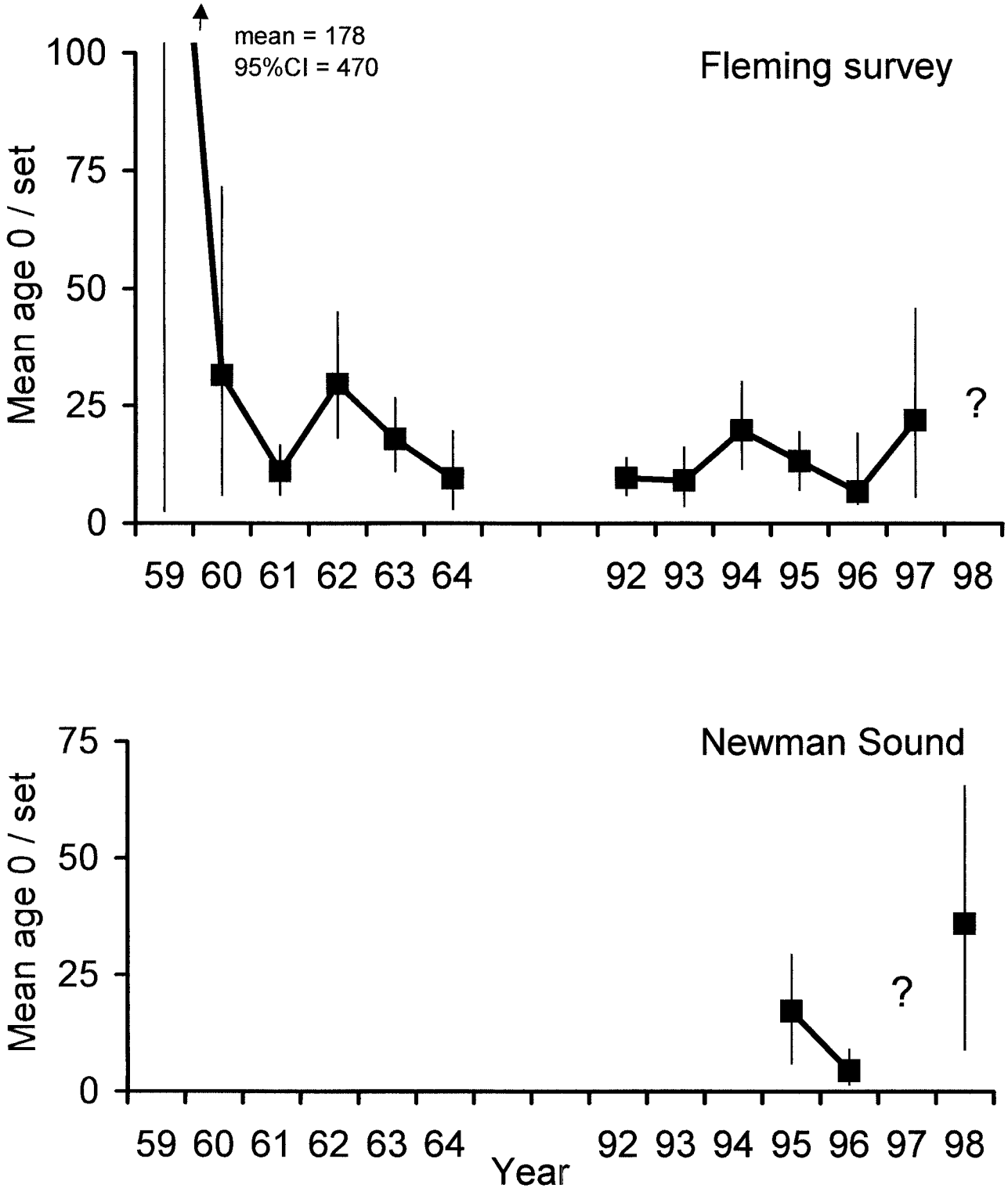

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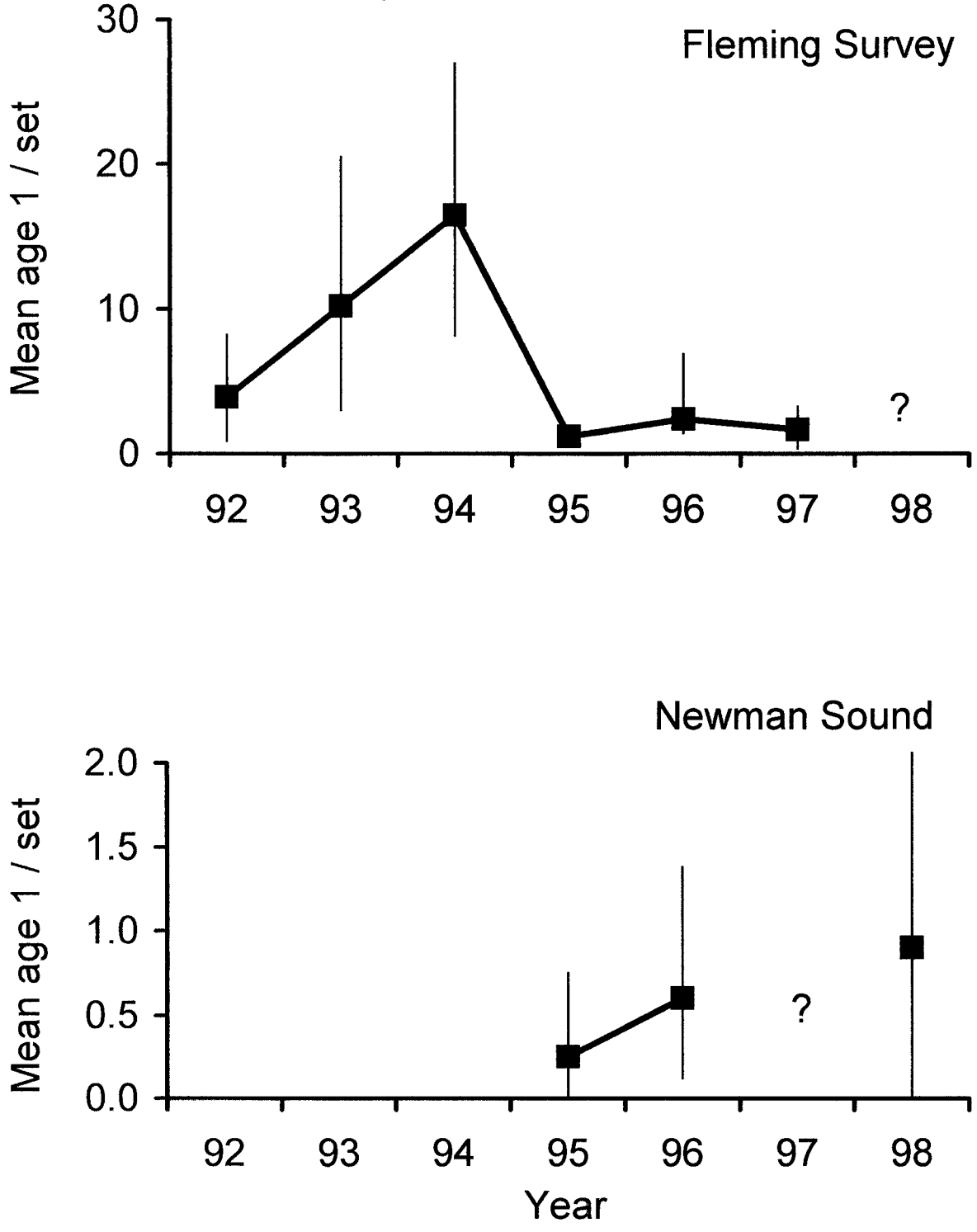

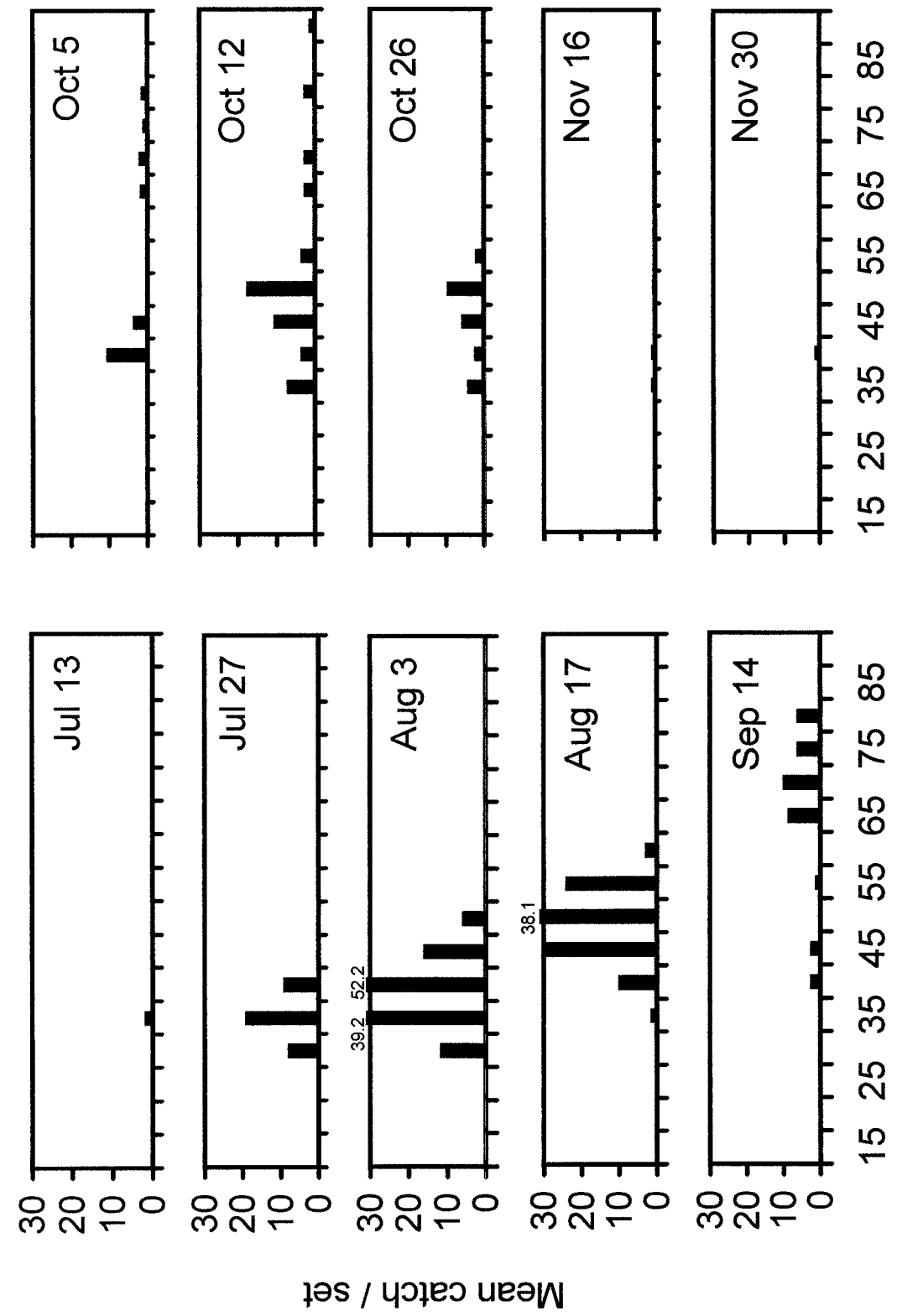

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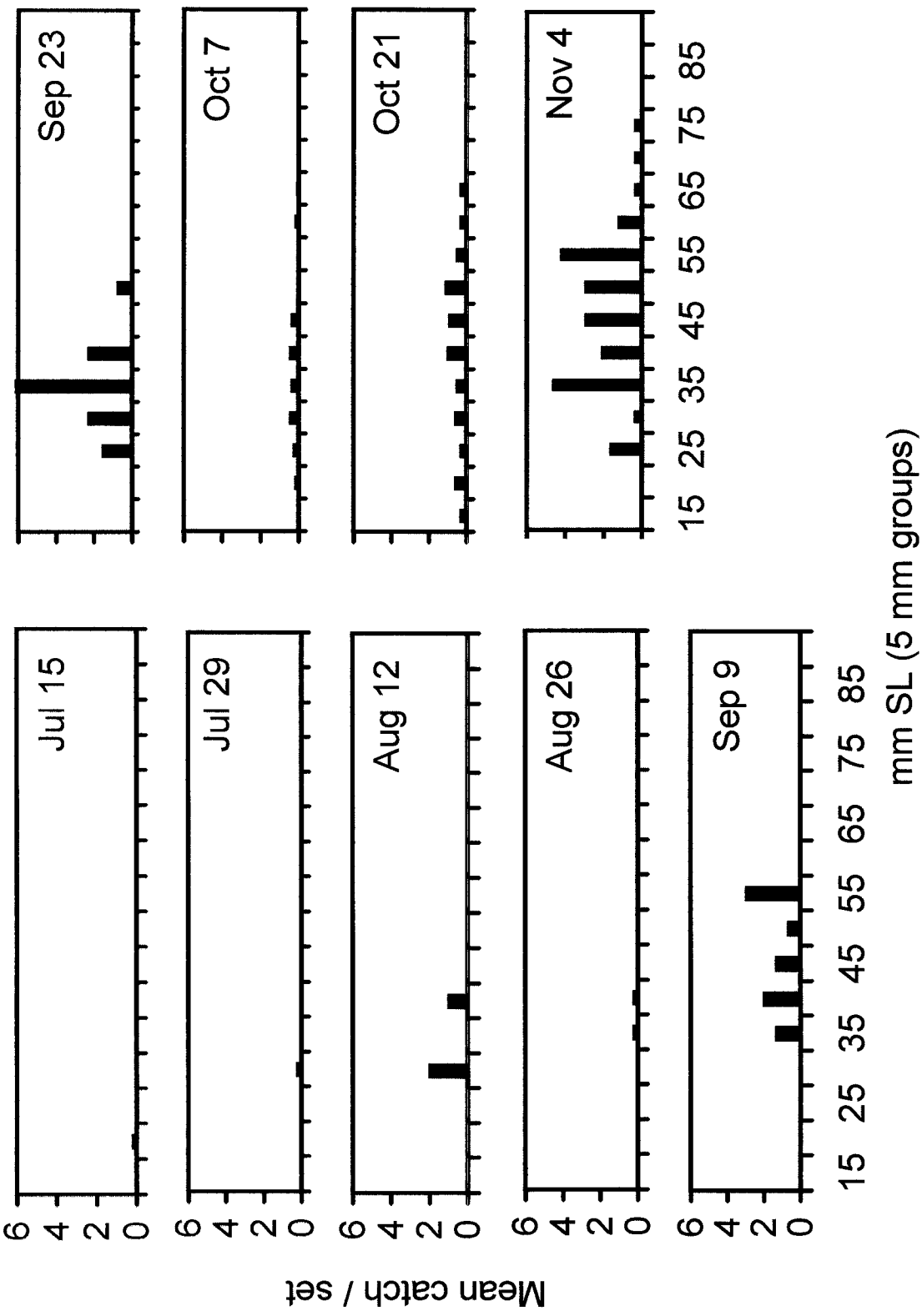

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