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Annual and geographical variations in sealworm (Pseudoterranova decipiens) larvae in rainbow smelt (Osmerus mordax) from the Gulf of St. Lawrence.

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ANNUAL AND GEOGRAPHICAL VARIATIONS IN SEALWORM (PSEUDOTERRANOVA DECIPIENS) LARVAE IN RAINBOW SMELT (OSMERUS MORDAX) FROM THE GULF OF ST. LAWRENCE.

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Infestation levels of sealworm larvae (Pseudoterranova decipiens) in rainbow smelt (Osmerus mordax) were determined from nine (9) locations in the Gulf of St. Lawrence. Sealworm data from the 1989 collection were analyzed with those from previous collections (1984-1988) in order to evaluate annual and geographical variations for each of four size-groups. Significant annual variations in sealworm prevalences/counts were detected, with strong sealworm annual classes being carried out in Loggieville, N.B., River John and Cheticamp, N.S.. Preliminary analysis of sealworm data from American plaice (Hippoglossoides platessoides) and cod (Gadus morhua) indicates that the offshore sealworm abundance is similar to inshore sealworm abundance in smelt.

Key words: Sealworm Pseudoterranova decipiens, nematode, parasitic anisakine, rainbow smelt Osmerus mordax, Gulf of St. Lawrence.

RÉSUMÉ

Landry, T. 1990. Annual and geographical variations in sealworm (Pseudoterranova decipiens) larvae in rainbow smelt (Osmerus mordax) from the Gulf of St. Lawrence. Can Tech. Rep. Fish. Aquat. Sci. No. 1734. viii + 10p.

Les niveaux d'infestation de larves de vers du phoque (Pseudoterranova decipiens) chez l'éperlan d'amérique (Osmerus mordax) ont été déterminés pour neuf (9) localités dans le golfe du Saint-Laurent. Les données sur le vers du phoque de cette série d'échantillons (1989) ont été analysées avec celles des années précédentes (1984-1988) pour évaluer les variations annuelles et géographiques pour chacun des quatre groupes de tailles. Les fréquences/comptes de vers du phoque présentent des variations annuelles significatives avec le déplacement d'importantes classes annuelles (vers du phoque) à Loggieville, N.-B., River John et Chéticamp, N.-E. L'analyse préliminaire de données sur le vers du phoque chez la plie

canadienne (Hippoglossoides platessoides) et la morue (Gadus morhua) démontre que l'abondance hauturière du vers du phoque est semblable à celle des régions côtières ressortant de nos suivis effectués sur l'éperlan.

INTRODUCTION

The use of rainbow smelt Osmerus mordax as a host indicator of sealworm Pseudoterranova decipiens abundance, offers an accurate temporal and geographical index for inshore areas (Landry and Hare, 1990). A recent survey on the use of smelt parasites as biological indicators has shown that smelt are sedentary in nature, being restricted to small geographical areas (Landry, in preparation).

The smelt sealworm survey was initiated in 1984 with four locations sampled along the New Brunswick coast, and has increased to nine locations from the Gulf of St. Lawrence in 1989. This inshore survey is complementary to the American plaice (Hippoglossoides platessoides) sealworm survey for offshore areas initiated by McClelland et al. (1983), which were established to provide sealworm abundance indices for the two environments.

Results from past analysis on the data collected from 1984 to 1988 have shown that sealworm abundance from inshore areas, for the most part, remained stable over the duration of this survey.

The data collected from 1989 are analyzed with those from past collections (1984-1988) in order to evaluate variations in sealworm abundance over a five year period.

METHODS

Samples of rainbow smelt were collected from nine coastal locations in the Gulf of St. Lawrence during the 1989 winter commercial fishery (January and February) (Figure 1).

Two hundred (200) smelt were randomly selected from each location and examined for the presence of sealworm larvae in the musculature and viscera using the same techniques as described in Landry and Hare (1990). Fork length, weight and sex were recorded for each smelt examined.

Four (4) size groups were selected as per previous surveys, approximating year classes 1 and 2 (length $\leq$ 16.0 cm), 3 (16.0 cm $>$ length $\leq$ 17.5 cm), 4 (17.5 cm $>$ length $\leq$ 19.0 cm) and 5 and older (length $>$ 19.0 cm).

Sealworm infection data from the 1984 to 1989 collections were analyzed to evaluate sealworm presence (prevalence)/host length relationship by logistic regression, and to evaluate geographical and annual variations by log-linear model, using the CATMOD procedure (SAS, 1982). Annual variations in sealworm counts were also evaluated by the Kruskal-Wallis test (Siegel, 1956).

RESULTS

In general, sealworm infection levels in smelt from 1989, were not significantly different from those

in smelt collected earlier (1984-1988) (Table 1). The overall sealworm prevalence (percentage of infected fish per sample) in smelt collected from 1984 to 1988 was 10.1% compared with 9.5% in smelt collected in 1989. In earlier surveys, the lowest sealworm abundance (mean number of parasites per host) was observed in the Nouvelle, P.Q. (0.03), whereas the highest sealworm abundance was found in River John, N.S (0.35) (Figure 2). Due to the random nature of the samples collected and the variation in host size composition from one sample to another, density (number of parasite per unit of weight (kg) of host examined) offers the most reliable comparative statistic. Sealworm densities obtained from the samples examined in this survey ranged from 0.5/kg in Nouvelle, to 8.5/kg in River John.

The effect of host size on sealworm presence was evaluated by a log regression model, and was found to be significant ($p < 0.05$) in seven of the thirty one samples examined (Table 1). Sealworm prevalence increased with host size in all of these seven samples.

Evaluation of the geographical and annual variations were carried out by a log linear model for each of the four size groups representing approximately ages 1-2, 3, 4, and 5 years and older. Geographical variation in sealworm prevalence was found to be significant for all four size groups (Figure 3). Annual variations in sealworm prevalence were found to be significant in Loggieville, N.B. for size groups 1 and 2; in Cheticamp, N.S. for size groups 3 and 4; and in River John, N.S. for size group 4 (Table 2). Similar results were also obtained when evaluating annual variations in sealworm counts, using the Kruskall-Wallis test.

A smelt sample was collected for the first time of this survey, from East Bay (Port au Port), Nfld. This location was of particular interest since a sample from the same location was collected and examined in 1953 (Templeman et al. 1957). From the 122 smelt they examined, 2% were infected with sealworms, with a density of 0.18/kg. Smelt collected in 1989 from this area had a sealworm prevalence of 4.5%, with a density of 1.18/kg.

DISCUSSION

Sealworm infection levels in smelt from the Gulf of St. Lawrence have remained relatively stable since this survey was initiated in 1984, with the exception of 1988, where sealworm density rose to 5.69/kg from a five year average of 3.77/kg (3.10/kg excluding 1988). Comparison of the results obtained from a single sample collected in 1989 from Port au Port, Nfld, with those from Templeman et al. (1957) from the same area, however, suggests that sealworm density in smelt have increased over 6 folds since the early 1950's.

Unlike previous surveys, each of the four size groups were included in the analysis in order to

evaluate variations in sealworm prevalence and count within each size-group. This may provide a potential to follow the dynamics of specific sealworm year classes within a geographical area. Increases in sealworm abundance from 1988 were reflected in the presence of significant annual variations in Loggieville, N.B. for size-groups 1 and 2, in Cheticamp, N.S. for size-groups 3 and 4, and in River John, N.S. for size-group 4. It is interesting to note, however, that Loggieville was the only location where the younger smelt (size-groups 1 and 2) were affected whereas in the two other locations, the older fishes reflected this increase. This could suggest that in Cheticamp and River John, N.S., where samples were examined for the first time in 1988, a year of high sealworm abundance was being carried out by the older year classes of smelt. In Loggieville, N.B., the presence of significant annual variation was reported from the 1988 sample for size-group 1 (Landry, 1989). Here, the absence of significant differences in sealworm prevalence and counts in size-groups 3 and 4 would indicate that the older smelt are less affected by an annual increase in sealworm abundance, due to differences in their behaviour or diet composition. One possible explanation is that during the first year of their lives, smelt do not participate in the spawning migration, remaining in the marine environment and feeding actively throughout the year, thus increasing their exposure to sealworm infection (McKenzie, 1964). In this case, the increase in sealworm abundance in size-groups 1 and 2 should be noticeable in size-groups 3 and 4 over the next two years.

The distribution of sealworm abundance in the Gulf of St. Lawrence is considered to reflect the distribution of grey seals (Halichoerus gryp us) which is reported to be the most important definitive hosts of P. decipiens (McClelland et al., 1983). The use of smelt as biological indicator of sealworm abundance reflects the limited information available on the temporal and geographical distribution of grey seals in the Gulf of St. Lawrence. The highest sealworm abundance from this survey was found in River John, in the vicinity of Amet Island, N.S., which serves as an important pupping ground for the Gulf grey seal population (Mansfield, 1977). Miramichi Bay is also considered to be an important area for the Gulf grey seal population (Bowen, W.D., personal communication). It harbours a local grey seal stock (500 to 1000 animals) throughout the spring, summer and fall. Furthermore, the Miramichi Bay area is an important feeding ground for a large number of grey seals in the course of their migration to (fall) and from (spring) their pupping grounds in the Amet Island/St. Georges Bay area (personal observation). Sealworm densities in smelt from the Miramichi Bay (Loggieville) are the second highest from this survey. However, unlike the American plaice sealworm survey (McClelland et al., 1987), which provides information for offshore areas, annual sealworm abundances from this inshore survey fail to reflect the growing Gulf grey seal population (Zwanenburg and Bowen, 1990). Two hypotheses can be formulated from this observation: 1) The recruitment of sealworm larvae in smelt is independent from the increasing sealworm abundance in the final host population, due to the inshore distribution of smelt. The presence of significant geographical

variations in sealworm abundance in smelt shows that the limiting factor is not associated with the carrying capacity of smelt as paratenic host of sealworm larvae, but may reflect differences in the sealworm carrying capacity of the ecosystem for each of the inshore area surveyed, due to differences in their intermediate, paratenic and definitive host populations and/or environmental characteristics, eg. average sealworm densities in smelt from the Gulf of St. Lawrence vary from 0.66/kg in Nouvelle to 13.15/kg in River John. The limited annual variation would then reflect stable epidemiological factors for these inshore areas over the duration of this survey (1984 - 1989). 2) The dissemination of sealworm eggs via seal defecation is more pronounced during their offshore activities. Consequently, sealworm abundance is not limited to the carrying capacity of the inshore ecosystem, but rather to the feeding/defecating (recruitment/transmission of sealworm larvae) behaviour of grey seals. It would also suggest that while sealworm abundance is increasing in the Gulf of St. Lawrence, the transmission rate (via seal defecation) in inshore areas has been reduced to the point that sealworm abundance has remained stable for most of the locations that have been investigated in this survey. These two hypotheses are based on the assumption that the American plaice survey for offshore areas is accurately showing an increasing trend in the Gulf's sealworm abundance. However, based on preliminary analysis of sealworm data from an ongoing seal prey species survey (unpublished data), the sealworm density in American plaice collected from offshore areas in the vicinity of the Miramichi Bay in 1988 and 1989, has remained constant at 5.37/kg over this two year period. Furthermore, these results closely resemble those from this survey (smelt) with sealworm densities of 6.79/kg in 1988 and 3.63/kg in 1989. Sealworm densities in cod (Gadus morhua) (seal prey species survey - offshore Miramichi Bay) which is not considered to be a good host indicators due to their migratory behaviour (McClelland et al., 1985), are even closer to the sealworm density in smelt, with 5.04/kg in 1988 and 3.11/kg in 1989. The discrepancy between the sealworm infection levels in American plaice and cod here and those reported from the same area by McClelland et al. (1983, 1985 and 1987) may be attributed to host size differences, which would imply a change in the biology of plaice and cod from the size range examined here to the size range examined by McClelland and is team. From these results, however, it appears that the use of smelt as host indicator of sealworm abundance may be as appropriate for offshore areas as it is for inshore areas, considering that sealworm abundance does not seem to differ significantly between these two environments.

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REFERENCES

Landry, T. 1989. American smelt, Osmerus mordax, as host indicator of sealworm, Pseudoterranova decipiens, abundance in the Gulf of St. Lawrence, Canada. In: Moller, H. (ed): "Nematode problems in North Atlantic fish. Report from a workshop in Kiel, 3-4 April 1989." Int. Counc. Explor. Sea, C.M./ F:6, 37-41.

Landry, T. in preparation. The use of parasites of rainbow smelt (Osmerus mordax) from the Gulf of St. Lawrence as biological indicators.

Landry, T., and G.M. Hare. 1990. Abundance of sealworm (Pseudoterranova decipiens) in rainbow smelt (Osmerus mordax) from the southwestern coast of the Gulf of St. Lawrence. p. 000-000. In W.D. Bowen [ed.] Population biology of sealworm (Pseudoterranova decipiens) in relation to its intermediate and seal hosts. Can. Bull. Fish. Aquat. Sci. 222. (in Press).

Mansfield, A.W., and B. Beck. 1977. The grey seal in eastern Canada. Environment Canada, Fish. Mar. Serv. Tech. Rep. 704.

McClelland, G., R.K. Misra and D.J. Marcogliese. 1983. Variation in abundance of larval anisakines, sealworm (Phocanema decipiens) and related species in cod and flatfish from the southern Gulf of St. Lawrence (4T) and the Breton Shelf (4Vn). Can. Tech. Rep. Fish. Aquat. Sci. No. 1201. ix + 51 p.

McClelland, G., R.K. Misra and D.J. Martell. 1985. Variations in abundance of larval anisakines, sealworm (Pseudoterranova decipiens) and related species, in eastern Canadian cod and Flattfish. Can. Tech. Rep. Fish. Rep. Fish. Aquat. Sci. No. 1392. xi + 57 p.

McClelland, G., R.K. Misra and D.J. Martell. 1987. Temporal and geographical variations in abundance of larval sealworm Pseudoterranova (Phocanema) decipiens in the fillets of American plaice (Hippoglossoides platessoides) in Eastern Canada: 1985-1986 surveys. Can. Tec. Rep. Fish. Aquat. Sci. No. 1513. ix + 15 p.

McKenzie, R.A. 1964. Smelt life history and fishery in the Miramichi River, New Brunswick. Bull. Fish. Res.

Board Can. No. 144, 77 p.

Siegel, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Company Inc. New York. 312 pp.

Templeman, W., H.J. Squires and A.M. Fleming. 1957. Nematodes in the fillets of cod and other fishes in the Newfoundland and neighbouring areas. J. Fish. Res. Board Can. 14(16): 831-897.

Zwanenburg, K. and W.D. Bowen. 1989. Population trend of the grey seal (Halichoerus grypus) in eastern Canada. Bull. Can. J. Fish. Aqua. Sci. (In Press).

Table 1. Prevalence, abundance and density of sealworm larvae (Pseudoterranova decipiens) in rainbow smelt (Osmerus mordax) from the Gulf of St. Lawrence (1984-1989).

Location	Year	n	Prevalence	Abundance	Density
1. CARAQUET, N.B.	1985	200	1.50	0.015	0.88
	1987	200	7.00	0.100	2.75
	1988	200	4.00	0.055	1.84
	1989	200	2.50	0.025	0.93
2. CHETICAMP, N.S.	1988	147	19.05	0.286	4.93
	1989	200	6.50	0.170	5.90
3. COCAGNE, N.B.	1984	200	10.50	0.120	4.37
	1985	200	11.50	0.120	4.06
	1987	200	6.50	0.100	3.49
	1988*	200	8.00	0.110	3.59
	1989	200	11.00	0.150	4.26
4. GASPE, P.Q.	1988	185	15.68	0.168	2.64
	1989	200	11.00	0.120	4.50
5. KOUCHIBOUGUAC, N.B.	1984	200	5.00	0.070	2.97
	1985	200	9.00	0.100	3.35
	1987*	200	10.50	0.145	3.87
	1988*	200	17.50	0.235	6.79
	1989*	200	11.00	0.120	3.04
6. LOGGIEVILLE, N.B.	1984	200	14.50	0.145	4.76
	1985	200	12.00	0.150	4.86
	1987*	200	13.00	0.140	3.90
	1988	200	23.00	0.280	6.70
	1989	200	12.00	0.135	3.63
7. NOUVELLE, P.Q.	1984	200	1.50	0.030	1.05
	1985	200	0.50	0.005	0.21
	1987	200	1.50	0.015	0.33
	1988	200	5.50	0.055	1.24
	1989	200	1.00	0.020	0.47
8. PORT AU PORT, NFLD	1989	200	4.50	0.050	1.18
9. RIVER JOHN, N.S.	1988*	200	31.00	0.650	17.55
	1989*	200	26.00	0.350	8.55

* indicates samples with significant ($p < 0.05$) variation in sealworm prevalence among size groups.

Table 2. Log-linear model analysis of annual variation in the prevalence of sealworm larvae (Pseudoterranova decipiens) in four size groups of rainbow smelt (Osmerus mordax) from the Gulf of St. Lawrence (1984-1989).

Location	Size Group	Chi-Square	Probability
1. CARAQUET, N.B	1	7.01	0.0716
	2	0.79	0.8524
	3	2.34	0.5042
	4	0.14	0.9345
2. CHETICAMP, N.S.	1	------	---------
	2	1.12	0.2902
	3	4.33	0.0375*
	4	9.73	0.0018*
3. COCAGNE, N.B.	1	6.03	0.1969
	2	9.13	0.0580
	3	5.39	0.2498
	4	1.25	0.8692
4. GASPE, P.Q.	1	2.60	0.1065
	2	0.00	0.9652
	3	2.53	0.1115
	4	3.37	0.0664
5. KOUCHIBOUGUAC, N.B.	1	4.37	0.3588
	2	4.88	0.3002
	3	4.40	0.3546
	4	1.51	0.8242
6. LOGGIEVILLE, N.B.	1	13.60	0.0087*
	2	11.94	0.0178*
	3	4.51	0.3409
	4	5.67	0.2250
7. NOUVELLE, P.Q.	1	1.89	0.7552
	2	2.38	0.6661
	3	2.49	0.6467
	4	4.44	0.3492
8. PORT AU PORT, NFLD	-	------	---------
9. RIVER JOHN, N.S.	1	2.98	0.0841
	2	2.17	0.1409
	3	0.16	0.6903
	4	4.73	0.0297*

* indicates significant ($p < 0.05$) annual variation.

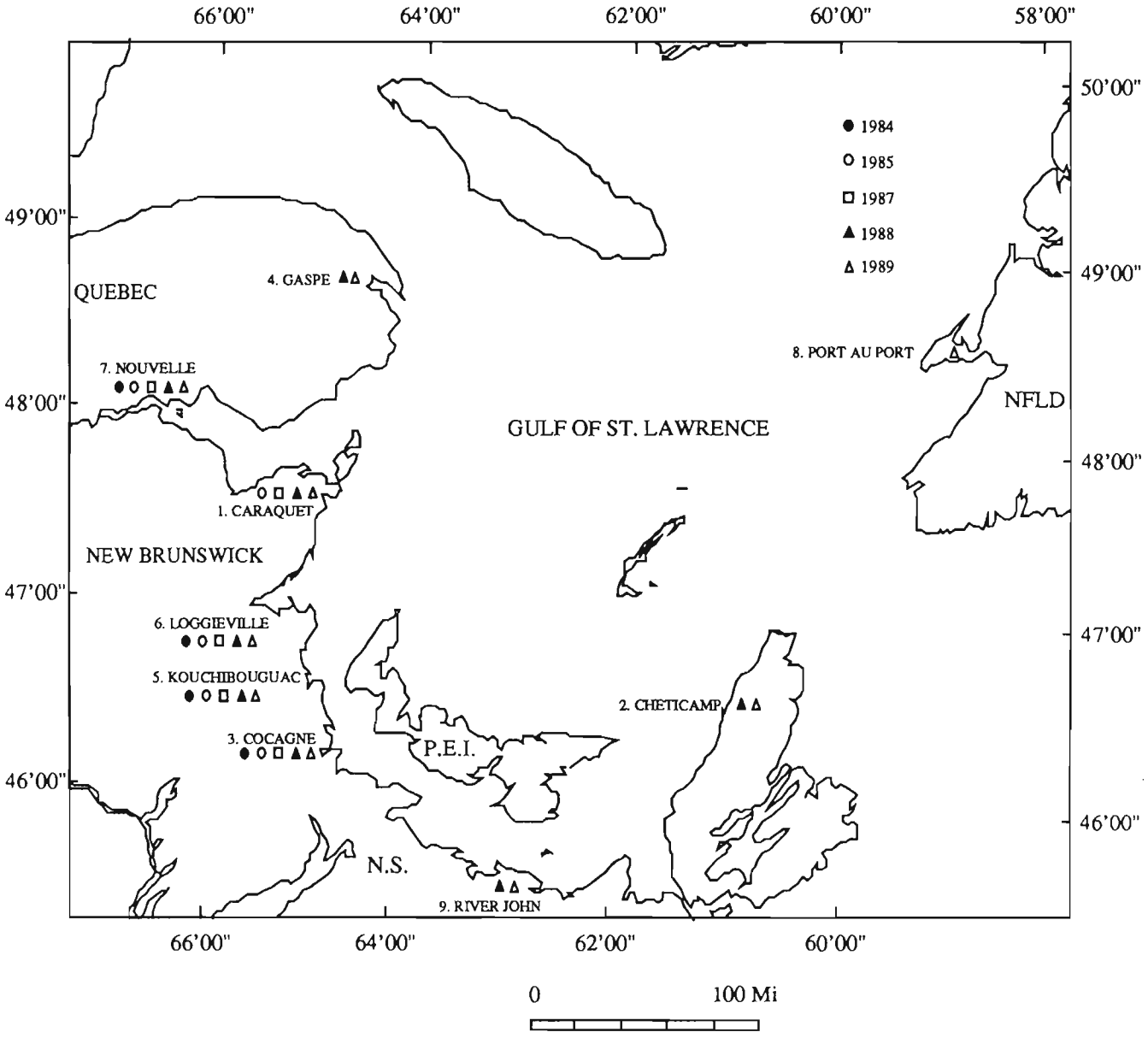

Figure 1. Sampling locations in the Gulf of St. Lawrence (1984-1989).

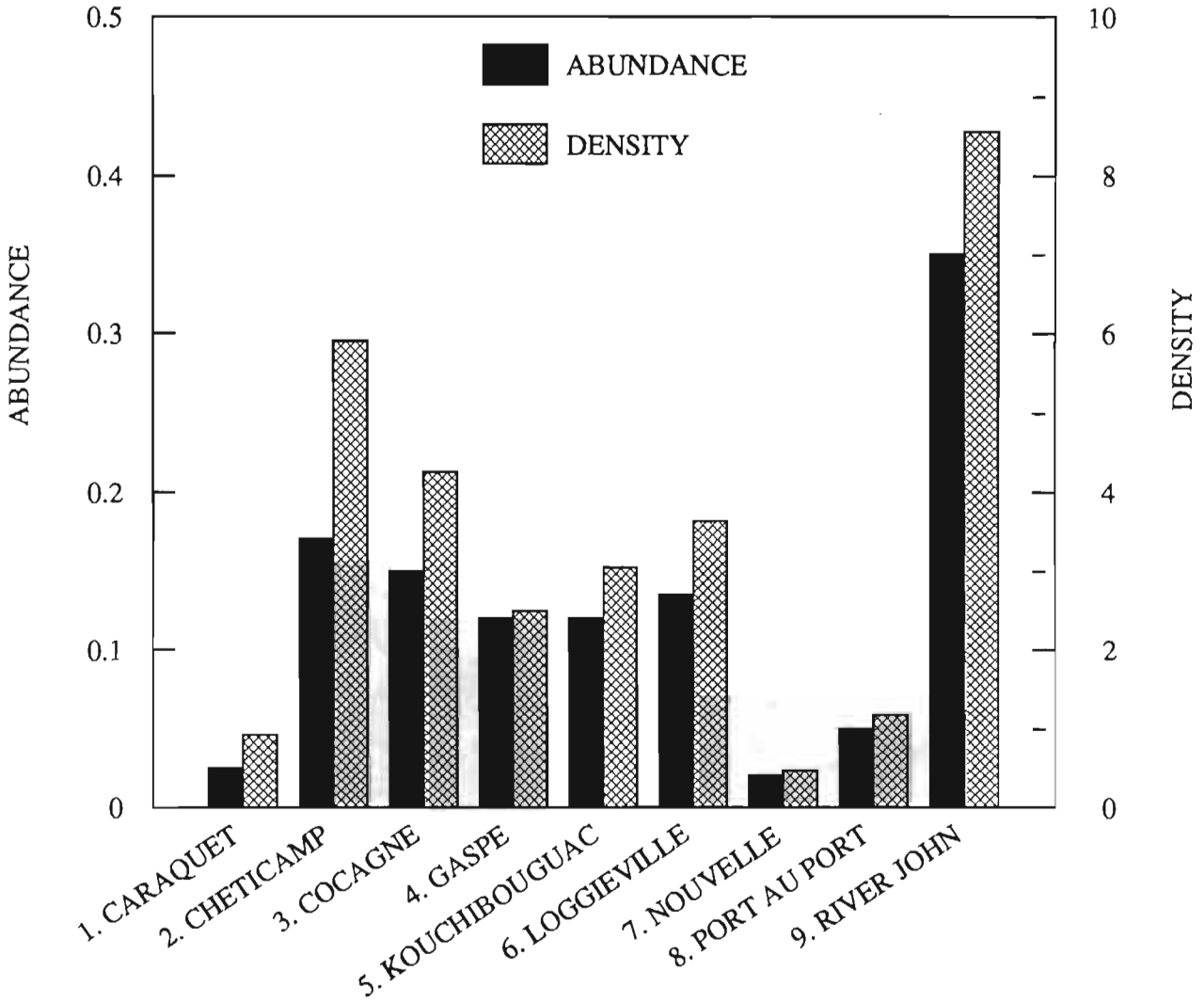

Figure 2. Geographical variation in abundance and density of sealworm larvae *(Pseudoterranova decipiens)* in rainbow smelt *(Osmerus mordax)* from the Gulf of St. Lawrence, 1989.

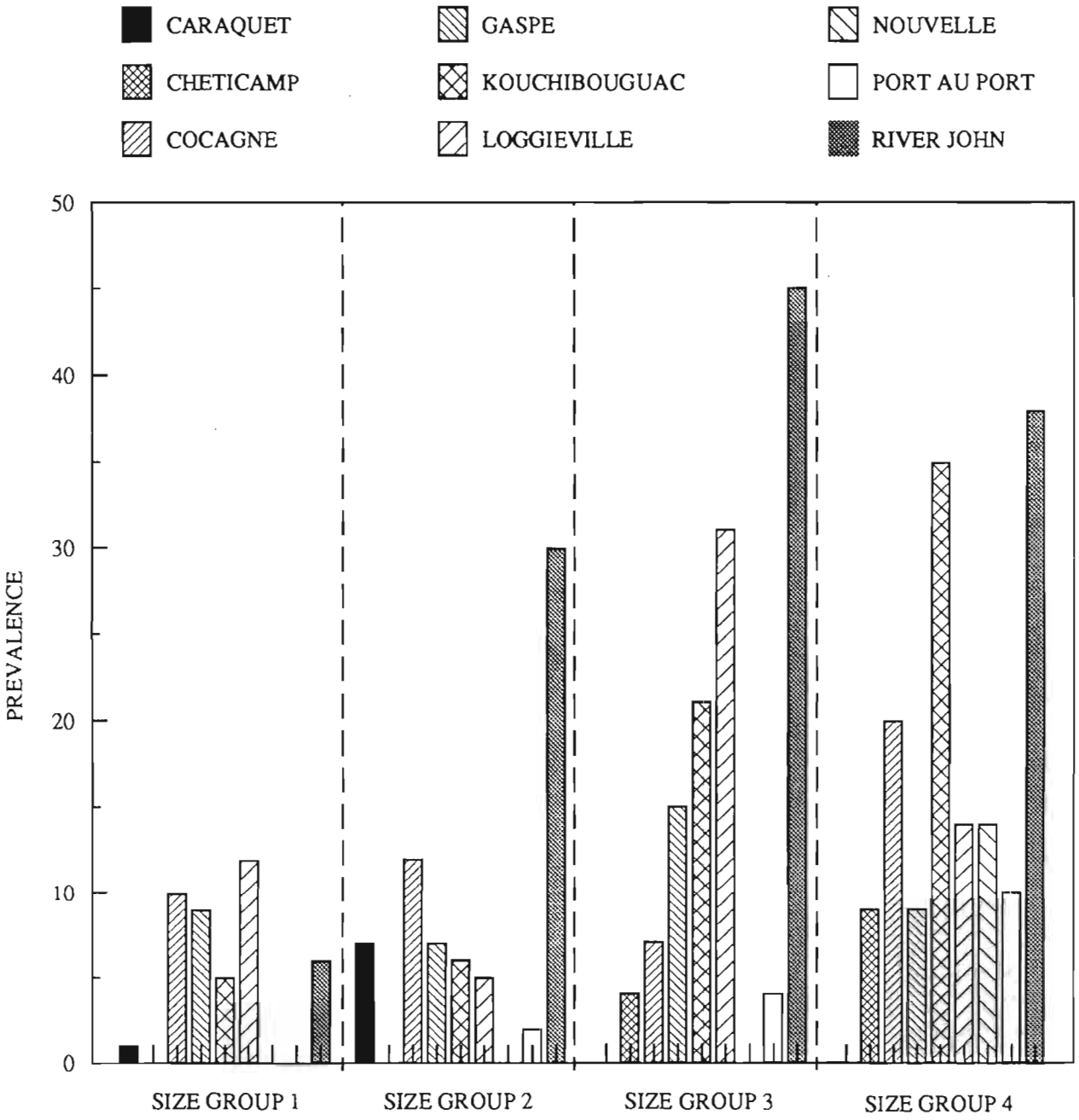

Figure 3. Geographical variation in prevalence of sealworm larvae *(Pseudoterranova decipiens)* in four size groups of rainbow smelt *(Osmerus mordax)* from the Gulf of St. Lawrence, 1989.