Preliminary Study of the Stock Structure of Pollock (*Pollachius virens* L.) on the Scotian Shelf and in the Gulf of Maine

by

J.M. McGlade
Marine Fish Division
Fisheries and Oceans
P.O. Box 1006
Dartmouth, N.S. B2Y 4A2

Abstract

Information from three stages of the life history are presented, in an attempt to provide a background for stock delineation of pollock in the northwestern Atlantic. The conclusions support the thesis that pollock in the Gulf of Maine are distinct from those on the Scotian Shelf, however commercial fisheries exploit the various stocks at different phases of the life history. It is therefore concluded that until more detailed evidence of the genetic structure of the pollock populations is available, current management strategies should contine to treat them as one unit.

Résumé

Nous présentons des informations tirées de trois étapes du cycle biologique, dans une tentative pour jeter les bases de la description des populations de goberge dans l'Atlantique nord-ouest. Les conclusions viennent à l'appui de la thèse suivant laquelle le goberge du golfe du Maine est distinct de celui du plateau continental Scotian; la pêche commerciale exploite toutefois les diverses populations à différentes étapes du cycle biologique. La conclusion qui s'impose par conséquent est que, tant que l'on ne disposera pas de données plus précises sur la structure génétique des populations de goberge, il y a lieu de continuer à les traiter comme un tout homogène, conformément aux stratégies de gestion actuelles.

Introduction

Pollock, (Pollachius virens L.) is an amphiboreal species of the Atlantic Ocean. It has a number of synonynies (Table 1) but is generally regarded to be a distinct species. Its life span is approximatley 17 years, although signs of senescence have been observed in specimens aged 11 years or more (Storozhuk 1978). As juveniles, pollock migrate from offshore areas, to inshore nursery grounds: they then disperse, as adults, throughout the continental shelf. Pollock is however a schooling fish, forming age-specific aggregates; this fact confounds any simple areal approach to management. The results of various studies are thus presented, to provide some background information on the underlying stock structure of pollock in the northwestern Atlantic.

Temporal and Spatial Distribution of the Life History Stages of Pollock on the Scotian Shelf

A. Eggs and Larvae

The Scotian Shelf Ichthyoplankton Program (SSIP) was designed to provide basic information on the spatial and temporal distribution of eggs and larvae. A standard sampling grid of 150 stations, with an interstation spacing of approximately 30 km was established, and surveyed as completely and as often as possible from August 1976 to 1982. Samples were taken with a MARMAP 61 cm bongo sampler (Pogsay and Marak 1980), which had a flowmeter in each drum and 0.333 mm mesh nets. The nets were lowered to 200 m, at a ship's speed of 2.0-2.5 knots, to give a 45° wire angle. Wire speed rates were 20 and 50 m min^{-1}, in and out respectively. Surface tows were also undertaken. A 1.8 m Isaacs-Kidd midwater trawl with 0.471 mm mesh was also used, in a stepped oblique tow for 30 minutes at a ship's speed of 5 knots. The maximum sampling depth was 400 m or 5 m off the bottom. All samples were stored in 5% buffered formalin, and subsequently identified to genus or species where possible. Eggs and larvae were then counted and larvae measured to the nearest mm. Abundance estimates were calculated as numbers per m^3 for bongo collections, and numbers per tow in the case of the Isaacs-Kidd trawl. The separation between larvae and juveniles for pollock was based on a size criterion, where all specimens above 17 mm were assigned as juveniles.

Historical data from the Gulf of Maine and Bay of Fundy were collated from various literature sources (Bigelow 1917; Bigelow and Schroeder 1953; Colton and Temple 1961; Steele 1963; Colton and Byron 1977; Bolz et al. 1981; Sherman et al. 1981).

The occurrence of eggs, larvae and juveniles is given in Table 2. It should be noted that the rate of development from spawning to hatching is approximately seven days. Thus the distribution of eggs and larvae (Stage 1) provide a good indication of spawning activity. Moreover any demonstration of larval drift, as described by Cushing (1982), is questionable. Rather the data from the SSIP program show that eggs and larvae occur in the same general area over considerable periods of time, despite highly variable patterns of surface-water circulation on the Scotian Shelf. Instead larval retention areas (Iles and Sinclair 1982) and larval

aggregation may play important roles in defining gadoid stock structure.

Eggs and larvae appear in the samples between October and May, with the heaviest concentrations in January in the Emerald-Western Banks area, and on the southern edge of Browns Bank; these gradually decline until April-May (Figs. 1-6).

Pollock larvae also occur in the Bay of Fundy larval herring survey, which covers the whole of the Bay out to the eastern part of the Gulf of Maine (Scott 1980). Their distribution however suggests that they come from spawning grounds outside the Bay. This agrees with the conclusions made by Steele (1963), who suggested that pollock in the Bay of Fundy originate from the Gulf of Maine or the Scotian Shelf. Studies in the Gulf of Maine and Middle Atlantic Bight (Bigelow and Welsh 1925) as well as ichthyoplankton surveys conducted in the 1950s and 1960s, indicate that pollock spawn in the southern part of the Gulf of Maine (Massachusetts Bay, Stellwagen Bank and South Channel) from November to February (Colton et al. 1979).

Juveniles were only present in samples from the Scotian Shelf during February through to May. Their low numbers may be indicative of migration away from the offshore banks, or simply avoidance of the Isaacs-Kidd trawl, and Bongo gear. They are however observed close inshore during April and May, at lengths of 5 cm, which would suggest that migration is of importance.

The results of ichthyoplankton surveys conducted throughout the range of this species in the northwestern Atlantic indicate that pollock spawn on the Scotian Shelf and in the Gulf of Maine from October to May; the highest levels of activity occur between November and February. The presence of temporal and spatial discontinuities in the distribution of eggs and larvae supports the conclusion that pollock have separate spawning grounds around Emerald and Western Banks, on Browns Bank, inshore along the south shore of Nova Scotia, and in the Gulf of Maine on Jeffries Ledge.

B. Juvenile Distribution

Results from tagging studies, the age composition of catches from inshore fixed gears and historical reports all indicate that 0+ and 1+ pollock occur along the seaboard of the Gulf of Maine, New Brunswick, and Nova Scotia (W. Stobo pers. comm.; McGlade and Beanlands 1982; Bigelow and Schroeder 1953; Steele 1963). There are however several areas along the coastline that have become nursery areas, for example Chedabucto Bay, in which large concentrations are observed throughout the summer period. Returns from tagging experiments in the area show that juveniles are subsequently captured across the entire Scotian Shelf and on the northeastern edge of Georges Bank (W. Stobo, pers. comm.).

C. Adult Distribution

Results from the research bottom-trawl surveys and the commercial fishery indicate that pollock are distributed throughout the Gulf of Maine and Scotian Shelf during the summer months (Bigelow and Schroeder 1953; Scott 1976; McGlade and Beanlands 1982). The preferred depth range on the Scotian Shelf for pollock is 20-199 fath., with temperature preference lowest in the northwestern part and relatively constant (7.2°-8.6°C) over the rest of the range (Scott 1982). The salinity preferendum was highest over the middle and southern Shelf, and lowest in Division 4Vn and the Bay of Fundy.

Results from the spring surveys in 1979 and 1980 and fall survey in 1979 (H013/14; H026/27; H033/34) show that pollock aggregate in the Emerald-Western Banks area during the fall and spring, and off Browns Bank, during the spring (Figs. 7-9).

Maturity stages from research cruises conducted in November in 1981 and 1982 (Table 3) indicated that a large number of fishes were ripe or running at this time. Aggregations of spawning pollock were located around the northern edges of Emerald Basin, and Western Bank, whilst none were observed further south along the Scotian Shelf and Browns, LaHave and Roseway Banks. Similarly, no aggregations of pollock were observed in the Browns Bank, Georges Bank and Gulf of Maine areas during October 1982 on the U.S. fall research vessel survey (S. Clark, pers. comm.).

Characteristics of Spawning Aggregations of Pollock

Samples of tissues, and morphological and meristic measurements were taken from subsamples of catches from the R.V. survey cruises H062 and H087 (November/December 1981 and 1982), the U.S. fall R.V. survey (1982), and inshore surveys (1982). Electrophoretic analyses have yet to be completed on the tissues, but will be matched against samples of juveniles taken along the seaboard of Nova Scotia and the Gulf of Maine in 1982 and 1983. A multivariate analysis, including principal components analysis and discriminent function analysis of the meristic data and the morphological data (based on a truss configuration showed a clear division between adult fish from the western Gulf of Maine, Browns and Roseway Banks, and Emerald and Western Banks (Fig. 10). The methodology employed follows the procedures given by Strauss and Bookstein (1983).

Conclusions

Results indicate that pollock form spawning aggregations on Emerald-Western Banks, Browns, Roseway and LaHave Banks, inshore along the south shore of Nova Scotia, Georges Bank and Jeffries Ledge in the Gulf of Maine. Eggs, larvae and juveniles show discontinuities in the offshore areas that coincide with these spawning grounds. Juveniles (0+ and 1+) are found inshore, in inlets and harbours throughout the following summer, in what may be termed "nursery areas".

The distribution of juvenile pollock, as determined from tagging studies, indicates a trans-Scotian Shelf and eastern Gulf of Maine distribution for the 3+ and 4+ age groups. The main questions are ones which cannot be answered until electrophoretic studies have been completed. These are whether certain spawning areas and nursery areas are linked, and whether their gene pool is discrete both spatially and temporally. There is some evidence from the meristics data that spawning aggregations share suites of characters that have some genetic basis. Moreover these same areas are characterized by fish with slightly different growth rates but with similar patterns of year class strengths (McGlade and Beanlands 1982). However the distribution of age 2, 3, and 4 year old pollock across the whole area, suggests that the commercial fishery exploits all of the different gene pools. Thus regardless of gene leakage or integrity, part of the potential spawning biomass is likely to be removed in areas outside of a simple division of the spawning resources viz. Divisions 4X and 4VW.

Acknowledgements

This study would not have been possible without the help of D. Beanlands, C. Annand, V. Sisk, R. Stone, W. Stobo, S. Hawkins, M. Poitven, R. O'Boyle, P. Hurley, and M. Fowler.

References

Bigelow, H.B. 1917. Explorations of the coast water between Cape Cod and Halifax in 1914 and 1915, by the U.S. Fisheries Schooner Grampus. Oceanography and Plankton. Bull. Museum. Comp. Zoology at Harvard College, Vol. LXI, No. 8, July, 1917.

Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bull. of the Fish and Wildlife Serv., Vol. 53, 577 pp.

Bigelow, H.B. and W.W. Welsh. 1925. Fishes of the Gulf of Maine. Bull. U.S. Bur. Fish., Vol. 40, Part 1, 567 pp.

Bolz, G.R., R.G. Lough, and D.C. Potter. 1981. Autumn and Winter abundance and distribution of ichthyoplankton on Georges Bank and Nantucket Shoals, 1974-1976, with special emphasis on dominant species. Rapp. p-v Reun. Cons. int Explor. Mer., 178: 168 - 170.

Colton, J.B. Jr. and R.R. Byron. 1977. Gulf of Maine-Georges Bank ichthyoplankton collected on ICNAF larval herring surveys September 1971 - February 1975. NOAA Tech. Rep. NMFS SSRF 717, 35 pp.

Colton, J.B. Jr., W.G. Smith, A.W. Kendall Jr., P.L. Berrien, and M.P. Fahay. 1979. Principal spawning areas and times of marine fishes, Cape Sable to Cape Hatteras. Fish Bull. NOAA (U.S.), 76(4): 911 - 915.

Colton, J.B. Jr and R.F. Temple. 1961. The enigma of Georges Bank spawning. Limnol. & Oceanog., 6: 280 - 291.

Cushing, D.H. 1982. Climate and fisheries. Academic Press, London, 373 pp.

Day, F. 1882. Gadus virens 1: 293, pl. LXXXIV, in The Fishes of Great Britain and Ireland (1880-1884). London-Edinburgh.

Fleming, J. 1828. A history of British animals exhibiting the descriptive characters and systematical arrangements of the genera and species of quadrupeds, birds, reptiles, fishes, mollusca and radiata of the U.K., including the indigenous, extirpated and extinct kinds, together with periodical and occasional visitants. Edinburgh-London, xxiii + 565 pp. (2nd ed., 1842, same pag.).

Gill, T.N. 1864. Synopsis of the North American gadoid fishes. Proc. Acad. Nat. Sci., Philad., 1863 (1864), 15: 229 - 242.

Iles, T.D. and M. Sinclair. 1982. Atlantic herring: stock discreteness and abundance. Science 215: 627 - 633.

Lacepède, B. 1800. Histoire naturelle des poissons (5 vol. in 4, Paris 1798-1803). II: 1800, lxiv + 632 p., 20 pl.

Linnaeus, C. 1758. systema Naturae, ed. X, Vol. 1, 824 p. Nantes + Pisces: 230-338. (Reprint 1956, London.)

McGlade, J.M. and D. Beanlands. 1982. Assessment of pollock in Divisions 4VWX and Subarea 5. CAFSAC Res. Doc. 82/52, 28 pp.

Pogsay, J.A. and R.R. Marak. 1980. The MARMAP bongo zooplankton samplers. J. Northw. Atl. Fish. Sci., 1: 91-99.

Scott, J.S. 1976. Summer distribution of groundfish on the Scotian Shelf, 1970-74. Can. Tech. Rept. Fish. Mar. Serv. No. 635, 16 pp., 32 Figs.

Scott, J.S. 1980. Occurrence of pollock, Pollachius virens, and sand lance, Ammodytes sp., larvae in the Bay of Fundy. J. Northw. Atl. Fish. Sci., 1: 45 - 48.

Scott, J.S. 1982. Depth, temperature and salinity preferences of common fishes of the Scotian Shelf. J. Northw. Atl. Fish. Sci. 3: 29 - 39.

Sherman, K., R. Maurer, R. Byron, and J. Green. 1981. Relationship between larval fish communities and zooplankton prey species in an offshore spawning ground. Rapp. P-v. Reun. Cons. int. Explor. Mer., 178: 289 - 294.

Steele, D.H. 1963. Pollock (Pollachius virens L.) in the Bay of Fundy. J. Fish. Res. Bd. Canada, 20(5): 1267 - 1314.

Storozhuk, A.Y. 1978. Age-related features of the metabolism of the coalfish, Pollachius virens. J. Ichthyol., 18(4): 655 - 665.

Strauss, R.E. and F.L. Bookstein. 1982. The truss: body form reconstructions in morphometrics. Syst. Zool., 31(2): 113 - 135.

Svetovidov, A.N. 1962. Fauna of the USSR. Fishes. Vol.IX, No. 4. Gadiformes. Israel Program for Scientific Translations, 304 pp. Jerusalem.

Table 1. Synonymies and common names for pollock (*Pollachius virens* L.).

Pollachius virens (Linnaeus, 1758)

Gadus virens Linnaeus (1758) Syst. Nat., ed. X: 253.

Gadus carbonarius Linnaeus (1758) ibid: 254.

Gadus colinus Lacepède (1800) 2: 366, 416, 419.

Gadus sey Lacepède (1800) ibid.: 367, 417, 422.

Merlangus virens Fleming (1828): 195.

Merlangus carbonarius Fleming (1828): 195.

Pollachius carbonarius Gill (1864): 231.

Gadus virens Day (1882) 1: 293 pl. LXXXIV.

Pollachius virens Svetovidov (1948): 152, fig. 24, pl. IX (fig. 1), pl. XLIX, pl. LXX (fig. 6).

Common Names: pollock (NA), Boston bluefish (NA), blister-back (NA), merlan moire (Fr), merlan (Fr), colin (Fr), goberge (Fr), lieu noir (Fr), coalfish (En), saithe (En), Sej (Da), Seelachs (DE), koolvis (Ne), sei (No), saida (Ru), gråsj (Sw).

NA = North America; Fr = France; En = England; Da = Denmark; DE = West Germany; Ne = Netherlands; No = Norway; Ru = Russia; Sw = Sweden.

Table 2. Occurrence of early life history stages of pollock on the Scotian Shelf, derived from SSIP cruises (1976-1981).

Month	Year	Cruise	Egg	Larvae	Juveniles
August	1976	P170	-	-	-
	1977	CL01	-	-	-
	1978	VY01-H005	-	-	-
	1980	LE01-AR01	-	-	-
September	1977	FT01	-	-	-
	1979	VY01-H006-H007	-	-	-
	1979	H025	-	-	-
	1980	LE02-AR02-H041	-	-	-
October	1980	AR03	+	-	-
November	1979	H028	+	+	-
	1980	H045	+	+	-
January	1979	H011	+	+	-
	1981	H047	+	+	-
February	1977	CC01	-	-	-
	1980	H032	+	+	+
April	1977	P182		-	-
	1979	H015	-	+	+
	1981	H050	+	+	+
May	1978	CC02	-	-	+
	1979	H018	+	-	+
	1980	H035	+	+	+
June	1980	H036	-	-	-

Table 3. Maturity stages for pollock taken in November/December 1982 on the Scotian Shelf.

Year	N	Sex	MATURITY STAGES (%)				
			Immature	Mature	Ripe/Spawning	Spent	Resting
1982	610	M	21	0	27	0	0
		F	25	0	26	0	1
1981	384	M	7	6	33	2	0
		F	7	9	35	0	1

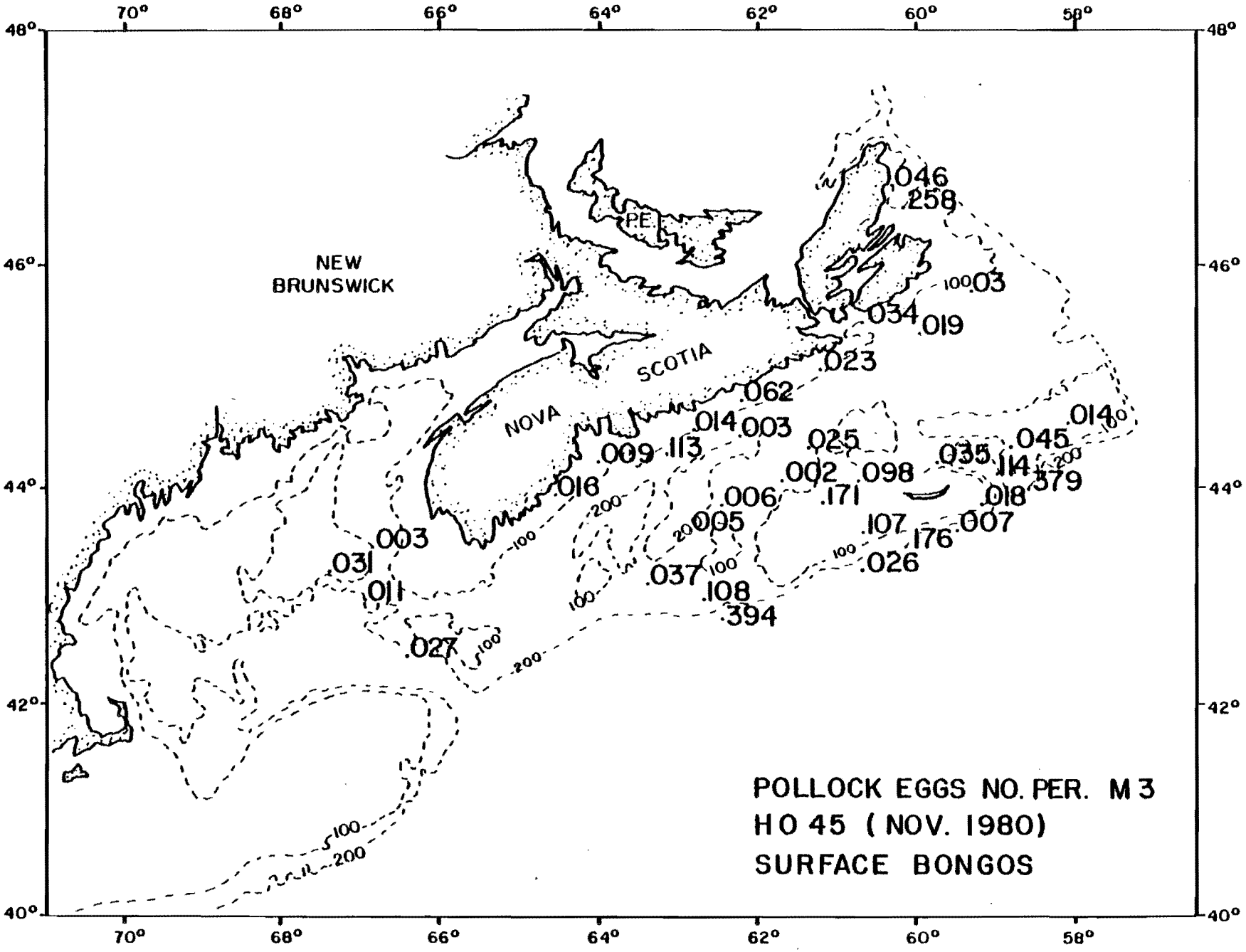

Figure 1. Distribution of pollock eggs from SSIP Cruise H045 (Nov. 1980).

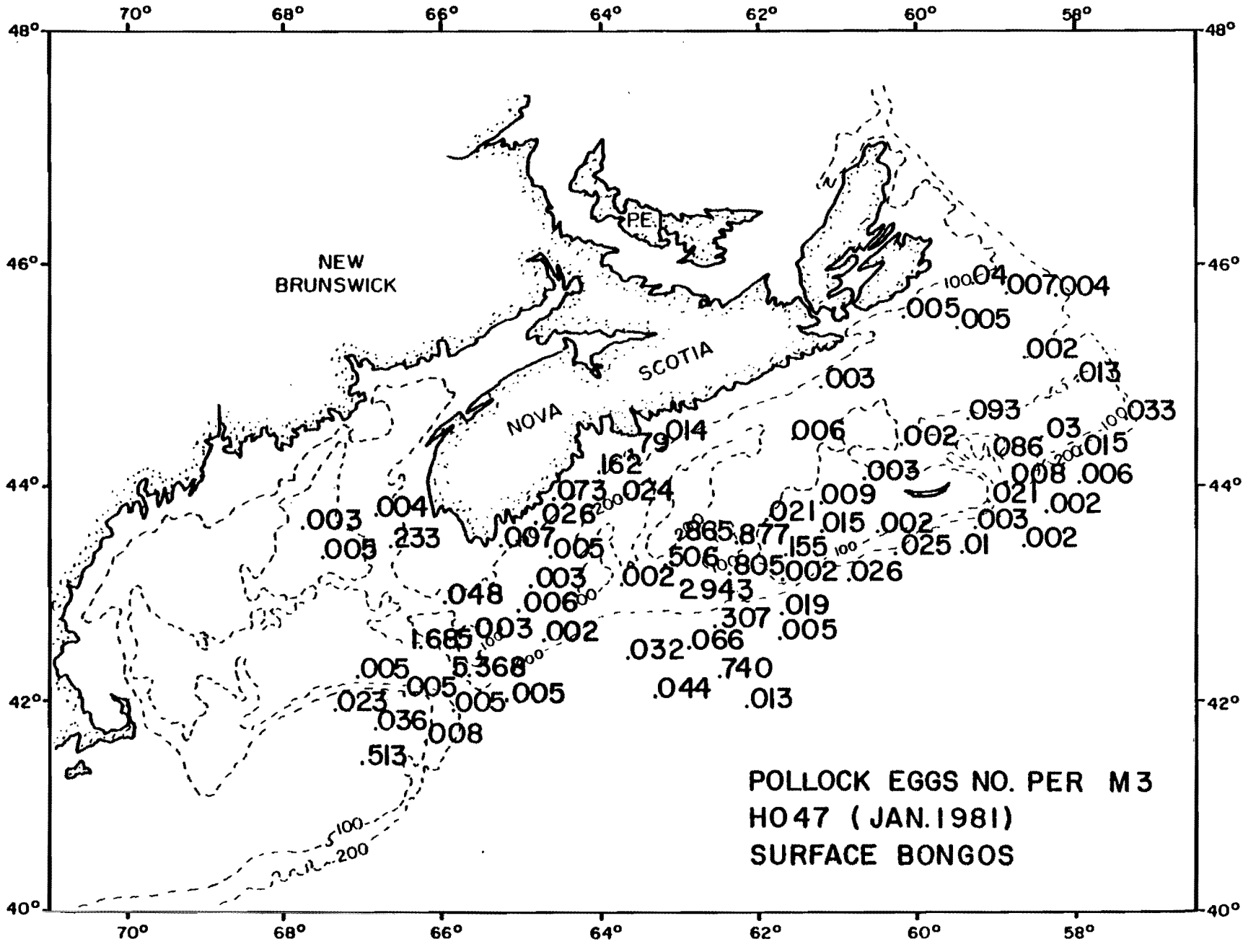

Figure 2. Distribution of pollock eggs from SSIP Cruise H047 (Jan. 1981).

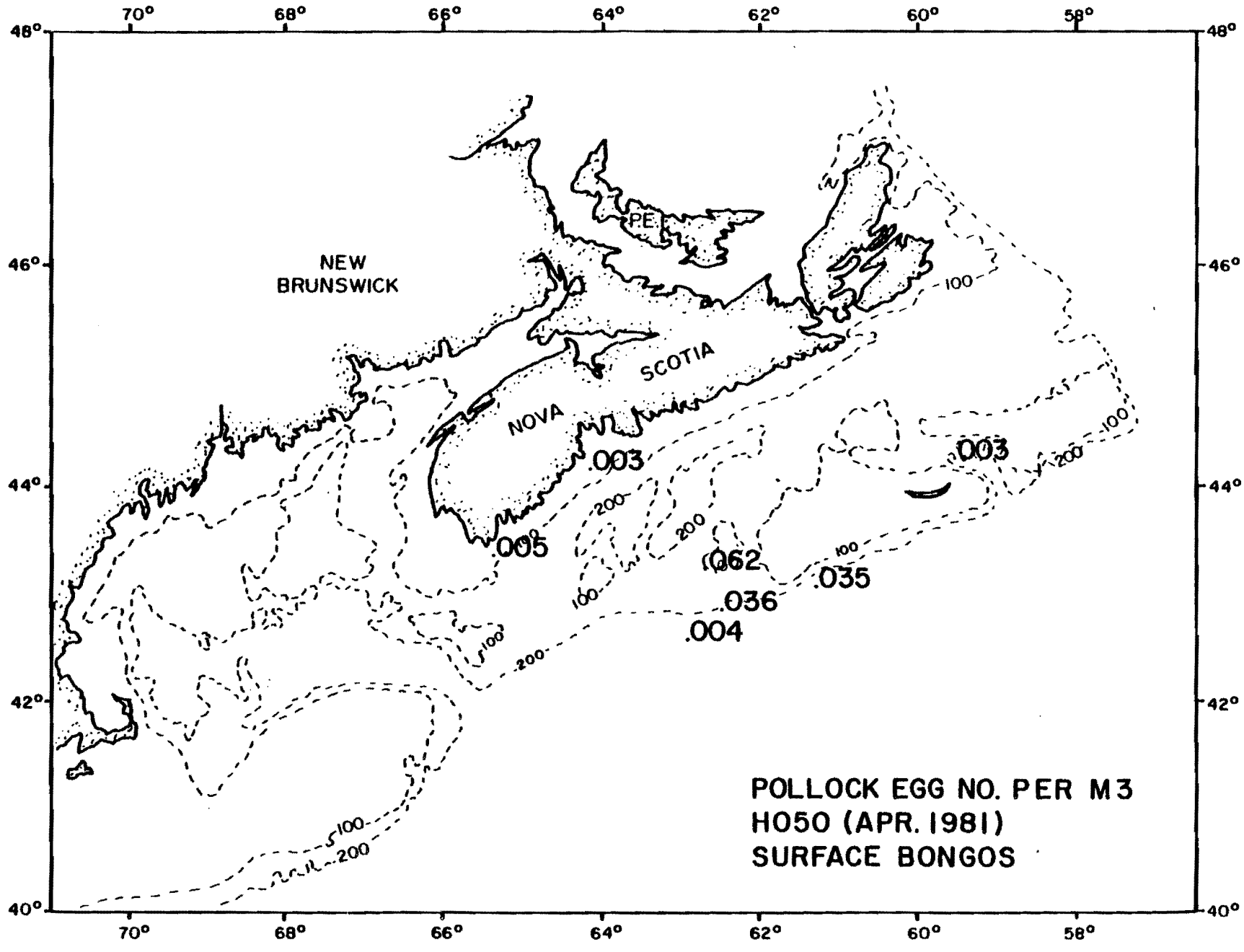

Figure 3. Distribution of pollock eggs from SSIP Cruise H050 (Apr. 1981).

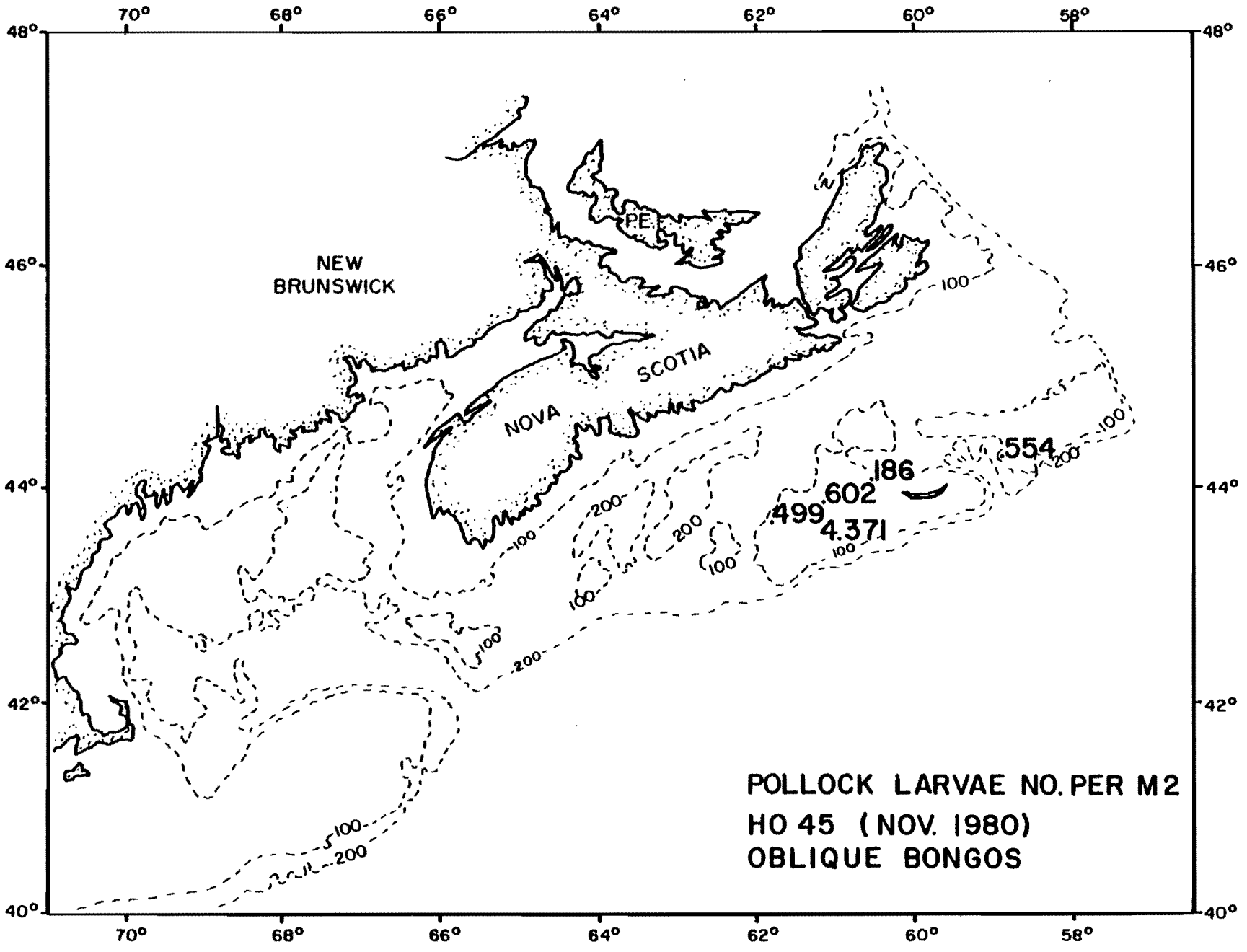

Figure 4. Distribution of pollock larvae from SSIP Cruise H045 (Nov. 1980).

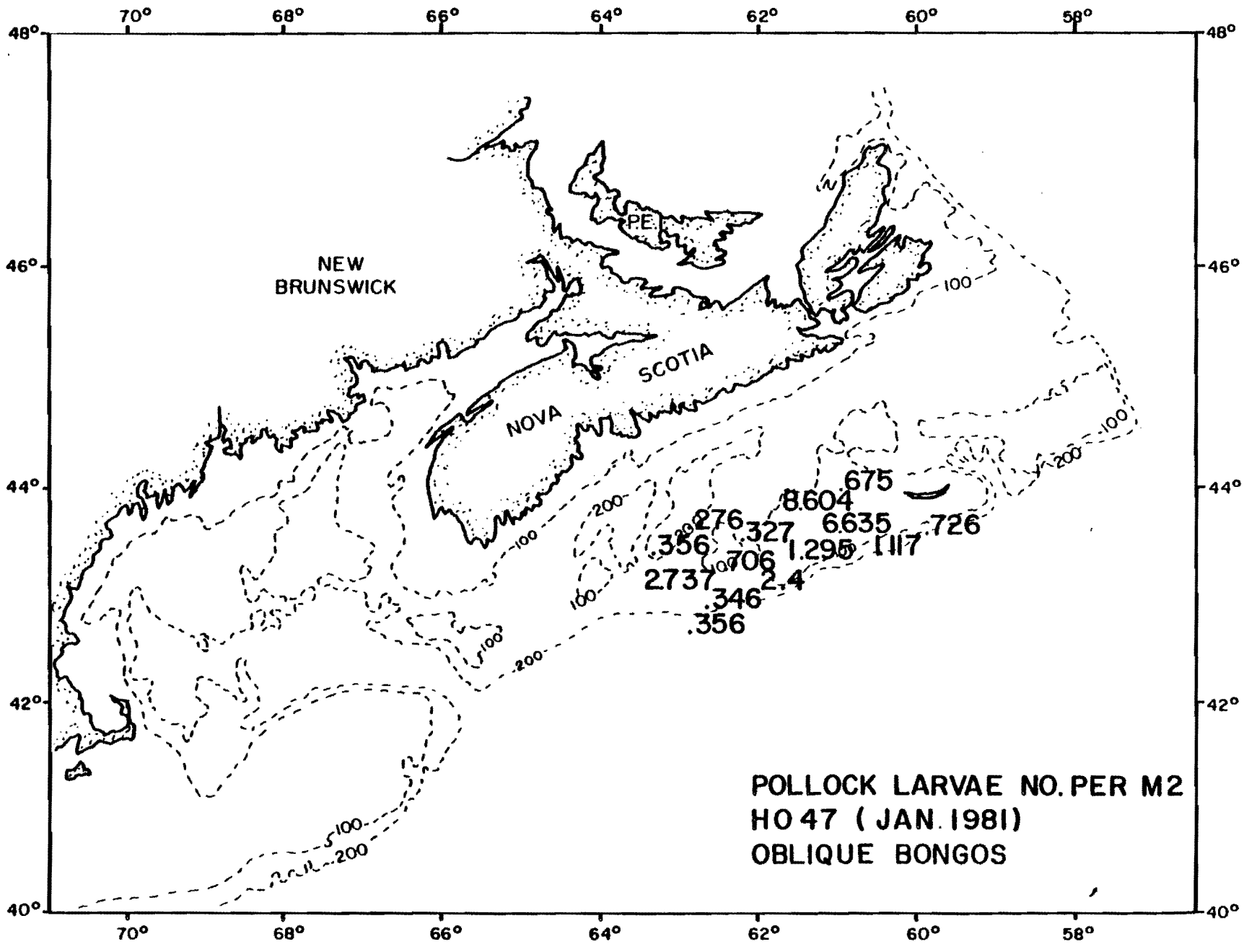

Figure 5. Distribution of pollock larvae from SSIP Cruise H047 (Jan. 1981).

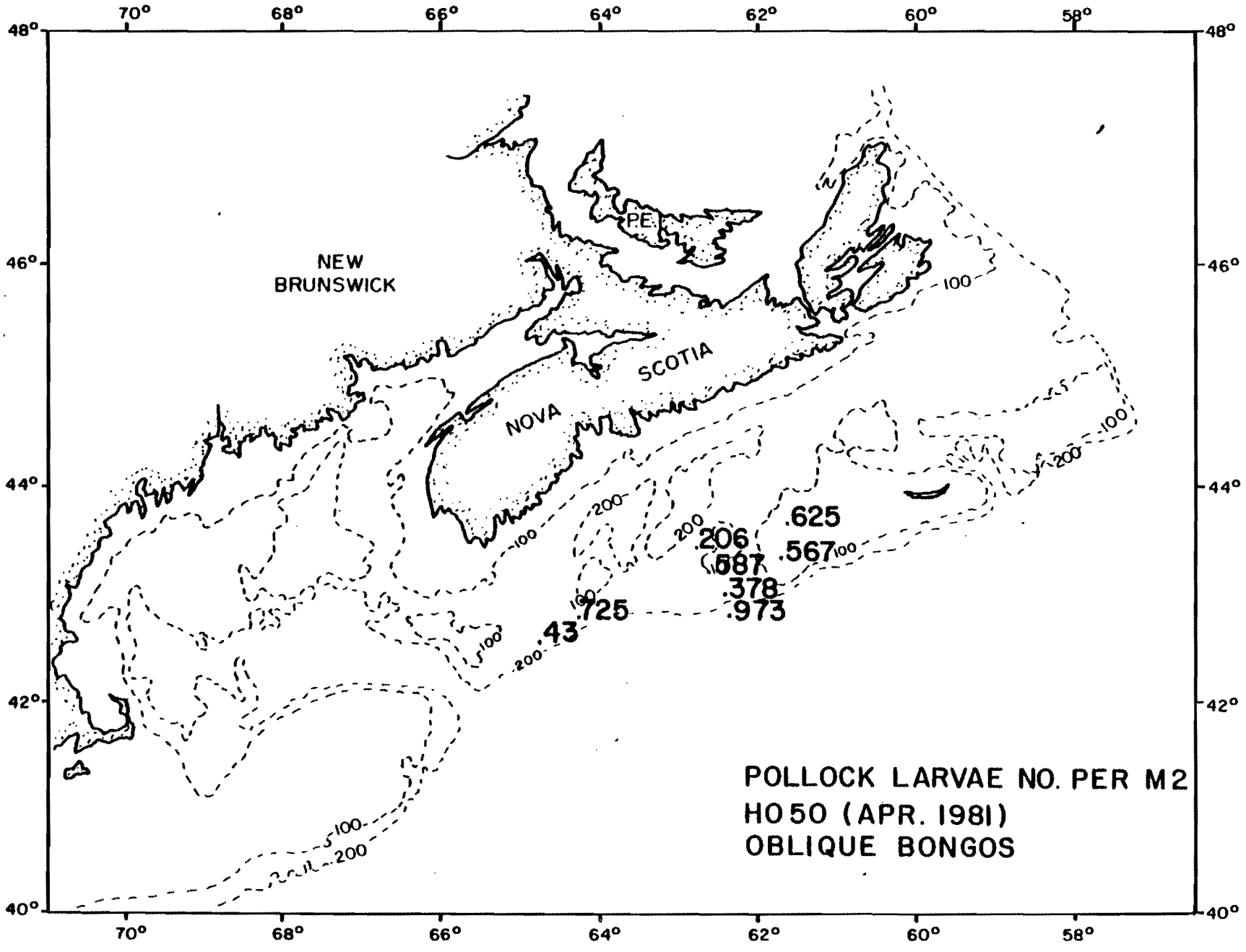

Figure 6. Distribution of pollock larvae from SSIP Cruise H050 (Apr. 1981).

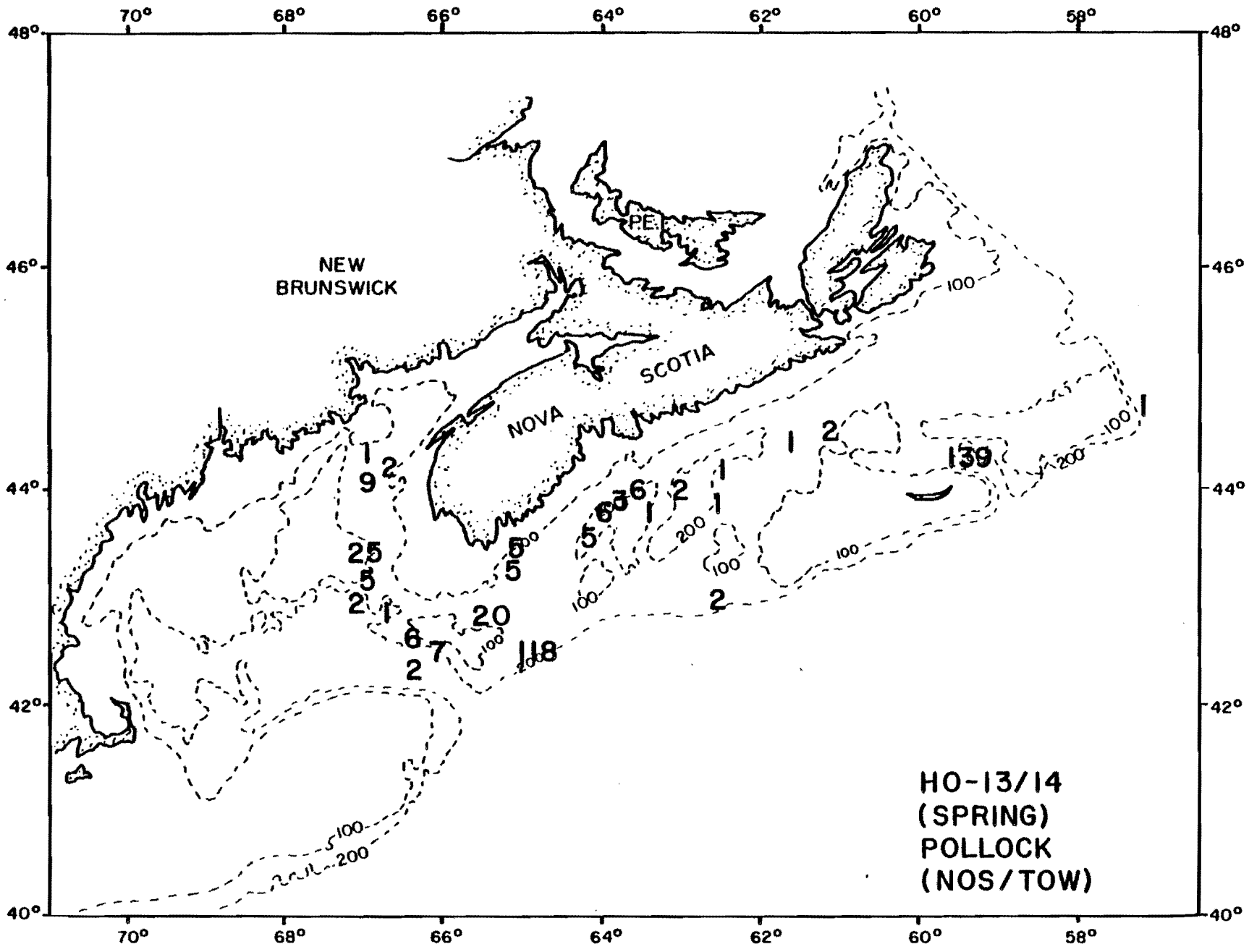

Figure 7. Distribution of pollock from Research Vessel Survey H013-14 (Spring).

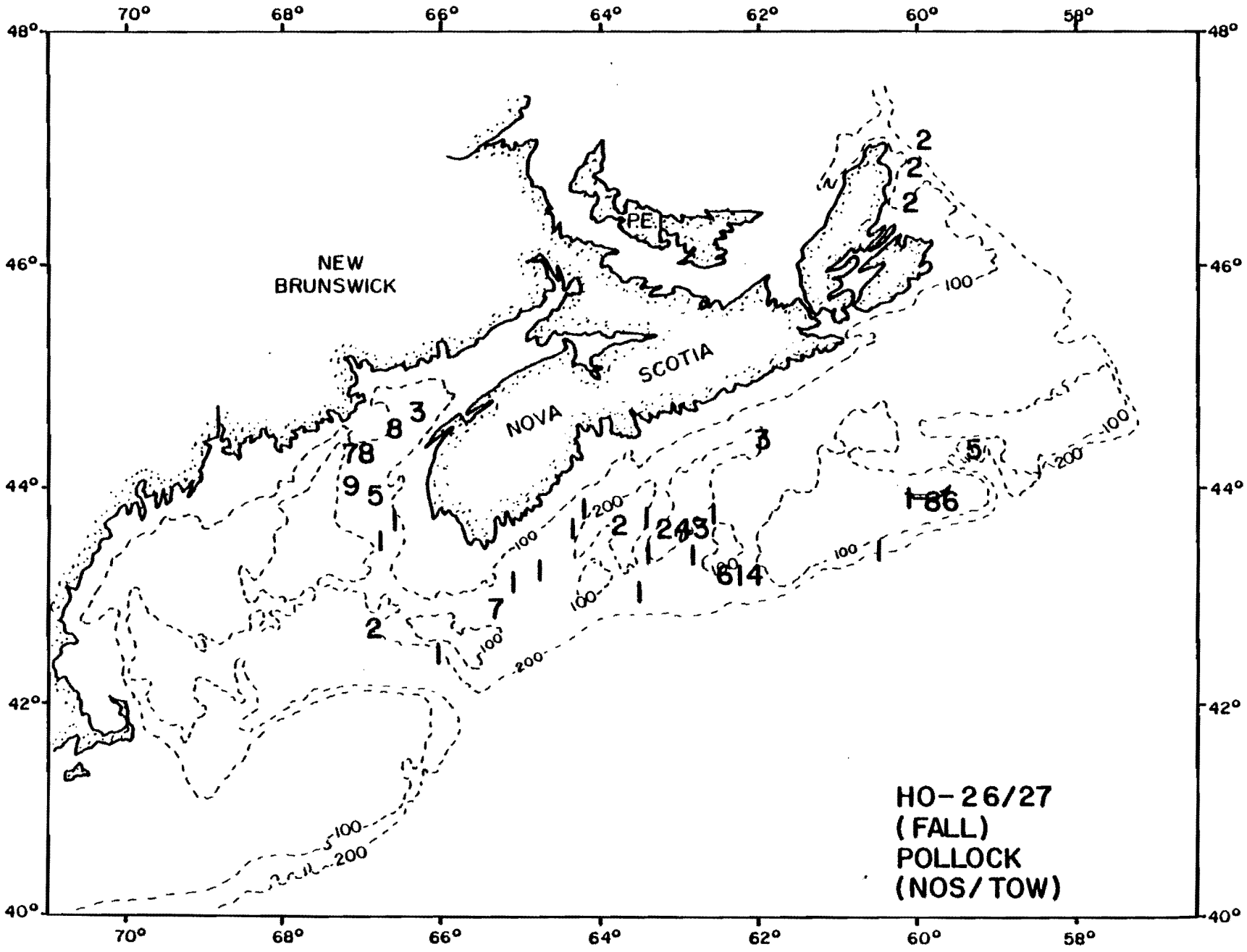

Figure 8. Distribution of pollock from Resarch Vessel Survey HO26-27 (Spring).

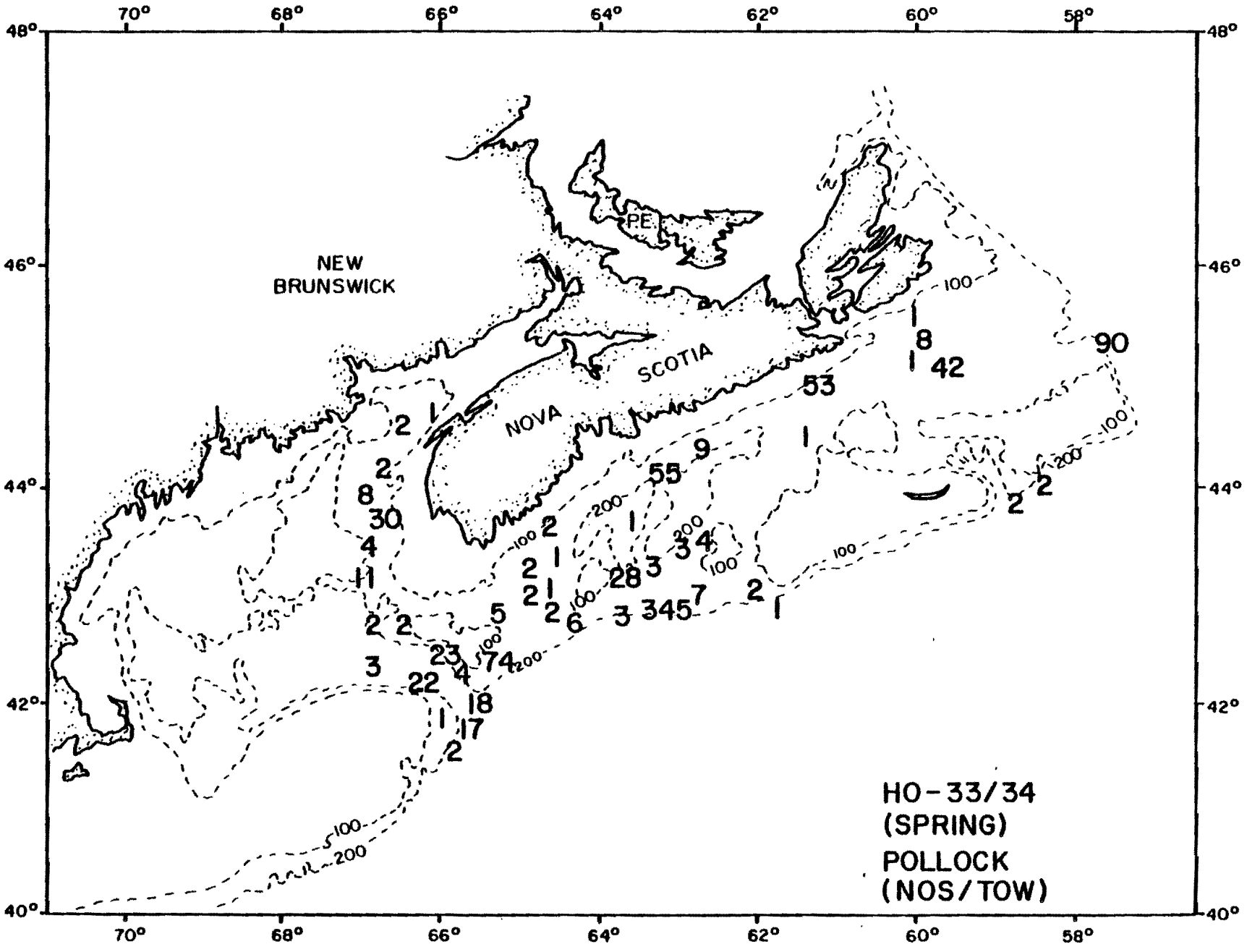

Figure 9. Distribution of pollock from Research Vessel Survey H033-34 (Spring).

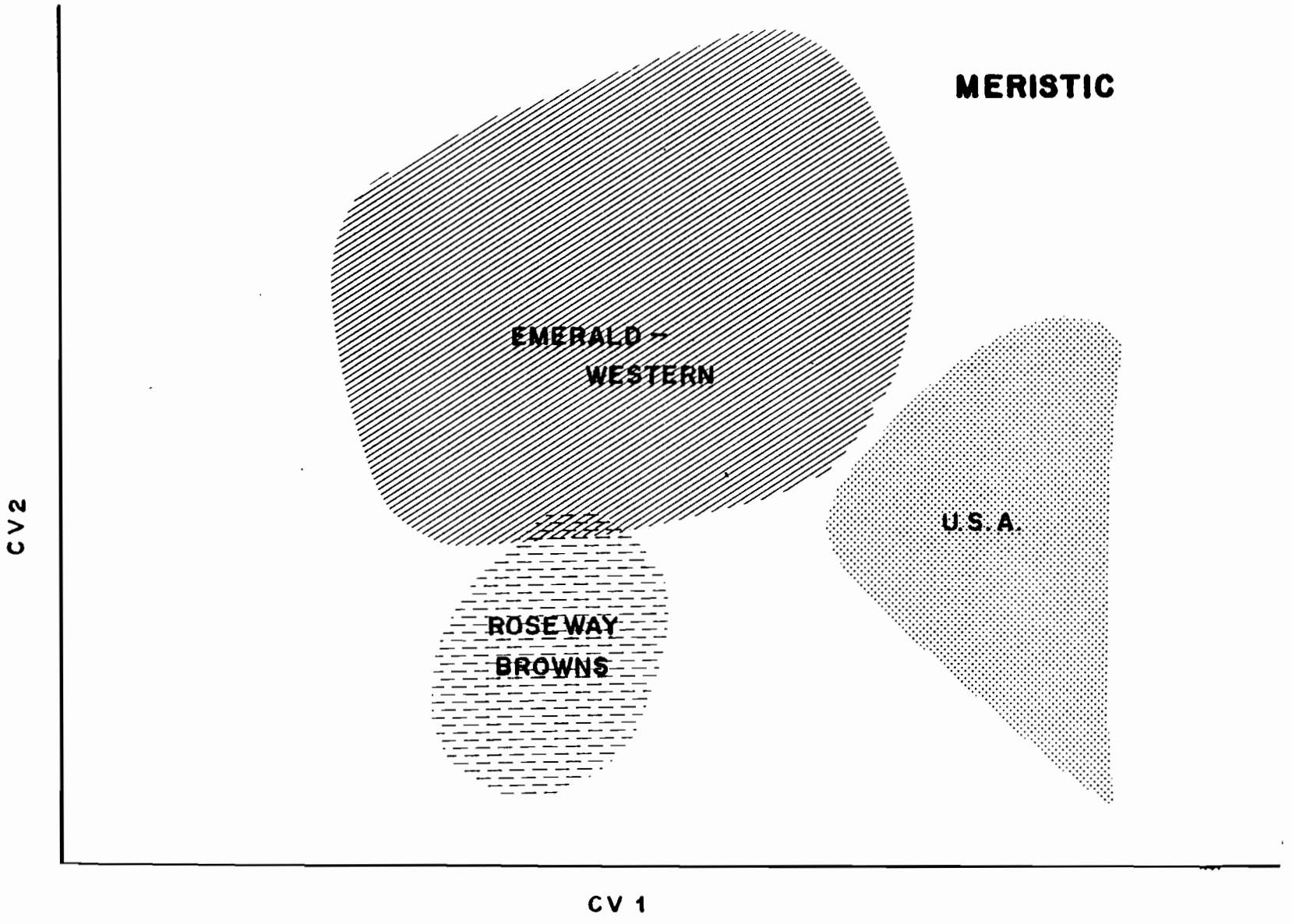

Figure 10. PLOT OF CANONICAL VARIABLES I AND 2 FROM A DISCRIMINANT FUNCTION ANALYSIS OF THE MERISTIC DATA FROM POLLOCK