Northwest Atlantic Fisheries Organization

Serial No. N4567 **NAFO SCR Doc. 01/178**

SCIENTIFIC COUNCIL MEETING – November 2001

Geographical Distribution and Mean Size of Different Life Stages of Northern Shrimp (*Pandalus borealis*) off West Greenland

by

K. Wieland [1] and D.M. Carlsson [2]

Greenland Institute of Natural Resources
[1] P.O. Box 570, 3900 Nuuk, Greenland
[2] Pilestræde 52, P.O. Box 2151, DK-1016 Copenhagen K

Abstract

Annual geographical distribution and mean size of different life stages of Northern shrimp (*Pandalus borealis*) off West Greenland has been analysed using data from a stratified random bottom trawl survey for the years 1993 to 2000. Density of males and females varied considerably in the survey area but the distributions patterns were rather similar for both. Mean size of males, primiparous and multiparous females was significantly correlated with depth and, in the case of the males, also with bottom temperature. Geographical distribution of mean size varied substantially between years and areas with low mean size differed between males and females. The results indicate that small males occur first in several relative small and isolated areas and extend over a wider region with increasing size and age.

Introduction

Since 1988, a stratified random bottom trawl survey has been conducted out annually in West Greenland waters by the Greenland Institute of Natural Resources. The survey is a major component of the assessment of the stock of Northern shrimp in NAFO Subarea 1 and Division 0A, and the survey results concerning biomass, distribution and size composition of this stock are updated each year (Carlsson and Kanneworff, 2000). The present study has been carried out in order to supplement this information by a comprehensive description of the geographical distribution of different life stages, their mean size and possible effects of depth and temperature.

Material and Methods

Survey data

Catch and size data of Northern shrimp has been available from bottom trawl surveys carried out in West Greenland waters by the Greenland Institute of Natural Resources. The design of this survey has been subject to several changes since the survey was introduced in 1988 (Carlsson *et al*., 2000). Major modifications were extensions of the survey area in 1991 and 1993 and a reduction in the mesh size of the cod-end liner from 44 to 20 mm in 1993. Since then the survey covered West Greenland offshore waters between 59°30' and 72°30'N from the 3 n.m. limit to the 600 m depth contour as well as inshore waters in the Disko Bay area (Fig. 1). Due to these changes the present analysis has been limited to the years 1993 to 2000.

The survey area is divided into geographical strata corresponding to latitudinal divisions of shrimp fishing grounds and where reliable depth information exists sub-stratified into four depth zones: 150-200 m, 201-300 m, 301-400 m, and 401-600 m (Carlson et al. 2000). In addition, the survey covers waters shallower than 150 m depth (Tab. 1) at

the major West Greenland fishing banks. Detailed information on fishing practice and biological samples taken during the survey is given by Carlsson and Kanneworff (2000). In 1993 and 1994 bottom temperatures were measured by a CTD just before or after each trawling operation. From 1995 and onwards a temperature recorder was mounted on one of the trawl doors and for each station a mean temperature along the track was calculated from measurements made in 1 min time intervals.

Data analysis

Basic data on weight of total catch of Northern shrimp, weight of subsample sorted into different sexual groups and corresponding measurements of oblique carapax length for each station together with ancillary tow information and bottom temperature were extracted from the survey database. Counts and size measurements of different sexual groups were initially aggregated into 3 life stages: males, primiparous and multiparous females, and for some purposes primiparous and multiparous females were combined later.

Densities of different life stages (in numbers per m^2) were obtained from the numbers measured, their proportion in the subsample raised to the total catch and the nominal swept area of the tow. The nominal swept area was computed as the track length multiplied by the mean wingspread recorded 5 times during the haul.

Mean sizes of males and females calculated for each station were interpolated on a grid with a resolution of appr. 1 × 1 n.m. using ordinary point kriging (Chiles and Delfiner, 1999) with a domain according to the survey strata between 150 and 600 m depth in the area south from 69°30'N and the outer boundaries of the geographical strata north from that limit.

Results

Geographical distribution of density

Males and females showed similar distribution patterns but with different levels of density (Fig. 2a,b and 3a,b). Areas in which males and females were fairly abundant (Males: $n/m^2 > 2$, females: $n/m^2 > 1$) in all years include the Disko Bay, offshore waters north from the Store Hellefisk Bank and the Sukkertoppen Deep. High densities were further observed in most of the years in the Julianehåb Bay (6 years: 1993, 1994, and 1997-2000) and in the Holsteinsborg Deep (5 years: 1993, 1995, and 1998-2000). Considerable numbers were also found in the deeper areas between the fishing banks and the coast in the region south from Fiskenæs Bank (all years but with different locations) and southwest from the Lille Hellefisk Bank in 1999 and 2000. The distribution of males and females was widest in 2000 with high densities (Males: $n/m^2 > 5$, females: $n/m^2 > 2$) in several areas, but not in the offshore waters north from 69°N where abundance was generally low.

Variability of mean size

Mean carapax lengths of males from the single survey stations of each year were highly variable indicating the presence of several age groups (Fig. 4). Coefficients of variation decreased distinctly with increasing size for males. This was not the case for primiparous and multiparous females for which the variability of mean size was much lower due to the fewer number of age groups involved and the corresponding coefficients of variation were relative uniform over the entire size range encountered. The change of the coefficient of variation of mean size of males was not related to the number of individuals measured (Fig. 5).

Mean size related to depth and temperature

Significant ($p < 0.001$) correlations between mean size and depth were found for males, primiparous and multiparous females when the data from all of the years were pooled (Fig. 6). It is, however, noteworthy that the lowest values of mean size were always observed at depths larger than 150 m and not in shallow waters that were less intensively sampled. Mean size of males was also significantly correlated with bottom temperature though low mean sizes were recorded almost along the entire range of temperature. Mean size of primiparous and multiparous females showed no relationship with bottom temperature.

Geographical distribution of mean size

Annual geographical distributions of mean size are shown in Fig. 7a,b and 8a,b for males and females, respectively. The locations at which low mean size of males were observed differed substantially between the years. Low mean size of males (<17 mm CPL) was, however, never found in the Julianhåb Bay and, with very few exceptions, in the offshore waters west from the major fishing banks. The extension of the area, in which small males prevail, increased since 1997 and included in 2000 large parts of the Disko Bay, offshore waters north from the Store Hellefisk Bank, the western part of the Sukkertoppen Deep and the deeper waters between the fishing banks and the coast in the Fyllas, Fiskenæs and Danas Bank region. The geographical distributions of mean size of females did not closely match those of the males, in particular not when the same year is considered. Similar to the males, areas with low mean size of females were enlarged in the most recent years. Small females were prominent north from the Store Hellefisk Bank but not in the Disko Bay, and since 1998 low mean size (<24 mm CPL) of females were further found in the Holsteinsborg Deep and at varying locations in the entire offshore waters of the southern survey area.

Discussion

The decrease of the coefficient of variation of mean carapax length of males with increasing size indicates that in some regions small males occur together with large ones while in other regions only larger males are found. This is further reflected by the geographical distribution of mean size and it appears that young males first occur in several relative small and isolated areas at depths of about 150-275 m and spread out over a wider region with increasing size and age. However, further analysis of the distribution pattern by size or age group defining distinct cohorts is required to describe this process in more detail including an identification of the most important nursery areas.

References

Carlsson,, D.M. and P. Kanneworff, 2000. Stratified-random Trawl Survey for Northern Shrimp (*Pandalus borealis*) in NAFO Subareas 0+1, in 2000. NAFO SCR Doc. 00/78. Serial No. N4335.

Carlsson,, D., P. Kanneworff, O. Folmer, M. Kingsley and M. Pennington, 2000. Improving the West Greenland Trawl Survey for Shrimp (*Pandalus borealis*). J.Northw.Atl.Fish.Sci. 27: 151-160.

Chiles, J.-P. and P. Delfiner, 1999. Geostatistics: Modeling spatial uncertainty. John Wiley & Sons, New York. 695 p.

Table 1. Survey dates.

Survey period	Depth range (m)	Number of stations total	with depth < 150 m
10. July – 25. Sept. 1993	26 - 597	213	39
11. July – 7. Sept. 1994	38 - 557	196	25
5. July – 31. Aug. 1995	35 - 606	227	30
6. July – 29. Aug. 1996	32 - 568	203	34
3. July – 15. Sept. 1997	58 - 578	225	31
21. July – 17. Sept. 1998	55 - 588	241	30
17. July – 17. Sept. 1999	57 - 592	256	27
13. July – 16. Sept. 2000	67 - 595	234	28

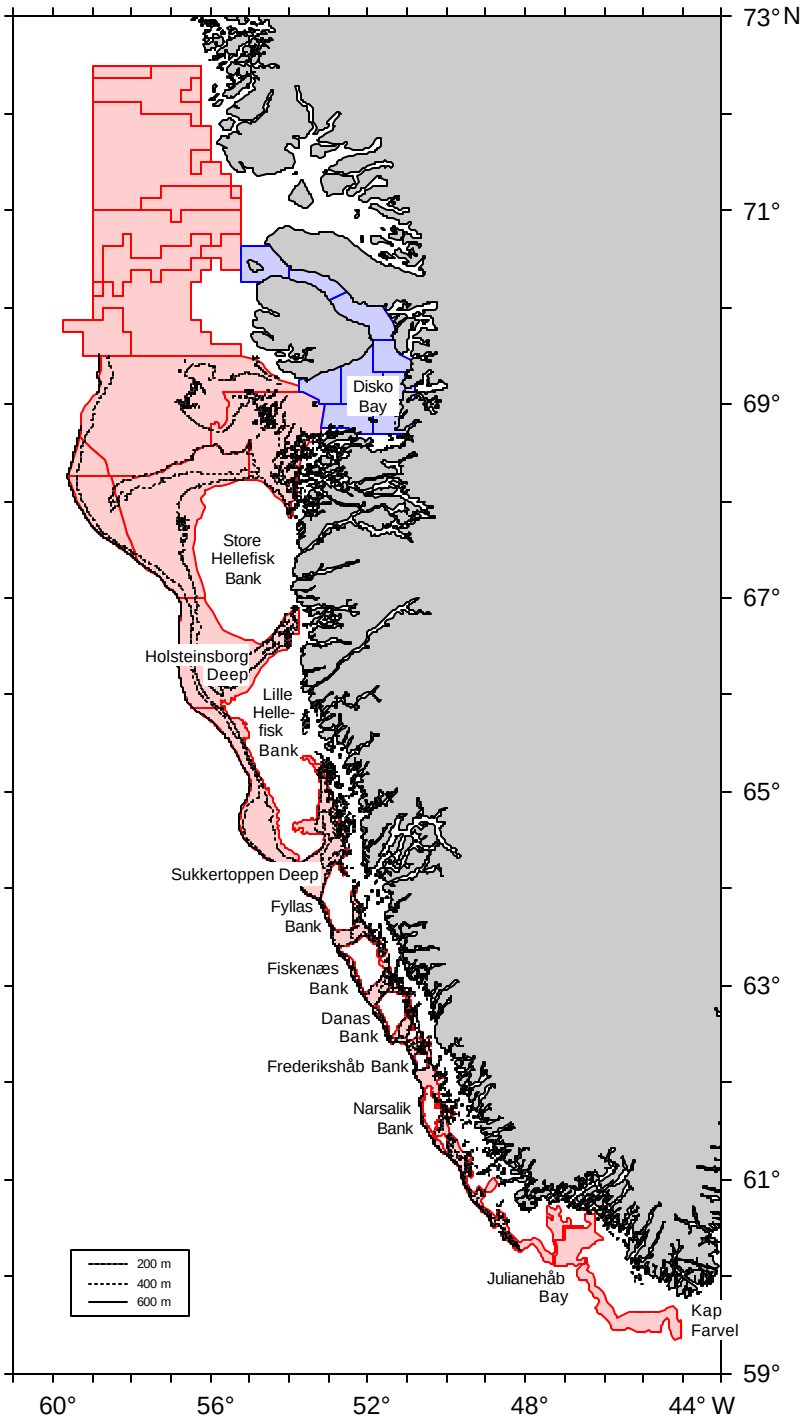

Fig. 1. Survey area and stratification.

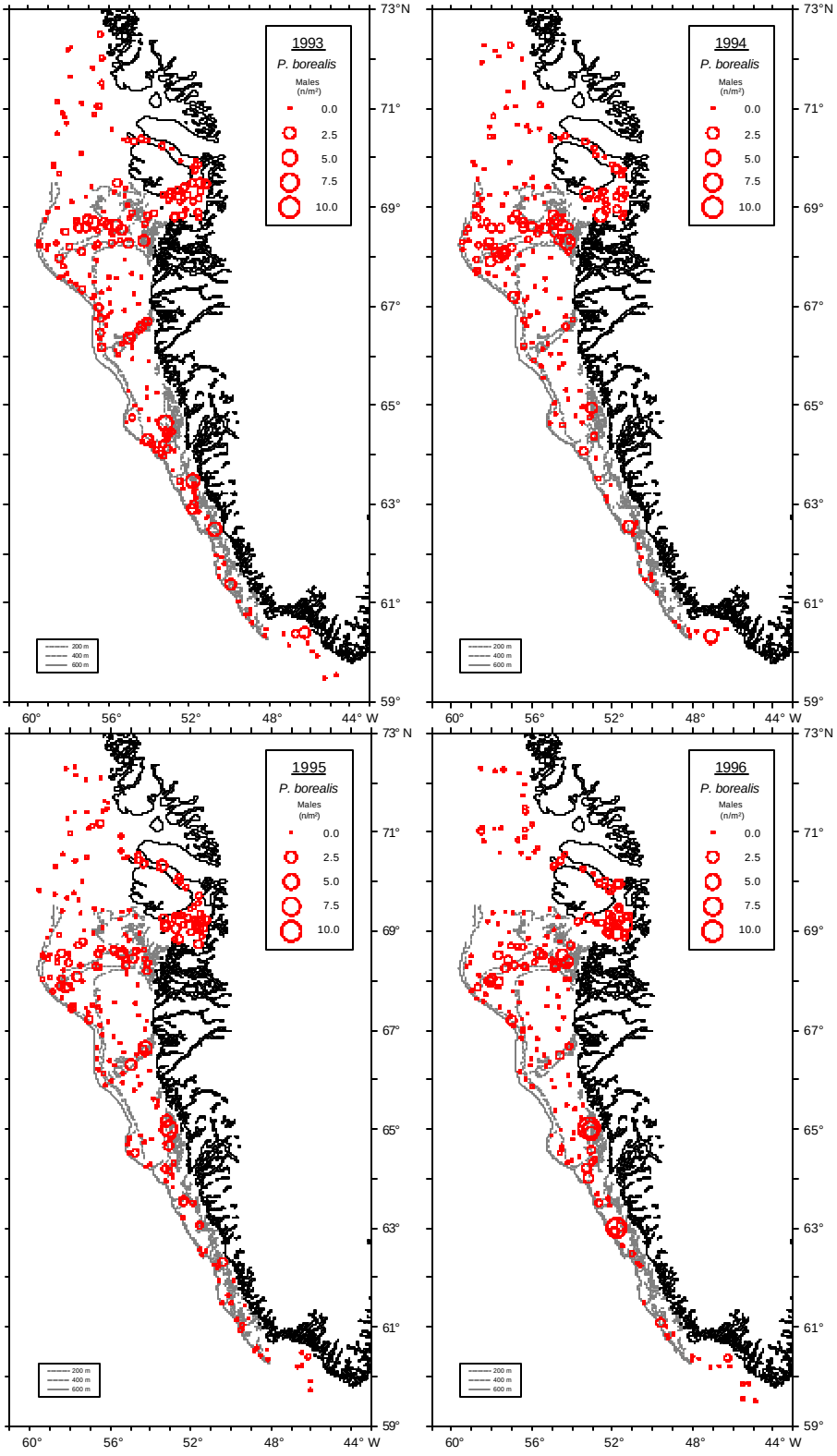

Fig. 2a. Distribution of males 1993-1996.

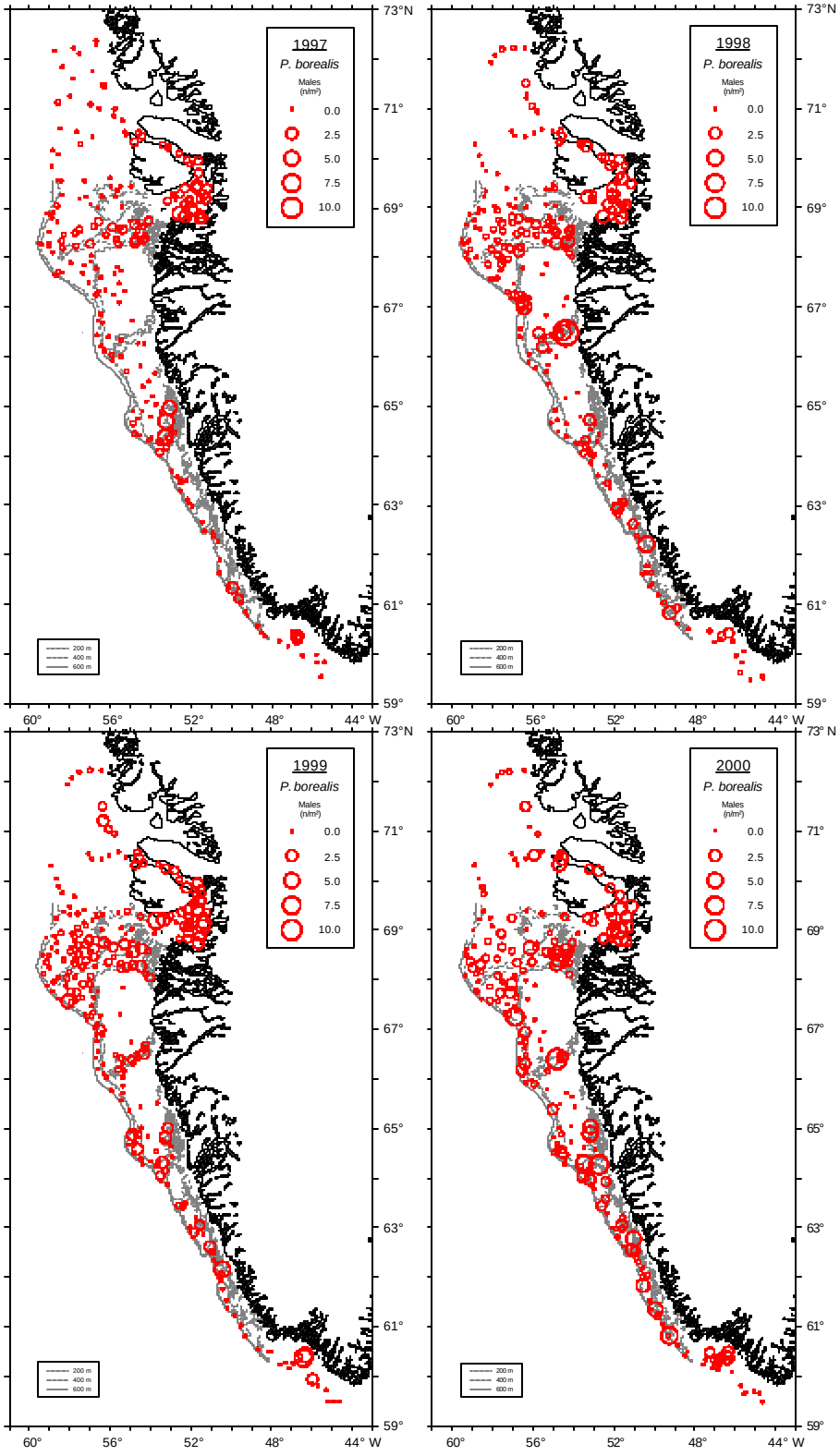

Fig. 2b. Distribution of males 1997-2000.

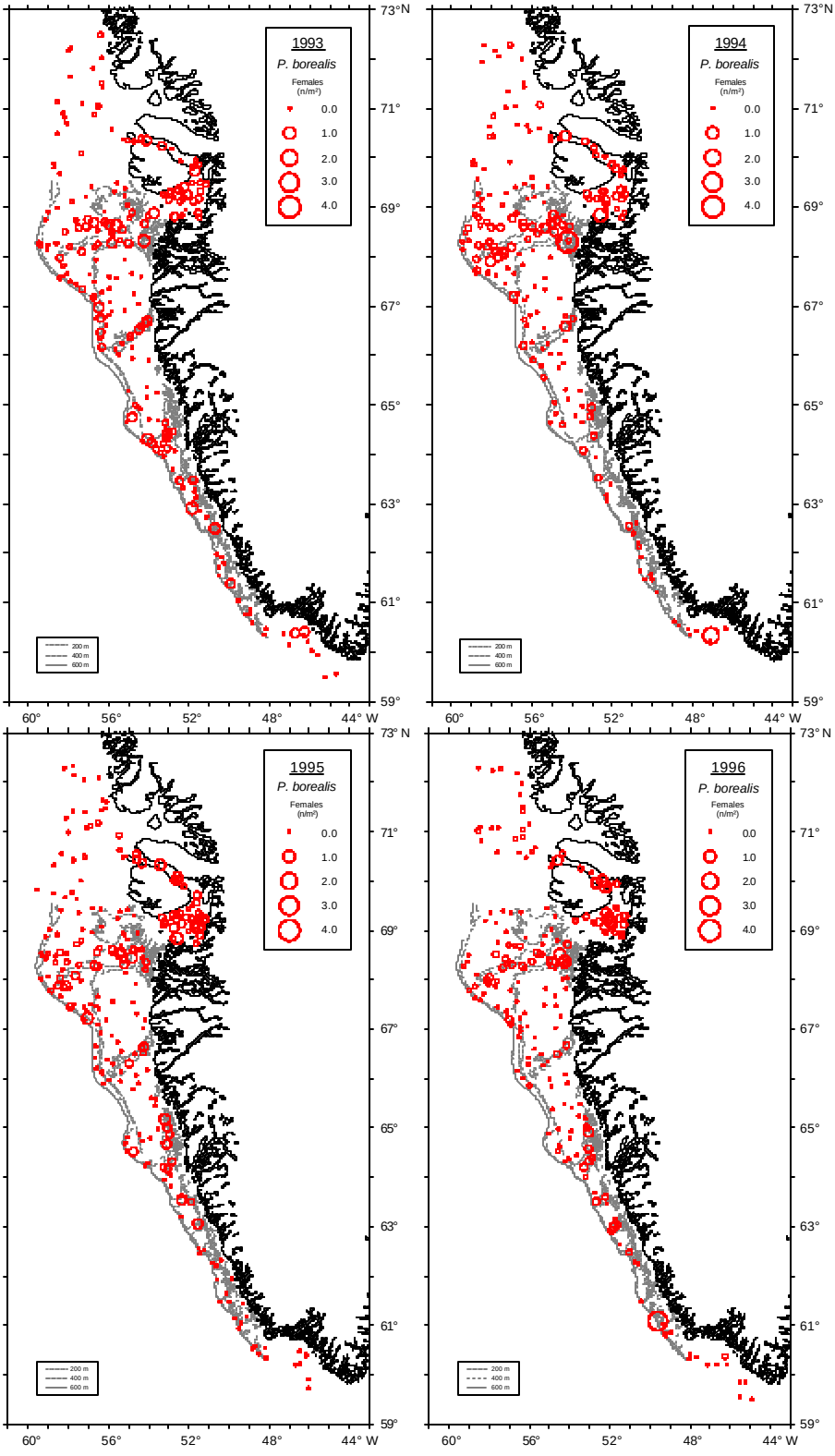

Fig. 3a. Distribution of females 1993-1996.

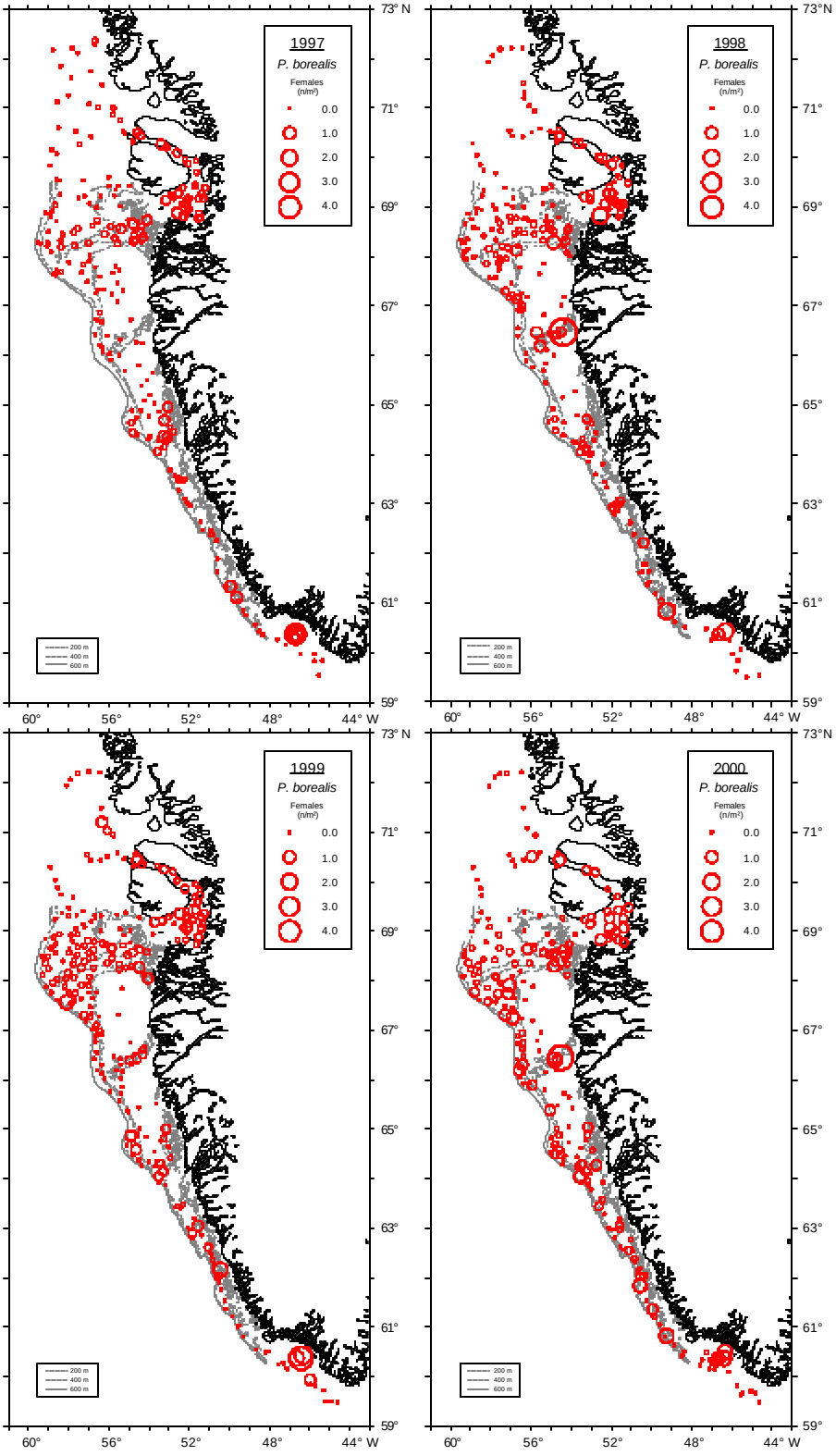

Fig. 3b. Distribution of females 1997-2000.

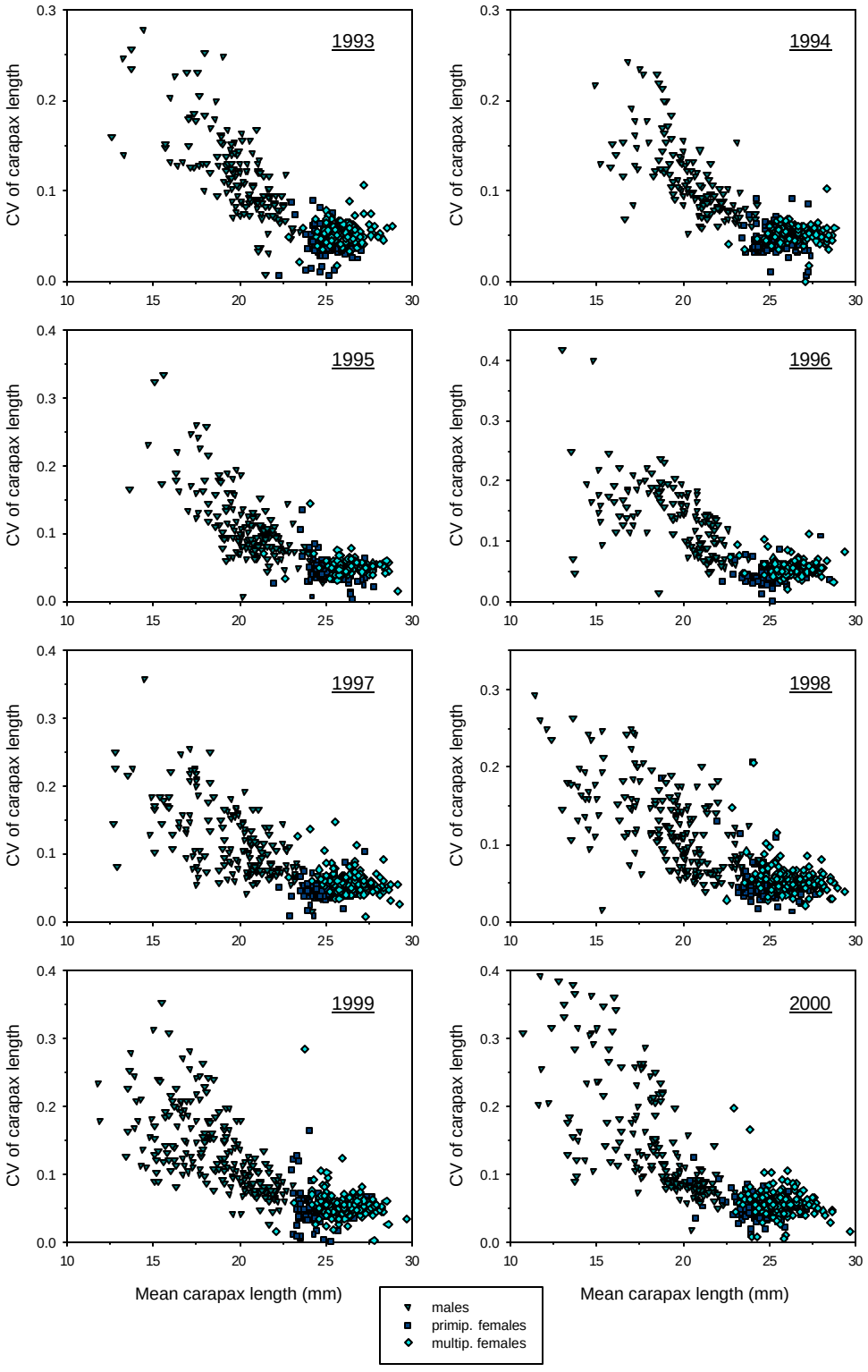

Fig. 4. Variability of mean size of males, primiparous and multiparous females (CV: coefficient of variation).

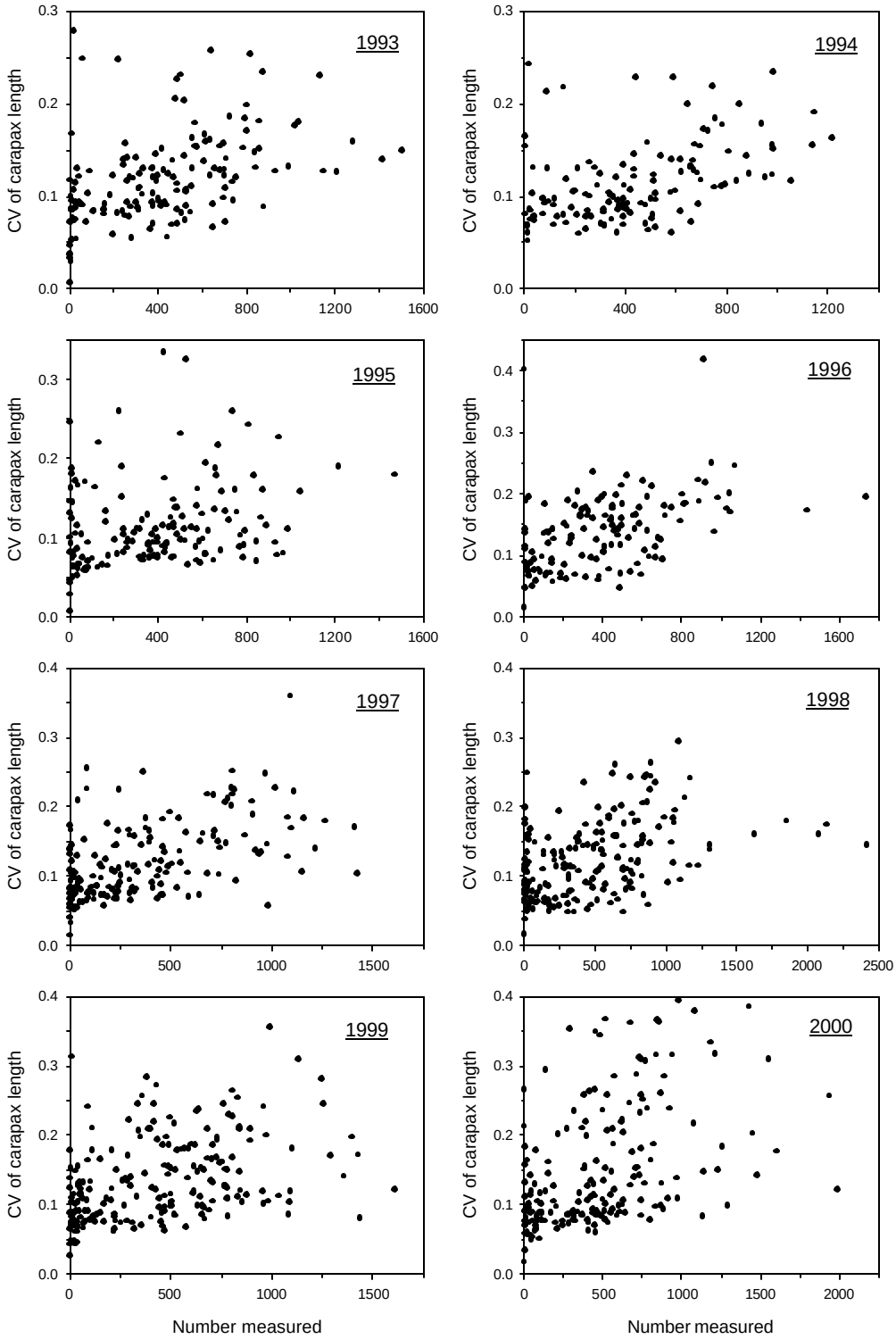

Fig. 5. Effect of sample size on variability of mean carapax length of males (CV: coefficient of variation).

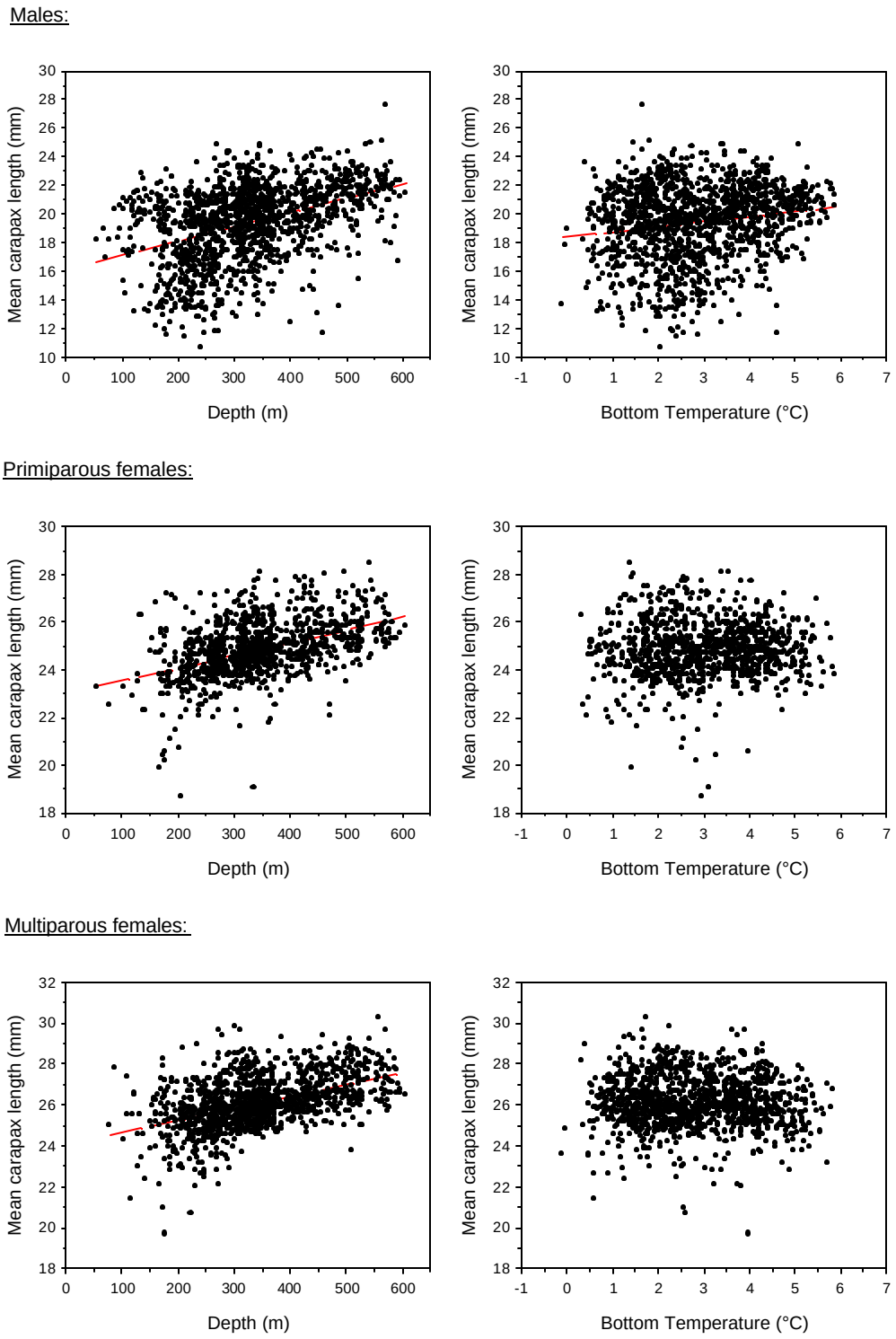

Fig. 6. Mean size of males, primiparous and multiparous females in relation to depth and bottom temperature, 1993-2000.

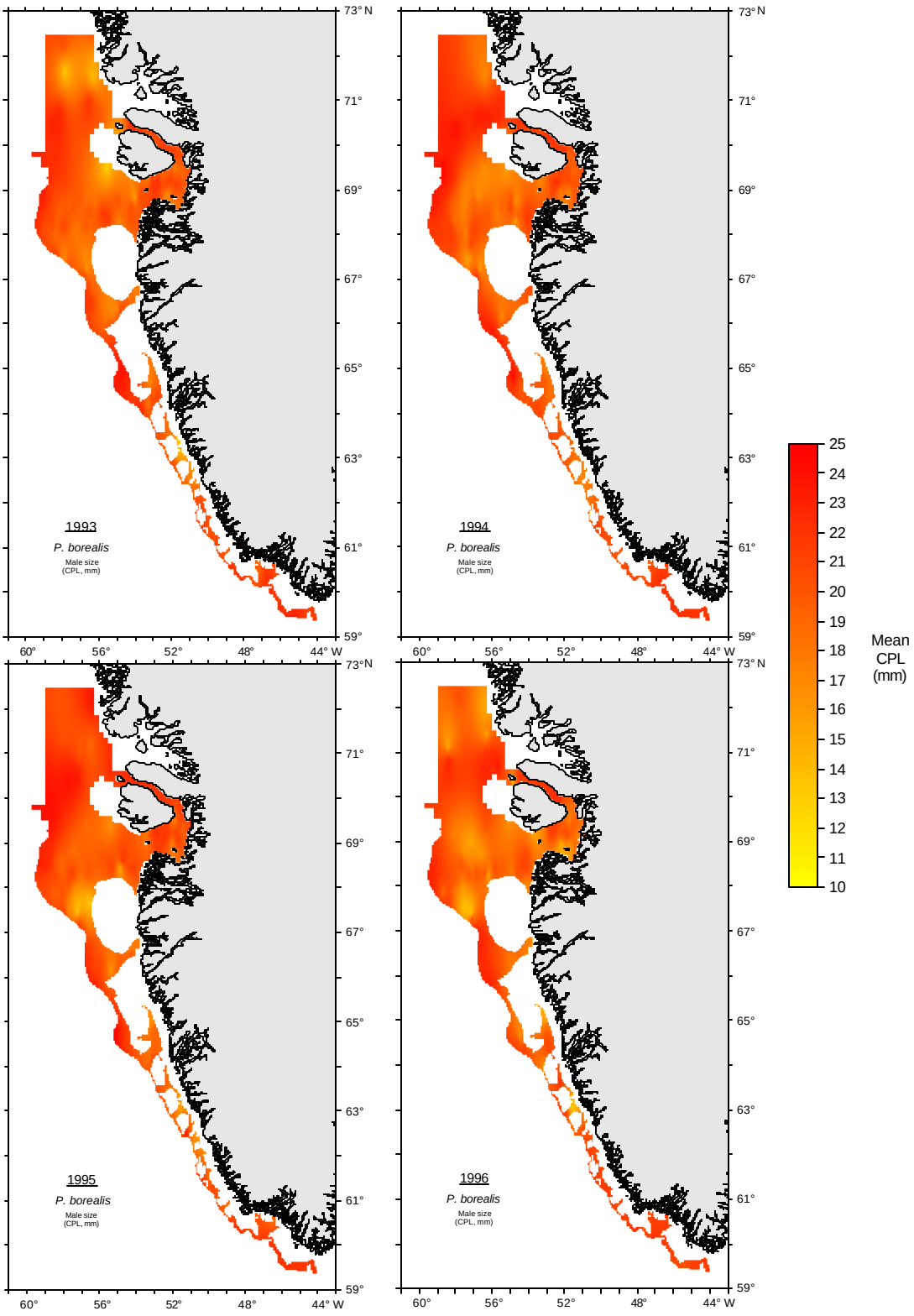

Fig. 7a. Geographical distribution of mean size of males 1993-1996.

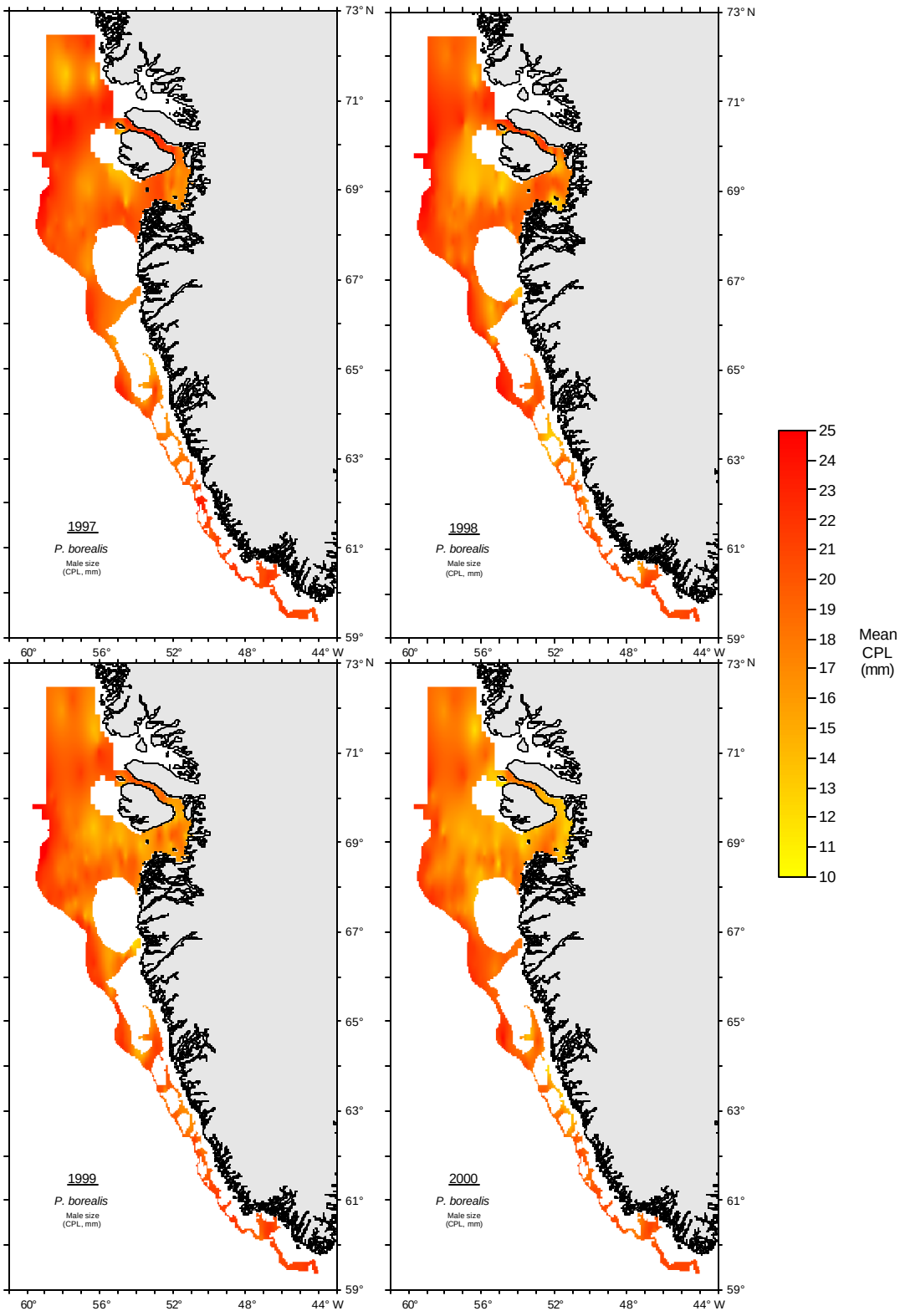

Fig. 7b. Geographical distribution of mean size of males 1997-2000.

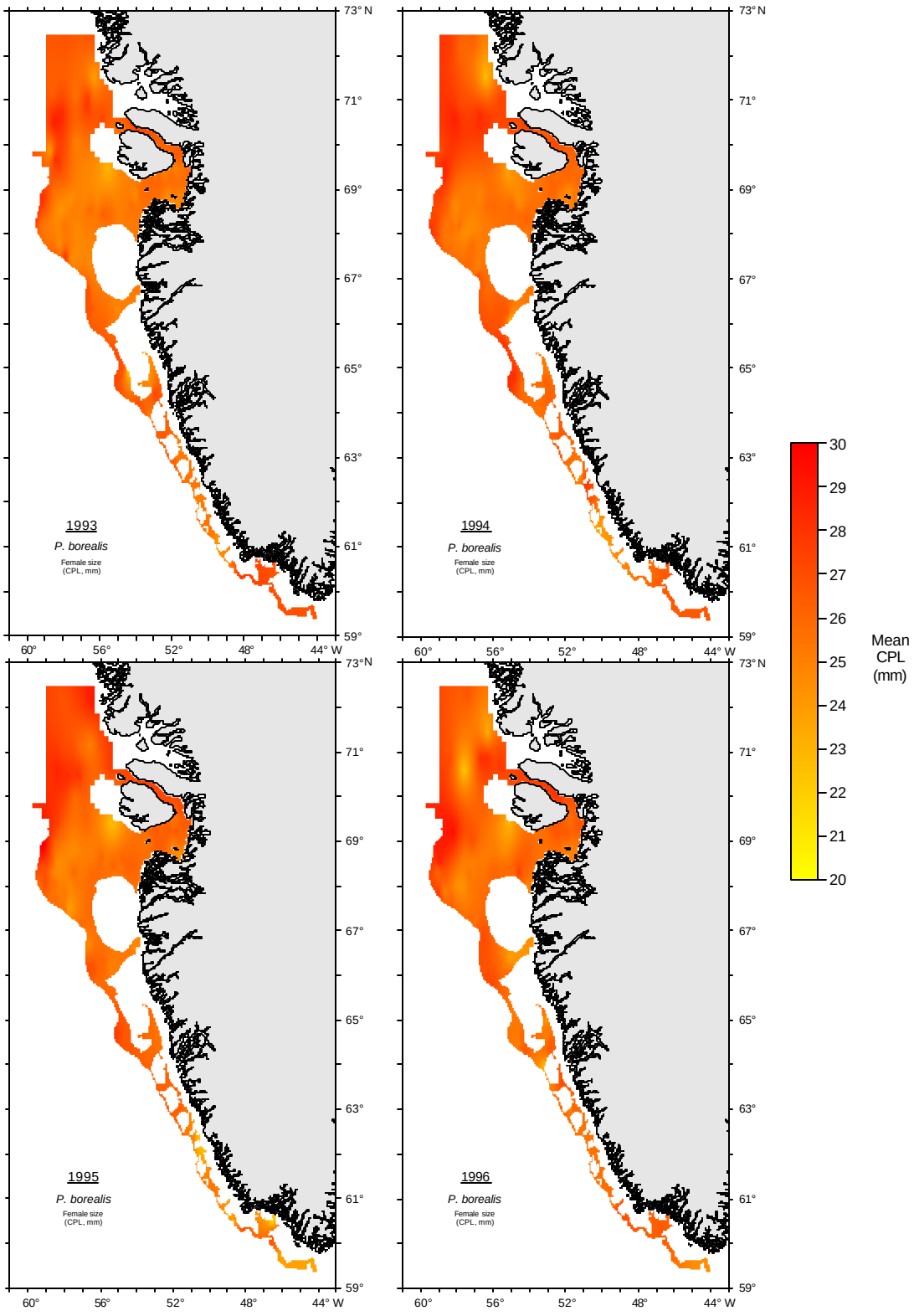

Fig. 8a. Geographical distribution of mean size of females 1993-1996.

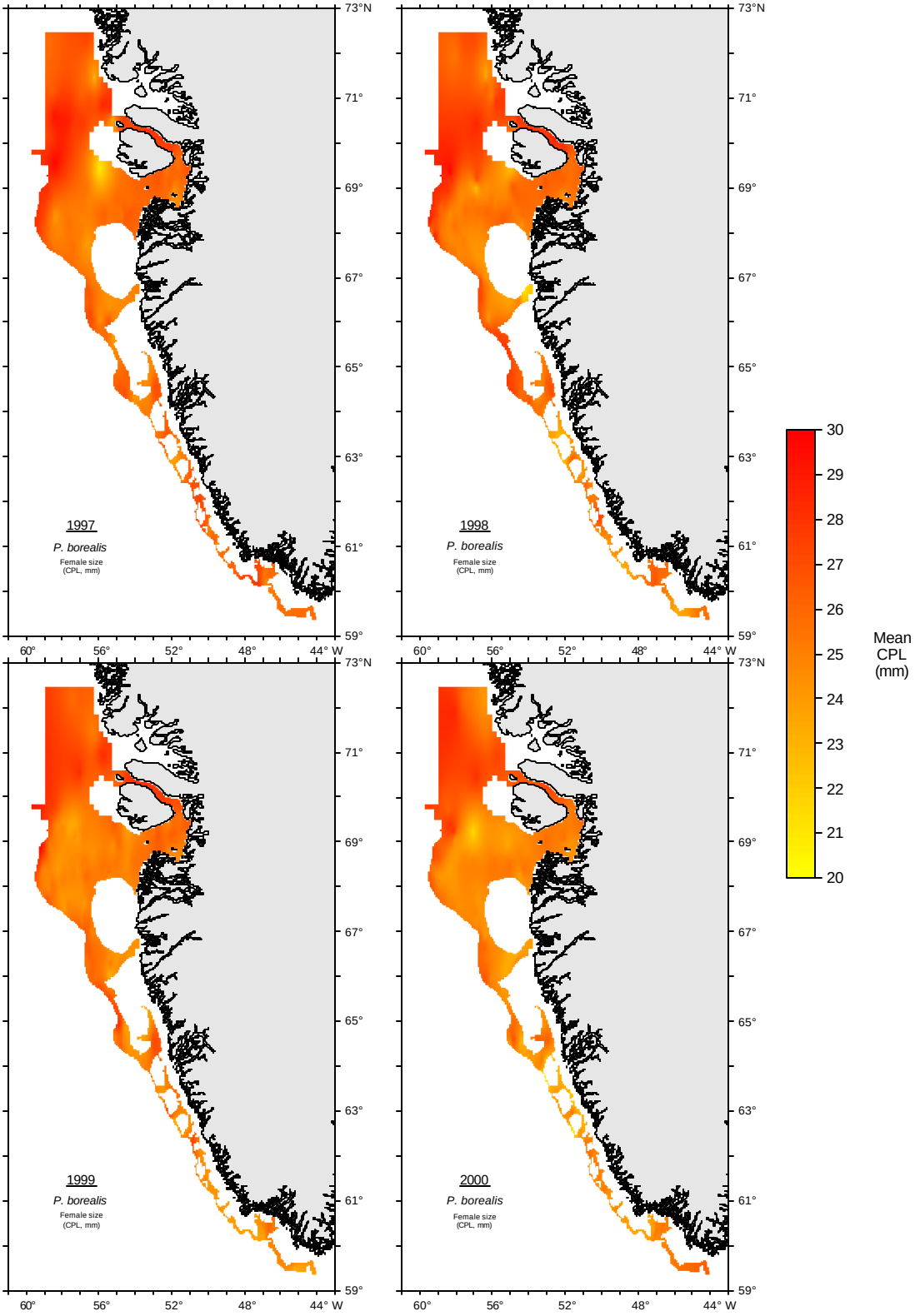

Fig. 8b. Geographical distribution of mean size of females 1997-2000.