Deep-Sea Research II 56 (2009) 2023–2036

Contents lists available at ScienceDirect

Deep-Sea Research II

journal homepage: www.elsevier.com/locate/dsr2

Catch, survey and life-history data for shrimp (*Pandalus borealis*) off Jan Mayen

Einar M. Nilssen *, Michaela M. Aschan

Norwegian College of Fishery Science, University of Tromsø, Breivika, N-9037 Tromsø, Norway

ARTICLE INFO

Article history:
Accepted 12 November 2008
Available online 3 December 2008

Keywords:
Pandalus borealis
Life-history
Environmental effects
Fishery
North-east Atlantic
Jan Mayen

ABSTRACT

The Jan Mayen area has an extreme environment with low temperatures and infrequent, but abrupt temperature changes. The shrimp population here is considered to be on its edge of distribution. The life-history parameters are in the same range as in other high-latitude shrimp populations and are characterized by slow growth, large size at maturation and extended longevity. Irregular and sporadic commercial exploitation limit fishing mortality and give the population life-history parameters not previously seen in other areas. The Jan Mayen shrimp are large compared to, e.g., the Barents Sea shrimp and can reach a maximum carapace length (L_{max}) of 37 mm and an age of 10–11 years. The large size at sex transformation (L_{50}, >24 mm) and analyses of length–frequency distributions indicate that the shrimp may be 6–7 years of age before changing sex. The change in L_{max} and L_{50} observed during the study period is probably caused by increased natural mortality due to sudden temperature changes or due to increased predation, rather than increased growth rates. The life-history strategy of shrimp in the Jan Mayen area can be explained by factors such as depth, temperature and population density variations caused by fluctuation in recruitment and mortality.

The shrimp fisheries in the Jan Mayen area began in the late 1970s and reached an annual landing of 2000 tonnes in 1985, and since then landings have oscillated around 500 tonnes depending on a combination of factors. The survey indices of stock biomass varied between 3000 and 6600 tonnes. For most years, the highest shrimp densities are at a depth of 200–299 m, while large shrimp (and therefore also female shrimp) are dominant at depths greater than 300 m.

Fish community data were studied as the composition of the demersal fish community is an integrated response to environmental conditions and as predation affects the shrimp stock. Polar cod and capelin are the most abundant fish species in the study area. A high number of blue whiting was registered in 1979, but the number declined in 1980 and 1981 as temperature decreased. During the surveys in 1994 and 1995, no blue whiting was registered. A few individuals were found again in the 1999 samples. The number of Greenland halibut has declined from the beginning of the 1980s to the 1990s.

1. Introduction

As in the Barents Sea, off Svalbard and East Greenland, commercial Norwegian shrimp fishing off Jan Mayen began in early 1970s (Torheim, 1980) and was initiated because of failure in the shrimp fisheries off Svalbard. In the 1974–1976 period, more than 1000 tonnes of shrimp was caught each year (Øynes, 1977) and the annual landings reached 2000 tonnes in 1985. From 1986, the landing sizes decreased, then increased again from 1993 and reached almost 1500 tonnes in both 1995 and 1996, before falling below 1000 tonnes until 2001 (Fig. 1). According to the Norwegian Fishing Vessel Owners Association, the Jan Mayen fishing ground's small size could barely support two vessels even when the large and high-quality shrimp were available. Annual catch sizes seem to depend on stock biomass, availability according to ice coverage and on economical conditions such as fuel costs and shrimp prices. Since 1993, the Jan Mayen shrimp fishing ground also served as a transit stop for Norwegian shrimp vessels on their way to East Greenland and to the Flemish Cap (Tor Are Vaskin, pers. comm., section leader at the Norwegian Fishing Vessel Owners Association). Fishing activity off Jan Mayen is therefore also dependent on the fisheries in the Barents Sea, by the Flemish Cap and off East Greenland.

Limited Russian shrimp fishing in the area began in 1974 with an annual catch of 178 tonnes. In 1975 the total Russian catch in the area was 582 tonnes. Russian shrimp fishing continued in the 1980s, but catch levels never reached the annual quota of 750 tonnes set by the Joint Norwegian-Russian Fisheries Commission (Anon, 1991).

* Corresponding author. Tel.:+47 77 64 45 35; fax:+47 77 64 60 20.
E-mail address: eni002@nfh.uit.no (E.M. Nilssen).

0967-0645/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.dsr2.2008.11.013

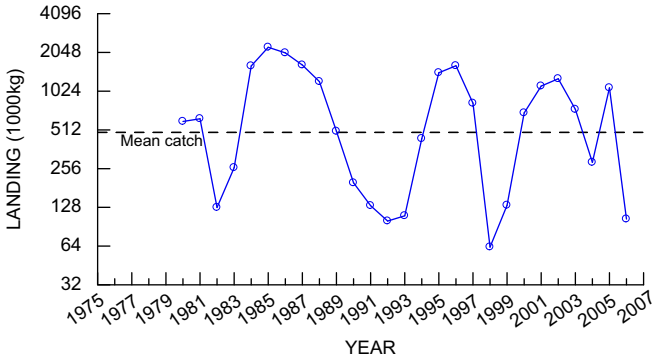

Fig. 1. Annual Norwegian *Pandalus borealis* landings at Jan Mayen 1980–2006.

During the first years of last century, a small number of scientific expeditions went to the Jan Mayen area to study hydrography and biology (Hjort, 1901; Collet, 1909). Iversen (1936) studied the hydrography while Gulliksen (1974) wrote a review about the marine conditions off Jan Mayen.

The Jan Mayen area is poorly studied compared to other shrimp grounds. The first known trawl haul for shrimp took place at 150–210 m during a survey with the R/V "G.O. Sars" in August 1950. The catch was 100 l and 639 individuals were measured and identified by sex (Devold, 1950; Rasmussen, 1953). Rasmussen (1953) assumed that the shrimp spawned in July and that hatching took place before the first of June, giving an ovigerous period of about 10 months. He also concluded that sex change started at an age of 5 and noted that the shrimp were exceptionally large. Later, the Directorate of Fisheries in Norway initiated shrimp surveys off Jan Mayen with commercial vessels (Godtlibsen, 1974; Torrissen, 1974; Strøm, 1976; Olsen, 1977; Øynes, 1977). From these early surveys, the 1974 and 1976 data are available (Godtlibsen, 1974; Strøm, 1976). The surveys indicated that the shrimp grounds were small and limited by topographic and climatic factors, but that the shrimp were large and of excellent quality. In October 1979, the R/V "M. Sars" mapped the shrimp and fish biomass distribution in the area (Torheim, 1980). The 1979 survey was followed by surveys in 1980 and 1981 (Torheim, unpubl. data). Russian scientists surveyed the shrimp resources to the south-west and north-east of Jan Mayen in 1974, 1975, 1978, 1979, 1986 and 1990 (Anon, 1976, 1991).

The Norwegian College of Fishery Science, University of Tromsø (in co-operation with the Norwegian Institute of Fisheries and Aquaculture Research) surveyed the bank off Jan Mayen in August 1994 and 1999 (in co-operation with UNIS-University Courses off Svalbard) with the R/V "Jan Mayen." In August 1995, The Norwegian Institute of Fisheries and Aquaculture Research rented the F/T "Remøy" and surveyed shrimp resources in the Jan Mayen area (Aschan, 1995; Ofstad, 1998).

Genetic samples from the 1995 survey along with samples from other areas were analysed for allozymic variations (Drengstig et al., 2000), while variation in genomic DNA was studied by Random Amplified Polymorphic DNA (RAPD; Martinez et al., 2006). Both studies concluded that the Jan Mayen shrimp population has a high genetic variability and resembles the Svalbard shrimp in its genetic structure. The genetic variation off Jan Mayen is examined further in this paper.

The Jan Mayen area has an extreme environment with low seawater temperatures and infrequent, but abrupt temperature changes. The shrimp population here is considered to be on its edge of distribution. The life-history parameters are likely to be in the same range as in other high-latitude shrimp populations and are characterized by slow growth, large size at maturation and extended longevity. Irregular and sporadic commercial exploitation is limited in this area. The combination of extreme climate and low fishing mortality may give the population life-history parameters not seen elsewhere.

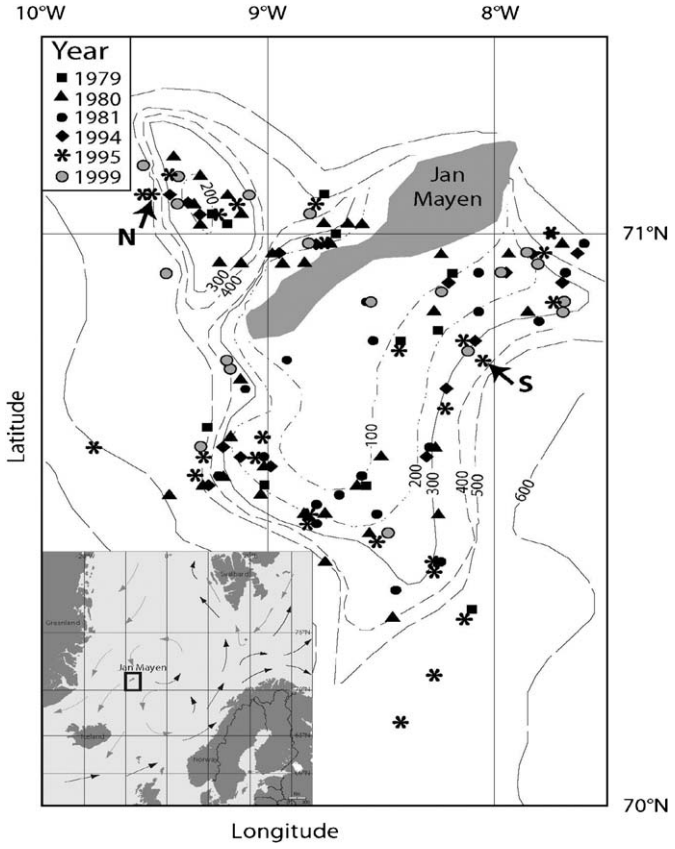

Fig. 2. Trawl and CTD stations taken during shrimp *Pandalus borealis* surveys off Jan Mayen 1979, 1980, 1981, 1994, 1995 and 1999. Bathymetry and main current systems are indicated. N and S—stations for genetic sampling in 1995.

The results from Norwegian shrimp surveys conducted in the period 1974–1999 are presented and discussed, and all hauls from viable trawl stations are included (Fig. 2). The life-history parameters (maximum length—L_{max}, mean ovigerous length—OL_{mean} and the length at 50% sex change—L_{50}) of *Pandalus borealis* are described and discussed in relation to the genetic structure of the shrimp population, the population density [standardised commercial catch per unit effort (CPUE) and survey indices of stock], by temperature and by depth. The results are discussed in relation to studies from other Arctic shrimp grounds.

2. Material and methods

The study area is defined as a rectangle with the southeast corner at 70°20′N and 7°30′W and the northwest corner at 71°20′N and 9°50′W (Fig. 2). The Jan Mayen Island, a volcanic island on the Mid-Atlantic Ridge, is situated in the northern part of the area with the Jan Mayen Bank on the southern side and the Marøy Bank on the northwestern side of the island. The bottom topography around the island varies. A narrow, relatively flat shelf with depths between 150–300 m covers an area to the east and southeast of the island. A similar flat bottom area with depths between 300 and 600 m covers an area from south-west to the northwest. To the north and north-east of Jan Mayen, the bottom inclines down to a depth of 2000 m in the Jan Mayen Channel (Fig. 2). Ice conditions vary from year to year and the mean southern ice limit in April reached Jan Mayen in the 1946–1963