International Council for the exploration of the Sea



Shellfish Committee
CM. 1997/BB:18

**Stock assessment, distribution and population structure of blue mussels (*Mytilus edulis*) in Hvalfjördur south-west Iceland.**

by

Gudrun G. Thórarinsdóttir

Marine Research Institute, P.O.Box 1390
Skúlagata 4, 121 Reykjavík, Iceland

## Abstract

Because of an increasing interest in utilizing fishable mussel beds in Iceland an investigation was carried out on biomass, distribution and population structure of *Mytilus edulis* in Hvalfjördur south-west Iceland. A dredge survey was conducted during June 1994 to provide a first assessment of resources of blue mussels in this area. Subtidal mussel beds were identified by an underwater tv-camera and their size was estimated. As only fishable mussel beds were of interest dredging was used for sampling at water depth > 2 m at low tide. During the survey mussels were found at 16 out of 30 stations investigated and the beds were located at 2-6 m depth. No fishable mussel beds were found at the mouth and the outer part of the fjord. The maximum densities, 2.1 - 3.9 kg $m^{-2}$, were found in the innermost part of the fjord and the estimated total biomass in all areas investigated was 12,876 tonnes. The greatest number of the mussels sampled by the dredge had heavy shells where width exceeded shell height. At most of the stations investigated shell length over 60 mm dominated in number and the shells in the catch were mainly of commercial size (shell length >50 mm).

## Introduction

At the end of the 19th century blue mussel (*Mytilus edulis*) was gathered from the shore in Iceland and mainly used as bait in line fishing (Kristjánsson, 1980, 1985). However, in the last few years an interest has arisen to investigate the possibility for developing an Icelandic fishery for human consumption.

The knowledge of the mussel resource in Iceland is very limited and an assessment of the stock has never been undertaken. It is however, known that the distribution of the mussel is all around Iceland except in the south at the exposed sandy shore.

At the end of the 19th century much of mussels were gathered from the shore in Hvalfjördur, south-west Iceland and in the recent years it has become more and more popular among the public to gather mussels for human consumption from this same site.

In summer 1994 it was decided to perform an investigation of the fishable mussel stock in Hvalfjördur, its distribution, abundance and population structure. This paper gives the results of this first survey.

## Materials and methods

In June 1994 a survey was undertaken to assess the resource of the fishable mussel stock in Hvalfjördur south-west Iceland (Fig. 1). Hvalfjördur covers approximately 140 $km^2$ of sea surface and the greatest depth is 84 m. The overall characteristic of Hvalfjördur is the tide, which provides frequent exchange of the water. The difference between low and high tide is normally about 3-4 m but can highest become 4.2 m. The common current velocity in the fjord is about 5-25 cm $s^{-1}$ at 10 m depth (Malmberg and Briem, 1985).

Only a small part of the sea surface area was investigated. The intertidal mussel beds were not investigated and no mussels were seen at greater depth than 15 m. The depth zone investigated was therefore only between 2-15 m at low tide. Selection of sampling sites was based on bottom topography, as rocky bottom was avoided, and depth as indicated on sea charts.

An underwater tv-camera was used to find the mussel beds. The wire length in the camera was 600 m and it was controlled from a boat. Once a bed was found its size was estimated and a mussel dredge with the width of 110 cm was used to take samples. A total of 30 stations were sampled by the dredge. For practical purposes the survey area where mussels were found was divided into subareas (I-VIII).

The mussel dredge worked well on sandy bottom but its catch efficiency is unknown. The hauling speed was two knots and the hauling time varied between 2 and 4 minutes.

In order to determine mussel densities the distance covered by the dredge was calculated. Mussels from each catch were weighed, and a subsample of 25 kg wet weight was taken from the gross catch to the laboratory. In the laboratory the subsample was sorted in fractions of live mussels, shells of different bivalves, gastropods and invertebrates. The fraction of live mussels was determined, counted, weighed and used to estimate the biomass of mussels on the sampling station. To give the standing stock of mussels in each area the total catch weight was divided by the size of the area covered in each tow to give biomass in $kg/m^2$. Biomass estimates for individual beds in a given area were calculated from the mean biomass for each bed multiplied by the total size of the bed.

To investigate the population structure, random samples of 30-100 individuals were taken from catches in three subareas. The length (mm) and weight (g) of each individual was measured to get mean values for the population. Length-frequency distribution for each area was established with 5 mm size classes.

## Results

### *Distribution and abundance*

During the survey, mussels were found at 16 of the 30 stations investigated (Fig. 1). At these 16 stations blue mussels were the dominant bivalve species encountered. Investigation by the tv-camera were made from 2 m depth and as deep as 15 m but all the blue mussel beds found were located at 2-6 m depth. The beds investigated were different in size and their limits were defined by the bottom topography and depth. The mussel beds were spaced in groups and were found on grounds with fine sediments, silt or fine sand but as soon as the bottom became more rocky the dredge used in the survey became useless. The mussel beds seen on rocky substrate are therefore not in this study. As the depth became more than 6 m blue mussels were seldom found but horse mussels (*Modiolus modiolus*) were abundant at many locations.

The mean biomass and total standing stock for each of the eight areas and all data are summarised in Table I. There were differences in estimated biomass (wet weight) of the mussels from one station to another, ranging from 0.5 kg $m^{-2}$ to the maximum of 3.9 kg $m^{-2}$. No fishable mussel beds were found at the mouth and the outer part of the fjord. The maximum biomass (2.1 - 3.9 kg $m^{-2}$) were found in the innermost part of the fjord, from area II at the north along the coast to area VI at the south (Fig. 1). The estimated total biomass in all areas investigated was 12,876 tonnes (Table I). These estimates must be cosidered minimum since the dredge is not completely efficient.

*Population structure and meat yield*

The dredge used fished mussels from flat sandy, silty or muddy bottom. The blue mussels were often found in groups of 15-20 individuals, which were tied together by byssus threads, lying on the bottom.

Statistical summaries of shell length and wet weight data for the mussels caught in the three major mussel beds are presented in Table II. Greatest mean weight and length were sampled in Botnsvogur, 72.0 mm (SD= 8.9 mm) and 36.9 g (SD=13.2 g).

The greatest number of the mussels sampled by the dredge had heavy shells where width exceeded shell height. This form was invariably accompanied by down-turned divergent umbones and varying degrees of incurvature of the ventral shell margin.

Fig. 2 shows the shell length-frequency distribution of mussels from the three main beds. In Botnsvogur (area IV) mussels with shell length over 60 mm dominated in number and the stock was mainly of commercial size (shell length >50 mm). In Brynjudalsvogur (area V) almost the whole size spectrum of mussels were observed (shell length between 10-80 mm). However, the dominating size class was 65-70 mm in shell length. At Fossá west (area VI), also the whole size spectrum of mussels were observed but here the dominating size classes by number were the small individuals of 5-20 mm.

## Discussion

Hvalfjördur opens in south-west into Faxaflói. From the mouth of the fjord to Katanes on the north coast and to Laxárvogur at the south no subtidal mussel beds were found. These results might be due to much wave action as the shore is exposed. On the north coast of the fjord the depth zone between 2-15 m is narrow and the bottom is rocky or gravel. At the south shore, however, the depth zone between 2-15 m is wider and the bottom is sandy. Here, one would expect a fishable mussel stock but in this locality a ship is regularly pumping up sand from the bottom and may prevent the mussel beds from growing. As the survey continued further in the fjord mussels became more common. From Katanes to Hrafneyri at the north and Laxárvogur to Hvítanes at the south mussels were found by the camera on rocky bottom. These beds were unacceptable by the dredge and therefore of no interest for this study.

The largest amount of blue mussels was found in the innermost part of Hvalfjördur, from Hrafneyri at the north to the bottom of the fjord and all the way to Hvitanes at the south. These beds were found on sand-silt bottom at 2 to 6 m depth and the blue mussel was the dominant species. This part of the fjord is sheltered and the current velocity is 6-7 cm $s^{-1}$ at 10 m depth (Malmberg and Briem, 1985).

The total fishable mussel stock in Hvalfjördur amounted to approximately 12,876 tonnes located on 5.1 $km^2$ area. The mean biomass ranged from 0.5. to 3.2 kg $m^{-2}$ from one subarea to another. As the mussel beds are spaced in groups the densities can vary considerably even within relatively small areas. In 1994 the mean biomass of mussels at water depth more than 4 m in Danish fjords was assessed to be from 0.15 to 3.8 kg $m^{-2}$. The area of these mussel beds varied from 1.5 to 51.4 $km^2$ (Kristensen, 1996).

In the present study the size of an area was assessed by the underwater tv-camera. Another way to estimate mussel beds is to perform an aeroplane photo survey to identify areas with mussels. However, photographing is only successful at low tide when there is no wind, no clouds and the sun is high on the sky, which only happens few times during summer in Iceland.

In the present study the mussels in the beds seemed to be mainly of commercial size (shell length >50mm). The mussels size in the samples from Botnsvogur and Brynjudalsvogur indicate this statement but shell length below 25 mm dominated the biomass in the sample from Fossá as the size distributions indicate.

The size distribution in the mussel beds, the shell form and great pearl content of the shells (Björn Guðmundsson, per. comm.) especially in the southern part of the fjord, indicate that the stock is an old one. As the stock has never been fished the only enemies are the predators. The main predators in the subtidal mussel beds in Hvalfjördur are crabs, *Hyas araneus*, starfish, *Asterias rubens* and eiders, *Somateria mollissima.*

The intertidal beds were estimated in Hvalfjördur at the same localities and at the same time as the subtidal beds. The results indicated that the largest amount of intertidal mussels were found in the innermost part of the fjord at the shore where the largest subtidal beds were located. The size distribution of the mussels at the intertidal beds were different from the subtidal, as individuals under 30 mm were always dominating the biomass. The biomass of mussels in kg $m^{-2}$ in the intertidal beds was not significantly different from the biomass in in the subtidal beds but the beds were smaller and the total intertidal biomass therefore much less than in the subtidal (Ólafsson, 1994).

There is a great density of mussels in the investigated mussel beds in Hvalfjördur and there may be intraspecific competition for food and space. Fishing would probably make this competition less.

The population structure indicates that the population is of considerable age. Utilization of an old population for human consumption can be difficult as the old individuals contain more pearls than the market can accept and the meat may not be of the best quality. Fishing would probably affect the age distribution, the stock would become younger and after some years better exploitable than it is now.

The results from the present study indicate that there are fishable mussel beds in the innermost part of Hvalfjördur. It is difficult to interpret what kind of impact the fishery will have on the size and distribution of the subtidal beds. If there will be fishery for mussels in Hvalfjördur in the future it should be monitored and further investigations on the stock, its abundance and population structure should be planned.

## References


Kristensen, P.S., 1996. Eelgrass (*Zostera marina*) and mussels (*Mytilus edulis*) in the Danish fjord's of Kolding, Vejle and Horsens, in 1994. ICES CM. 1996/K: 26.

Kristjánsson, L., 1980. Íslenskir sjávarhættir, vol. I. Reykjavík, 1980, Bókaútgáfa Menningarsjóds. (In Icelandic), 472 pp.

Kristjánsson, L., 1985. Íslenskir sjávarhættir, vol. IV. Reykjavík, 1985, Bókaútgáfa Menningarsjóds. (In Icelandic), 546 pp.

Malmberg, S. and Briem, J., 1985, Straummælingar í Hvalfirði júní til ágúst 1978.. Hafrannsóknastofnunin, Fjölrit 4, 26 pp. (In Icelandic).

Ólafsson, M.F., 1995. Útbreiðsla, magn og kortlagning kræklings (*Mytilus edulis*) í Hvalfirði. Raunvísindadeild Háskóla Íslands. Unpublished rapport, 22 pp. (In Icelandic)

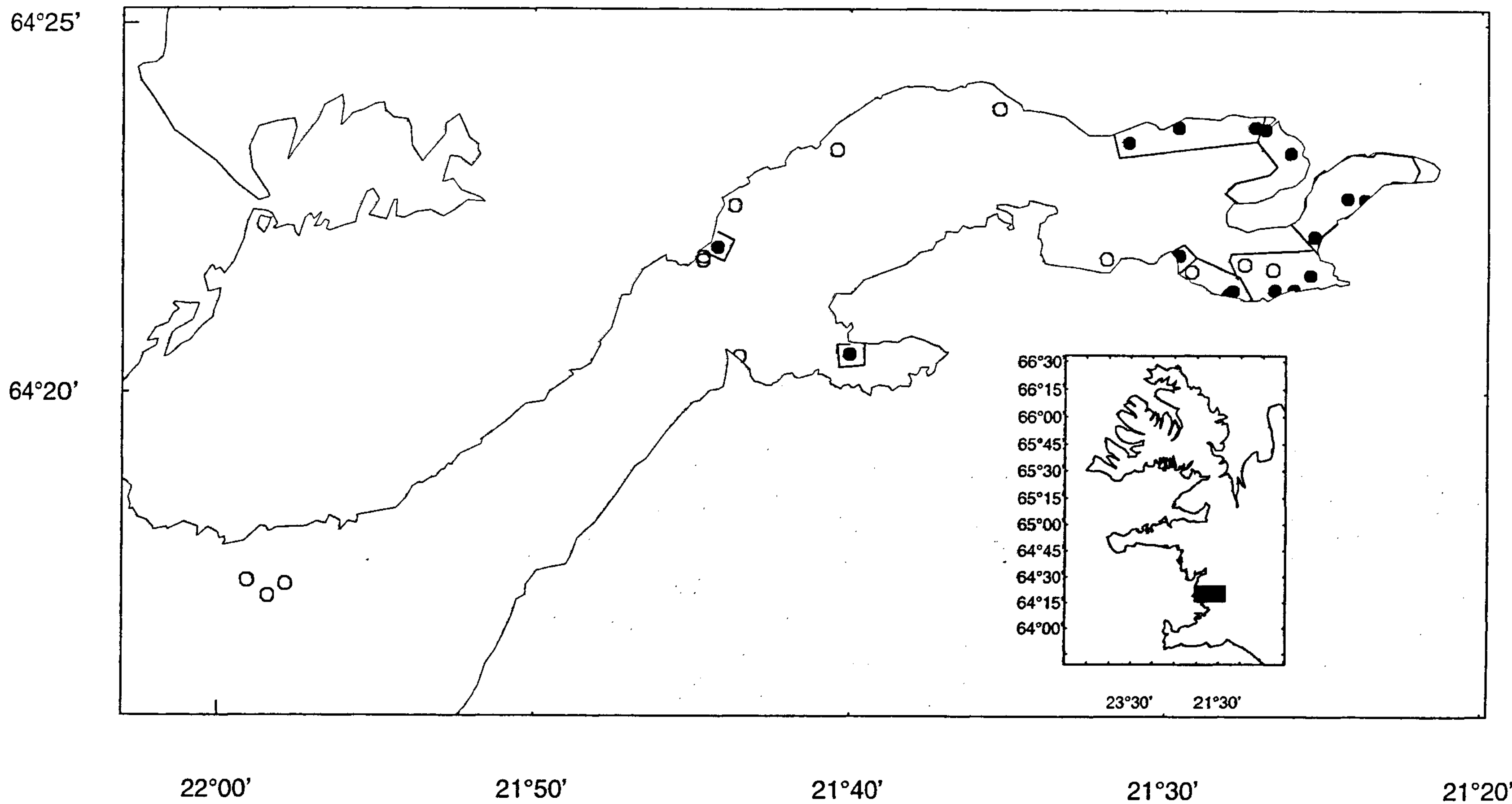


Fig. 1. A map of Hvalfjördur, south west Iceland with sampling stations marked. A black dot denotes a station were blue mussels were found, an open circle a station were no blue mussel were found.

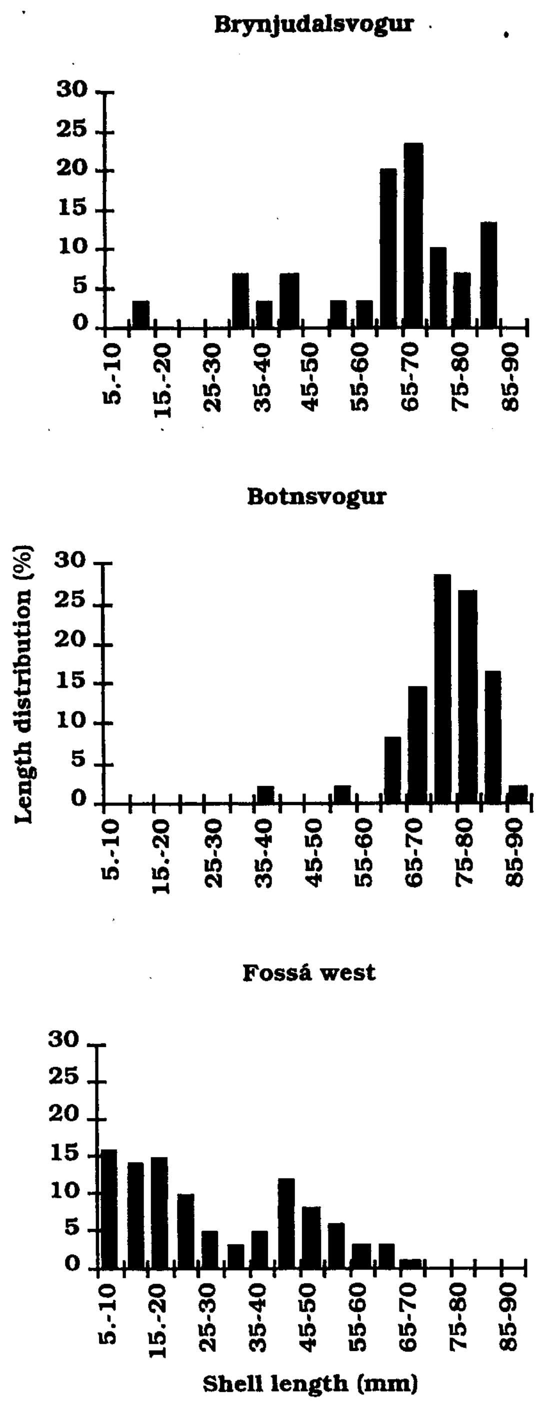


Fig. 2. Shell length-frequency distribution for 5 mm size classes of *Mytilus edulis* from three sites in Hvalfjördur south-west Iceland.

**Table I.** Estimated mean biomass (kg $m^{-2}$) and total standing stock (wet weight [mt]) for blue mussels (*Mytilus edulis*) in Hvalfjördur at water depth of 2-6 m.

| Area no | Geograph. area | No. of samples | Area $m^2$ | Biomass kg $m^{-2}$ | Range kg $m^{-2}$ | Standing stock (mt) | Depth m |
|---|---|---|---|---|---|---|---|
| I | Katanes | 1 | 100,000 | 0.7 | | 70 | 2.0-5.0 |
| II | Hrafneyri-Hvalst. | 3 | 600,000 | 2.1 | 2.1-2.1 | 1260 | 2.0-6.0 |
| III | Helguvík | 2 | 600,000 | 1.6 | 0.5-2.8 | 966 | 2.0-5.0 |
| IV | Botnsvogur | 3 | 2200,000 | 3 | 1.4-3.9 | 6622 | 2.0-5.0 |
| V | Brynjudalsv. | 3 | 800,000 | 3.2 | 2.1-3.9 | 2520 | 2.0-5.0 |
| VI | Fossá west | 2 | 400,000 | 2.8 | 2.8-2.8 | 1120 | 2.0-5.0 |
| VII | Hvitanes | 1 | 277,000 | 0.5 | | 138 | 2.0-3.0 |
| VIII | Laxárvogur | 1 | 120,000 | 1.5 | | 180 | 2.0-4.0 |
| All areas | | 16 | 5,117,000 | | 0.5-3.9 | 12,876 | 2.0-6.0 |

**Table II.** Summary of population structure data for blue mussel (*Mytilus edulis*) at 2-6m depth in Hvalfjördur

| Area | Geograph. | No. | Shell length (mm) | | | Wet weight (g) | | | Meat yield |
|---|---|---|---|---|---|---|---|---|---|
| no | area | | X | SD | Range | X | SD | Range | % |
| IV | Botnsvogur | 52 | 72.1 | 8.9 | 37.5-85.5 | 36.9 | 13.2 | 4.2-67.3 | 37.8 |
| V | Brynjudalsv. | 30 | 61.7 | 16.3 | 13.5-84.5 | 27.6 | 17.3 | 0.4-69.9 | 40.6 |
| VI | Fossá west | 100 | 28 | 17.1 | 7.0-67.0 | 3.8 | 5.2 | 0.02-23.5 | 38.9 |
| All areas | | 182 | 46.1 | 25.3 | 7.0-85.5 | 17.2 | 18.5 | 0.02-69.9 | 39.1 |