

KRILL ON THE SCOTIAN SHELF

Background

Krill (euphausiids) comprise the most important macrozooplankton group in the pelagic ecosystem on the Canadian east coast continental shelf. They are the primary trophic link between small zooplankton that feed directly on phytoplankton and most fish species. They occur in waters where the minimal depth is greater than 200 m and migrate diurnally to depths less than 50 m; they are thus precluded from most shelf banks. Three species are commonly found on the Scotian Shelf, in the Bay of Fundy and the Gulf of Maine: *Thysanoessa rashii*, *Thysanoessa inermis*, and *Meganctiphanes norvegica*. *M. norvegica* is the largest of the three species, reaching a maximum length between 3 and 4 cm. The other two species are similar in length at maturity (approximately 2.5 cm). *Thysanoessa* species have a one year life cycle with planktonic eggs released in the spring (April to May). *M. norvegica* can live up to three years, but the majority of animals will not survive past two years of age. They mature at age one, with breeding occurring in late June and early July. *M. norvegica* has been proposed as the target of a new fishery in the Maritimes Region. The main purpose of such a fishery would be to supply nutrient-rich additives to the aquaculture feed industry.

The Fishery

There is no krill fishery at the present time in the Maritimes Region. However, proposals to develop an experimental fishery in Scotian Shelf waters and the Gulf of Maine have been received by DFO in 1995. The first application requested that, commencing in 1997, the proposed fishery would target *M. norvegica* in Scotian Shelf waters. The main gear type would be a midwater trawl with an exclusion device to reduce by-catch

of such species as pollock, silver hake and redfish. Provision would be made for an associated scientific research program. The proposed fishery would comply with general regulatory requirements and the Dockside Monitoring Program. The proposed harvest would be limited to 1,000 t.

A zooplankton fishery in the Gulf of St. Lawrence has focused on krill and *Calanus*. In 1995, zooplankton was included in the regional assessment report for invertebrate stocks with a recommended TAC of 300 t for krill and 2,000 t for *Calanus*. It should also be noted that euphausiid stocks on British Columbia's inner coast (Strait of Georgia and adjoining inlets) are fished at a rate of about 500 t per year.

Resource Status

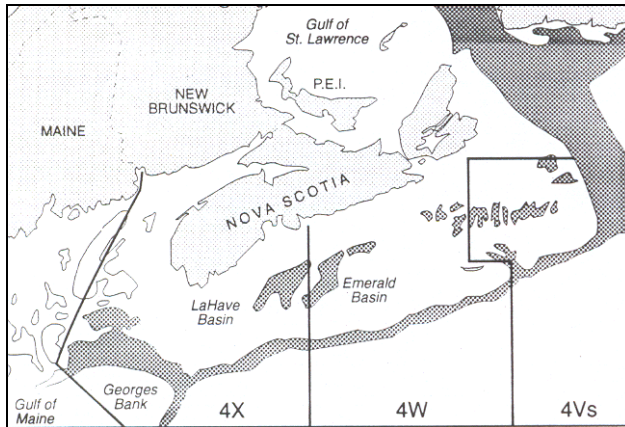
There are limited data on which to derive estimates of krill abundance in the Maritimes Region. However, standing stock estimates of *M. norvegica* per km² in regions of the shelf deeper than 200 m, and between 200 and 1,000 m, on the continental slope during the spring and summer were used along with known areas of distribution in order to estimate krill biomass. Because of uncertainties in the information, a conservative value for krill biomass of 10 g m⁻² was used to estimate total biomass in both the Emerald and LaHave Basins; 2 g m⁻² was used elsewhere (see table below).

Location	Area (km ²)	Krill biomass (t)
Emerald and LaHave Basin	5,296	52,960*
Basins in eastern half of Shelf	2,399	4,800**
Fundy Channel and Jordan Basin	7,714	15,000**
Continental shelf edge including Laurentian Channel (200-1,000 m)	25,406	51,000**
Total shelf		123,760

* Based on an average biomass of 10 g per m².

** Estimates are based on the conservative assumption of a biomass of 2 g per m².

Waters on the continental shelf (shown in grey) of the Maritimes Region in which *M. norvegica* is concentrated. 4X, 4W, and 4Vs are NAFO areas.



Multifrequency acoustics was the technique used to provide these density estimates. This allows the separation of backscattering echoes of the euphausiids from the fish. Biomass estimates are also available from net samplers. Good agreement was found between biomass estimates from both the net samplers and the acoustic techniques.

Ecosystem Considerations

At issue is whether krill harvesting could deplete a major food source for ecologically significant species, including species that support commercial fisheries. Related to this is the issue of by-catch during krill harvesting.

Caution should be the overriding principle when considering a harvest of species low in the marine food web. Adults of 12 finfish taxa overlap geographically with euphausiids on the Scotian Shelf, and three are commercially harvested: pollock, silver hake, and redfish. Euphausiids are prey for most fish species on the shelf at some stage in the fish's life cycle. The numerically dominant fish species in both Emerald and LaHave Basins (and in the Fundian Channel) have euphausiids as an important part of their diet. The Emerald Basin has been studied annually, from 1984 to 1995, using the frequencies appropriate for pelagic fish (12 kHz) and euphausiids (200 kHz). In the case of silver hake and redfish, the levels of backscatter at these two frequencies showed a close relationship between pelagic fish and krill in this area. Cod and haddock distributions include the tops of the banks where krill rarely occur. Thus, their dependence on krill as food is expected to be less than is the case for deeper water species. The Bay of Fundy has local concentrations of krill; however, little information is available on either their abundance or distribution. It is also known that herring feed on krill in Fundy waters.

Major centres of concentration of larval forms of many important fish and invertebrate species do not overlap geographically with krill, as the former tend to be "bank" rather than "basin" spawners. This is the case for lobster, silver hake, pollock, cod, haddock, and flatfish, but not for redfish on the Scotian Shelf.

Right whales are plankton feeders whose diet includes euphausiids. Their northern migration brings adults and their young to the Bay of Fundy and Scotian Shelf region, presumably for food. Their centres of abundance, in the Canadian leg of their annual migrations, occurs at the mouth of the Bay of Fundy and Roseway Basin (north of Browns Bank).

With respect to marine birds, both shearwaters and storm petrels are known to feed on krill, when inhabiting Scotian Shelf, southwestern Nova Scotia, and Bay of Fundy waters.

By-catch of other key species in the proposed fishery is a concern that will require close monitoring. The proposal states that the small-mesh midwater trawl to be used will incorporate an exclusion device (a grate similar to the Nordmore grate) to reduce this by-catch.

Outlook

An “experimental” krill fishery that would remove no more than 1,000 t from Scotian Shelf waters appears feasible and would have negligible effects on the overall marine ecosystem. This amount is estimated as being less than 1% of the biomass on the Scotian Shelf/Emerald Basin area targeted in the proposed fishery. Given the small portion of the biomass that would be removed, it is concluded that the impacts on the ecosystem would be negligible. Notwithstanding this, given the uncertainties in our knowledge of the resource, if this fishery proceeds it would be prudent not to take the 1,000 t from a single location, but rather spread it over several locations. For example, it could be removed on a *pro rata* basis according to the following table:

Location	Allocation (t)
Emerald and LaHave Basins*	444
Fundy Channel and Jordan Basin	126
Continental shelf edge, including Laurentian Channel (200-1,000 m)	430
Total	1,000

* Emerald Basin = 258 t.
LaHave Basin = 186 t.

Information is not available on which to calculate a quota for Bay of Fundy waters, because surveys have not been undertaken similar to those made in Emerald Basin. Season of harvest can, from a biological

perspective, occur at any time though maximum biomass is present during late spring/early summer.

There is much that is unknown on the status of krill on the Scotian Shelf, and on the impact of harvesting this species on the overall ecosystem. Thus, a fishery should be carefully monitored, including the collection of accurate catch-per-unit-effort data and details of the location and depth of harvest. In addition, measures should be taken to reduce by-catch of the larvae of other species. Given the uncertainty of the role krill play in the ecosystem, it would be prudent to restrict future harvests to 1,000 t until the scientific basis for an ecologically sustainable fishery is developed.

For More Information:

Contact:

Dr. John Pringle, Manager
Marine Environmental Sciences Division
Science Branch
Fisheries and Oceans Canada
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, NS B2Y 4A2 Canada

Tel: (902) 426-6138

Fax: (902) 426-6695

Email: john.pringle@maritimes.dfo.ca