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Does scyphozoan jellyfish, *Cyanea capillata*, limit habitat for the Barents Sea species during the late feeding period.

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Data over a period 1993–2013 were used to explore the following questions: Does scyphozoan jellyfish limit habitat for the Barents Sea species during the late feeding period. The area of high concentration of both studied species and jellyfish and area free for high jellyfish concentration were estimated and response of jellyfish overlap on krill/fish was tested by GAM. The area of co-occurrence of high fish/krill and jellyfish densities were positive correlated with species biomass indices/estimates (0-gr capelin, 0-gr herring, capelin (age 1-2), young herring and blue whiting, indicating that higher densities of jellyfish not necessarily limit fish aggregations. At the same time larger area free for high amount of jellyfish were associated with larger 0-gr capelin, 0-gr cod, capelin (1-2) and young herring indices/estimates. In years with low jellyfish indices, jellyfish has no effect on fish/krill densities, while in other years fish/krill were low with low jellyfish, increased with increased jellyfish densities, and fall with very high jellyfish densities. This most likely indicated that very high jellyfish densities have potential to limit 0-gr cod, 0-gr haddock and 0-gr polar cod habitat. However, co-occurrence of high densities of both jellyfish and fish/krill indicated most likely a high productive area.

The Barents Sea pelagic community consists of a huge amount of species belongs to plankton, invertebrates and fish. Among the zooplankton, scyphozoan jellyfish are less studied group and their role in the Barents Sea ecosystem are not understand yet. The majority of 0-group fish (5-7 month old) distributes widely, having the central parts of the Barents Sea is a core area, where the majority of jellyfish were observed (Eriksen et al. 2011). The pelagic species, such as capelin, young herring and blue whiting, are mainly plankton-feeders and follow plankton production, constituting important links between lower and higher trophic levels in the Barents Sea ecosystem (Skjoldal and Rey 1989).

Spatial (horizontal) overlap between different components of the pelagic community (jellyfish, krill, 0-group fishes (capelin, herring, cod, haddock, polar cod and redfishes) and pelagic fish stocks (capelin, herring, blue whiting and lumpfish) was exanimated using pelagic catches from the 0-group survey (1993-2003) and a Joint Norwegian-Russian ecosystem survey (2004-2013). All observations were summed to grid cells (60*60 square nautical miles (nm)) and mean densities, as wet weight (kg nm^{-2}) were calculated each for grid cell. To determinate whether the potential for competition between the species exists 1) the area (nm^{-2}) of high concentration of both studied species and jellyfish and area free for high concentration of jellyfish were estimated, 2) the response of jellyfish on krill/fish was tested by GAM, using jellyfish densities and jellyfish years (low, average and high annual biomass index) in model 1, and jellyfish densities and years with different temperature conditions (average and warm years) in model 2. Separate models of type 1 and 2 were constructed for all studies species.

Jellyfish of higher densities (> ca $3*10^3$ nm^{-2}) occupied an area of average of $92*10^3$ nm^{-2} for the study period, and the smallest area were observed in 1997 ($4*10^3$ nm^{-2}) and largest in 2001 ($220*10^3$ nm^{-2}). Larger area of co-occurrence of high fish/krill and jellyfish densities were significantly positive correlated with species biomass indices/estimates (0-gr capelin, 0-gr herring, young capelin, herring and blue whiting), indicating most likely that higher densities of jellyfish not limit fish aggregations. At the same time both 0-gr capelin, 0-gr cod and young capelin and herring showed positive response between annual biomass index/estimate and size of area free for high amount of jellyfish. This may indicated that in area free for higher density jellyfish aggregates more fish and/or larger year classes or stocks occupies larger area, overlapping area with or without jellyfish.

Jellyfish years were categorized as years with low annual biomass indices with an average of $332*10^3$ t, years with average annual biomass with an average of $1.3*10^6$ t, and years with high annual biomasses with an average of $3.1*10^6$ t. The additive models indicated that years with low annual biomass indices 1) increased jellyfish densities has no significant effect on fish/krill densities, 2) most of species of high densities overlapped with relatively low (> 1 t nm^{-2}) jellyfish densities, and fish densities higher than in other years. During years of average and high jellyfish annual biomass indices the most of fish/krill the lowest densities were related with low jellyfish densities (10-100 kg nm^{-2}), increased with increased jellyfish densities (krill, 0-gr herring, lumpfish, capelin 1-2 and herring), and fall when jellyfish densities were higher than 3 t nm^{-2} (0-gr capelin, 0-gr cod, 0-gr haddock, 0-gr polar cod). This most likely indicated that fish/krill were not limited by average and high jellyfish aggregation, but further increasing of jellyfish densities has potential to limit 0-gr cod, 0-gr haddock and 0-gr polar cod habitat. The highest densities of capelin (1-2) were associated with average jellyfish densities (300-900 kg nm^{-2}), and fall with further increasing of jellyfish, thus jellyfish of high densities, has also the potential to exclude the capelin from feeding area. Proportion of variance of fish/krill densities explained by the models was low and varied between 3.4 and 17.9%. The fish abundance cannot be explained by the jellyfish overlap alone, but some of their variation seems to be explained by inter-annual variation in jellyfish amount.

Years with different temperature condition were categorized as average years (mean T=5.9 °C) and warm years (mean T=6.5 °C). Densities of 0-gr capelin, 0-gr redfish, lumpfish, and capelin (1-2) were generally higher in warm than in average years. The additive models indicated that during years with average temperature conditions the lowest fish densities overlapped with low jellyfish densities (10-100 kg nm^{-2}), however that were higher than in warm years (0-gr cod, 0-gr haddock, 0-gr herring, krill, and young herring). However, the highest fish/krill densities were associated with high jellyfish densities (> 3 t nm^{-2}) and were higher in warm years (0-gr capelin, 0-gr cod, 0-gr herring, 0-gr polar cod, krill and lumpfish). This indicated that during warm years the fish/krill abundance generally higher than in years with average temperature conditions and high jellyfish amount will not influence negatively the most of studied species, except capelin (1-2) and blue whiting. Temperature influences fish directly through growth and indirectly through food availability. A high zooplankton biomass during warm years is presumably due to higher inflow of advected organisms, as well as higher temperatures leading to higher growth rates of zooplankton (Dalpadado et al., 2003). Therefore, we believe that co-occurrence of higher densities of both jellyfish and fish/krill indicated most likely a high productive area.

References:

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