Impact of food quality, nutritional status, birth rate and hunting pressure on Baltic grey seals

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Baltic grey seal
(Halichoerus grypus)

• The population crashed in the 1970s to only 2000-3000 due to hunting and environmental pollution which caused reproductive failure in females.

• After the grey seal was protected from hunting and DDT and PCB concentrations declined, population started to increase.

• At present, reproductive health of females is good and birth rate normal.

• Hunting was started again in 1998 in Finland and 2001 in Sweden.

• Grey seal is the top predator in the Baltic Sea.

• The most common prey fish of grey seals is the herring (Clupea harengus), especially in the northern parts of the Baltic Sea.
Aims of the study

- We studied:
  1) the possible impacts of food quality/quantity and ice conditions on the nutritional status of grey seals
  2) the effect of food quality and nutritional status on birth rate
  3) the impact of birth rate and hunting pressure on population abundance in the Finnish sea area.

Study area included ICES subdivisions 27 and 29-32. Birth rate and hunting pressure only from the Finnish sea area.
Methods

• Seal samples were collected from hunters and fishermen from Finland and Sweden since 2001.

• Sex, age, reproductive status of females and subcutaneous blubber thickness (an index of nutritional status) of seals were determined.

• Annual variation and trends in blubber thickness were tested with GLM. Variables which were included in the models as covariates (when significant) were: month, age, sex, sea region and cause of death (hunted vs. by-caught).

• Model predicted values (mean ± SE) for blubber thickness are given.
1) Impacts of food resources and ice conditions on the blubber thickness of grey seals (Kauhala et al. 2017)

1.1. Pooled data for all age groups

- Blubber thickness in the pooled data for Finnish and Swedish grey seals of all age groups (n = 2144) varied between years (year: \( p < 0.001 \), all independent variables as covariates).
- A significant declining trend in blubber thickness until 2010 (slope = -0.44, \( F = 7.2, p = 0.007 \)).
• Herring weight (mean for 5-6 years old) explained well the decline in blubber thickness of grey seals from 2003 to 2010 ($r^2 = 0.79$, $F = 23.0$, $p = 0.003$).

• A negative relationship between herring catch size (an index of herring abundance) and blubber thickness ($r = -0.86$, $p = 0.006$).

• A negative correlation also between herring weight and herring catch size ($r = -0.93$, $p = 0.001$).
1.2. Pups (< one year old seals)

- Also blubber thickness of pups varied between years (year: p 0.001, sea region and cause of death as covariates) and declined until 2010 (slope -1.13, F = 18.7, p < 0.001).

- The weight of 5-6-year-old herring explained well the decline, especially in Baltic Proper (largest data for pups; $r^2 = 0.88$, F = 42.2, p = 0.001).

- A negative correlation between herring catch size and blubber thickness of pups ($r = -0.77$, p = 0.026).
• In recent years in the Gulf of Finland, blubber thickness of grey seal pups decreased with decreasing ice cover during the breeding season in late winter ($r^2 = 0.85$, $F = 16.8$, $p = 0.026$).

• In other areas, blubber thickness of pups increased in recent years with increasing weight of 5-6-year-old herring ($r^2 = 0.78$, $F = 14.0$, $p = 0.020$).
1.3. Sub-adults (1-3 years old) and adults

- Sub-adults: blubber thickness varied between years (year: $p = 0.028$ with all independent variables as covariates), and was partly explained by herring weight ($r^2 = 0.66$, $F = 9.8$, $p = 0.026$).
- In recent years, the blubber thickness of sub-adults in Baltic Proper increased (slope = 2.02, $F = 6.7$, $p = 0.012$).
- Total data of adults: year was not significant.
- Blubber thickness of adult females in the Bothnian Bay increased in recent years (slope = 1.28, $F = 10.1$, $p = 0.002$).
In recent years, the increase in blubber thickness of sub-adults in Baltic Proper and that of adult females in the Botnian Bay were explained by increasing herring weight (ages 6+ and 7 years).

- Sub-adults: $r^2 = 0.88$, $F = 21.0$, $p = 0.019$.
- Adult females: $r^2 = 0.62$, $F = 9.6$, $p = 0.021$. 
2) Impact of food quality and blubber thickness on the birth rate of grey seals (Kauhala et al. 2016)

- Abundance index, birth rate and herring weight of grey seals in the Finnish sea area in the 2000s.
- Birth rate = % adult females giving birth each year
- Herring weight: mean weight of age 5+ herring
- Abundance index = grey seals seen during aerial monitoring
• Herring weight affected blubber thickness of adult females.
• There was a positive relationship between the blubber thickness and birth rate in BB ($r^2 = 0.53$, $F = 8.9$, $p = 0.024$; Kauhala et al. 2017).
• Herring weight thus explained well the variation in the birth rate of 7-25-year-old grey seal females mainly killed in the Bothnian Bay in the 2000s ($r^2 = 0.71$, $F = 14.8$, $p = 0.008$).
3) Impact of birth rate and hunting pressure on the grey seal abundance index (Kauhala et al. 2016)

Hunting pressure: $100 \times \frac{\text{hunting bag}}{\text{abundance index}}$
Proportion of pups increased and that of adults decreased in the hunting bag. Adult mortality rate is more important in long-living mammals.
• Hunting pressure partly explained the change in abundance index of grey seals in the Finnish sea area in the 2000s ($r^2 = 0.76$, $F = 31.3$, $p < 0.001$).

• In recent years, birth rate increased, and birth rate alone explained 86% of the variation in abundance index ($F = 38.0$, $p = 0.001$).
Conclusions

• Herring weight affected the nutritional status of grey seals in all age groups including adult females and thus it affected also their birth rate.

• Herring abundance did not have an effect on the blubber thickness, indicating that the herring quality, not the quantity, is important for Baltic grey seals.

• A negative correlation between herring abundance and herring weight indicated that in a dense herring population herring are slim and *vice versa*.

• When herring are slim seals have to use more energy for foraging than when herring are fatty.
• Ice cover in late winter had an impact on the nutritional status of pups in the Gulf of Finland.
• Pups born on land are lighter at the time of weaning than those born on ice (Jüssi et al. 2008).
• Climate change may thus affect the nutritional status of seal pups and thus their mortality rate during their first year.
• It may also affect their future reproduction because bad start may be seen later in their lifesp.
• Hunting pressure had a negative impact on grey seal abundance.
• It increased after the mid-2000s probably inhibiting population growth.
• In recent years, hunting pressure, especially towards adult seals, decreased.
• The decreasing hunting pressure and increasing birth rate resulted in a new phase of population growth since 2010.
• Both human-induced mortality and the quality of the main prey fish have an impact on the population growth rate of Baltic grey seals.
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