

The mystery of the M74 syndrome solved:

Plentiful fatty sprat as prey for salmon leads to reproduction disorder

Thiamine (vitamin B1) deficiency results in mortalities of yolk-sac fry of salmon (M74). Deficiency of thiamine develops when the fat content of prey fish is high and the thiamine concentration too low in comparison to energy density and the content of unsaturated fatty acids. Abundance of young sprat as food for salmon increases the prevalence and severity of M74 and impairs the reproduction of Baltic salmon.

The M74 syndrome is connected to a weak cod stock and strong year classes of sprat. The syndrome spiked in the early 1990s, when the sprat stock suddenly increased. The increase in the sprat stock resulted from pronounced decrease in the cod stock, as cod is the main predator of the sprat. The reproduction areas of sprat are in the southern Baltic Sea, the main area where salmon from the rivers of the Bothnian Bay feed. After the collapse of the cod stock, salmon had plenty of sprat as food in the southern Baltic areas.

The fat concentration of sprat is nearly twice that of herring. The fattiest sprat are young individuals. The fat content of sprat decreases with age. When there are large numbers of young sprat in the sea, salmon receive copious amounts of food with a high fat content and energy density. The condition factor of salmon was exceptionally high in the years with a high M74 incidence, and offspring of the largest and fattiest females most probably suffered from M74 symptoms.

Thiamine concentrations in sprat and herring are quite similar. In both species, the thiamine concentration changes with age: it is lowest in the youngest fish, and in the oldest fish it again decreases. The maximum thiamine concentrations in herring were in age groups 3–7, but in sprat not until age groups 6–10 years.

The thiamine requirement is determined by the energy density of food, as thiamine has a central role in energy metabolism. The fattier fish salmon eat, the higher the amount of thiamine needed. Considering the demand, the supply of thiamine is lowest when salmon prey mainly on sprat, especially young sprat.

During the long spawning migration and a long prespawning fasting period, thiamine reserves accumulated in the feeding areas are depleted. Fish fat contains lots of unsaturated fatty acids, specifically omega-3 fatty acids. A low thiamine intake and ample amounts of unsaturated fatty acids both increase susceptibility to oxidation of unsaturated fatty acids, in which reactions thiamine is destroyed. Thus the thiamine stores of female salmon decrease too much. Diminished thiamine body stores do not allow adequate deposition of thiamine into developing eggs; the development of offspring cannot be sustained until the end of the yolk-sac period, when fry start external feeding.

M74 incidence has decreased since the cod stock began its recovery

The M74 syndrome was at its worst in the early and mid-1990s. In those years, the syndrome threatened naturally reproducing salmon stocks that already were weak because of the over-fishing of the 1980s. Most wild salmon originate from the rivers of the northern Gulf of Bothnia, and there the Simojoki and Tornionjoki are the only Finnish rivers in which salmon reproduce naturally. The survival and recovery of salmon stocks were enabled through

temporary strengthening of fishing regulations and increased introduction of farmed salmon smolts. In the 2000s, M74-related mortality has remained below 30%. In some years, such as 2003–2005 and 2011, mortality due to M74 was insignificant. In autumn 2011, thiamine concentrations in eggs of spawning females were so high that M74 will not be a problem in spring 2012. This is a consequence of strengthening of the cod stock and flattening out of the sprat stock.

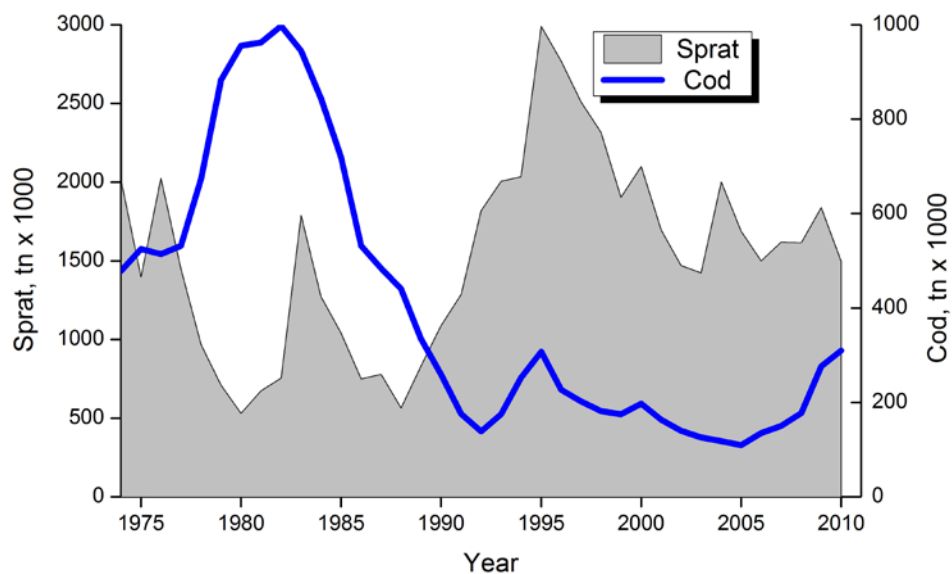
Sources of further information:

The thiamine deficiency syndrome M74, a reproductive disorder of Atlantic salmon (*Salmo salar*) feeding in the Baltic Sea, is related to the fat and thiamine content of prey fish

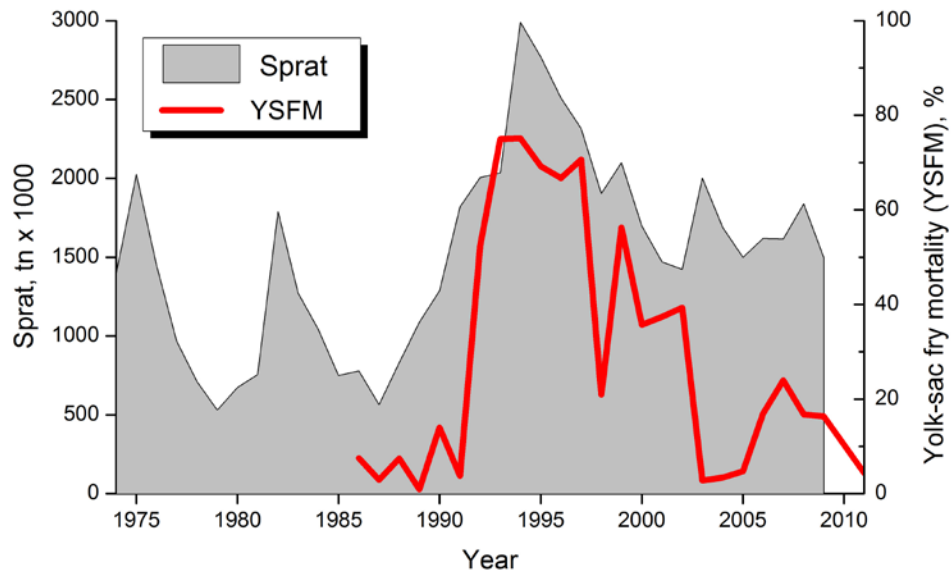
<http://icesjms.oxfordjournals.org/content/69/4/516.abstract>

Relationships between fish stock changes in the Baltic Sea and the M74 syndrome, a reproductive disorder of Atlantic salmon (*Salmo salar*)

<http://icesjms.oxfordjournals.org/content/68/10/2134.abstract>



The figure describes the biomass of cod (blue line) and sprat (grey area) from the mid-1970s to the early 2000s.



The figure presents the mean M74 mortality percentages of yolk-sac fry (YSFM, red line) from 1986 to 2011 and the biomass of sprat two years earlier – i.e., during the last full feeding year of female salmon.

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