Effect of Climate Change on Fisheries and Aquaculture with emphasis on Central and Eastern Europe

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SUMMARY

Climate change will slow down oceanic currents vital for the production cycles in the sea and will particularly affect primary production and the migration of fish larvae and plankton. The vertical stratification of layers will be stabilized and it is likely that for instance the Baltic will be impacted by this and by declining salinity due to increased precipitation and reduced inflow from the Skagerrak. Also flushing of the deep sea is likely to be reduced with a decrease in deep sea production as a consequence. This could influence the deep sea catches in the Mediterranean. The European region is expected to experience more frequently flooding – and drought in some areas and high temperatures may jeopardize existing inland aquaculture.

Freshwater aquaculture of many countries within the region is likely to be affected by the climate change and may be affected by flooding or by drought or high temperatures.

A. Introduction

There are basic differences in possible effects of global warming on marine and inland fisheries and aquaculture. Marine fish have large population sizes, high fecundity, and often planktonic stages; migration is less restricted. Marine populations undergo large population fluctuations (Brander 2005). They generally have a small egg size and early fish larval stages are very vulnerable to even small changes in availability of planktonic food. Inland and aquaculture fish will have markedly less opportunity to temporarily escape warm or oxygen poor water.

Changes in marine fish and plankton distribution happen much faster than changes in terrestrial flora and fauna, and many people in Northern and Central Europe will have noticed the increase in local caught southern species at the fishmonger’s desk.
Prediction of the consequences of climate change on marine population is complex and both positive and negative effects can be expected dependent on species, geographical area and distribution. Thus for many salmonids increased winter temperature will increase growth but also increase the risk for infectious diseases. An increase in summer high temperatures will result in high mortality. The influence on primary production will vary geographically but most model projections predict a moderate global increase of less than 10% (Branner, 2006). However major changes in algae species composition can be expected and this might affect growth in higher trophic levels particularly in sea waters. Also the slow down of oceanic currents (Curry and Mauritzen, 2005) will reduce the vital upwelling of nutrients and thus ultimately lower the primary production in some areas. The expected major changes in ocean currents are also likely to influence the distribution and migration of fish larvae.

West Greenland during the period of warming from 1920

<table>
<thead>
<tr>
<th>Changes in distribution and abundance</th>
<th>Fish species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species previously absent, which appeared from 1920</td>
<td><em>Melanogrammus aeglefinus</em>, <em>Brosme brosme</em>, <em>Molva molva</em></td>
</tr>
<tr>
<td>Rare species which became more common and extended their ranges</td>
<td><em>Pollachius virens</em> (new records of spawning fish), <em>Salmo salar</em>, <em>Squalus acanthias</em></td>
</tr>
<tr>
<td>Species which became abundant and extended their ranges poleward</td>
<td><em>Gadus morhua</em>, <em>Clupea harengus</em> (new records of spawning fish)</td>
</tr>
<tr>
<td>Arctic species which no longer occurred in southern areas, but extended their northern limits</td>
<td><em>Mallotus villosus</em>, <em>Gadus ogac</em>, <em>Reinhardtius hippoglossoides</em> (became much less common),</td>
</tr>
</tbody>
</table>

From Brander (2003) with permission from the author
B. Background Literature Review:

1. Estimates of the effect of Climate Change on Marine Fisheries

The dramatic influence of rising and falling sea temperatures on fish population’s geographic distribution has been well documented on cod stocks at Western Greenland and Eastern Canada (Brander, 2005). Populations decreasing weight-at-age can be caused by climate changes (cold or warm) and are clear indicia that the population is subjected to stress resulting in reduced resilience and lower reproductive output. It is frequently followed by a dramatic fall in biomass (as documented by North Atlantic cod populations) because population projections of numbers are translated into catch limits using overestimates of weight-at ages. Hence weight quotas result in catch of more (lighter) fish than expected and therefore a higher-than-planned fishing mortality on top of the factors mentioned above. Thus falling weight-at-age should be used as an indicator to initiate precautionary measures on fishing mortality.

It is well documented that fishing can cause changes in population genetic structure. Such changes and loss of genotypes suggests that during conditions of changing climate, special protection should be extended to the populations at the edges of their ranges, where the first adverse impacts (due to increasing temperature, declining salinity etc.) are expected to occur. The decline in the European cod stocks caused by over fishing has been aggravated by climatic caused changes in plankton production at the Southern borders of the cod abundance.

Climate change may have a significant impact on the supply of organic matter by dense shelf water cascading (DSWC) - a type of current that is driven solely by seawater density contrast - to deep-sea ecosystems. A 2006 paper of Miquel Canals et al. on DSWC presents interesting findings on how DSWC can transport large amounts of water and nutrient rich sediment from estuarine areas to the deep-sea environment. Several of these phenomena happen in the Mediterranean Sea and one investigated transported in four months the amount of water from the Gulf of Lions to the deep Western Mediterranean, via the Cap de Creus canyon, that equaled around 12 years of the water input from the river Rhone, or 2 years of input from all rivers draining into the Mediterranean. The deep-sea shrimp Aristeus antennatus (marketed as crevette rouge) is highly dependant on this flushing and stabilizing the vertical layers as an effect of the change in climate will most likely reduce its abundance.

Nellemann, Hain and Alder’s report (2008) points at “The Big Five Stressors” as primary threats to the worlds oceans to be:

1) Climate change
2) Fragmentation and habitat loss
3) Over-harvesting from fisheries
4) Pollution (mainly coastal)
5) Invasive species

2. Estimates of the effect of Climate Change on Inland Fisheries and Aquaculture.

A 2006 comprehensive report (Handisyde, Badjeck and Allison) applied 23 highly different layers in a GIS (Geographic Information System) model in order to identify the most overall vulnerable countries and areas to a coming climate change. The layers are based on information from FAO FISHSTAT and World Bank GDP data and a broad range of social and climate data and include among others sensitivity of world freshwater and brackish water
aquaculture, mariculture, cyclone-, flood- and drought risk. Each layer can predict a catastrophic situation for a country (i.e. drought, flooding, food security and combinations of such factors) and could be a valuable preliminary tool for governments to guide precautionary planning.

While North Korea shows the highest vulnerability (5 on a scale from 1-5) in terms of food security, several countries in the Central European area obtain a grade 3 (Slovakia, Moldova, Croatia, Bosnia-Herzegovina, Serbia and Bulgaria). Many countries in the Central and Eastern European area score 3 (Belarus, Ukraine, Czech Republic, Hungary, Romania, Bulgaria and Serbia) in relation to sensitivity on freshwater aquaculture, whereas two countries (Bosnia and Herzegovina and Moldova) are ranked 4. Precipitation decrease – temperature increase and population density combined shows high vulnerability exposure at 4 for Bulgaria and parts of Romania and 3 for Serbia, Ukraine. When it comes to vulnerability of aquaculture and its impact on food security only Bulgaria and Moldova are ranked 3 in the study. In the summary sheet pointing on the 53 most vulnerable countries of the world, Belarus, Czech Republic, Hungary, Romania and Ukraine are classified as vulnerable due to losses in freshwater aquaculture caused by inland flooding, whereas Turkey’s freshwater aquaculture is vulnerable to drought impacts.

The aquaculture sector is very reliant on fishmeal and fish oil for the production of fish-feed and less flexible to switch to other products. Peru is the world largest producer of fishmeal. The country’s production of fishmeal has been highly negatively affected by the El Niño developments and demand and prices of fishmeal and -oil are expected to rise. Limited or decreasing supply of fishmeal and fish oil is anticipated to be a problem for aquaculture production during climate change.

C. Generalizations on the Effect of Climate Change on Fisheries.

Climate change is affecting the aquatic habitats and the fishing resources already. A comprehensive amount of studies documenting this has been published for a variety of marine organisms like tunas, cod, sardine, anchovy, krill, photo- and zooplankton. Warm water species spread to the North and local extinctions has happen at the edges of the current range for salmon, sturgeon, etc. Keith Brander concludes in a PowerPoint presentation at Norwich 2003 on marine fisheries, and the same is likely for Inland Fisheries:

1. Climate change affects fisheries;
2. Climate change affects biodiversity; but so do fisheries affect biodiversity and fishing has a bigger effect on biodiversity than does climate change.

And this seems to be a generally accepted point of view i.e. that the fishing pressure and the pressure exerted on the bio-diversity by fishing activities has greater impact on stocks and ecosystem than the climate change. However because many fishery resources are heavily overexploited a change in climate is very likely to cause the final collapse of some stocks if the fishery management does not secure a reduction of the exploitation accordingly. Precaution is particularly important in border areas of a certain species distribution because it will be under more stress here than other places within its distribution.

The EU fisheries policy has failed with regard to management of the economic important cod stocks in EU waters. Effect of climate change on the stocks resilience should be included in future management of these (and other) stocks.
REFERENCES


