norden

Northern Fisheries

Newsletter from the Nordic Working Group for Fishery Research – NAF

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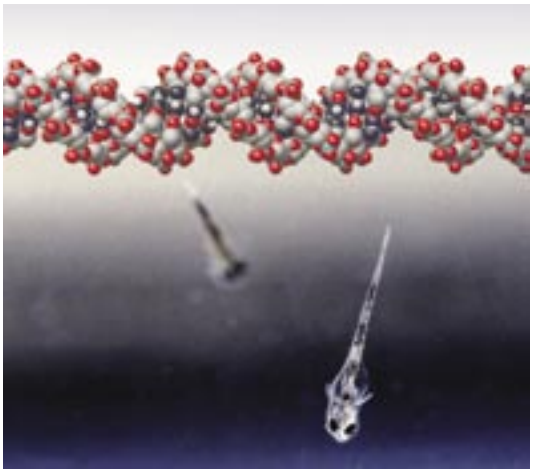
Great Need for Research into the Genetic Effects of Fishing

The fisheries management and fishing activities must be based on genetic information to a greater degree than today, say the participants at a Nordic expert seminar held at Hólar in Iceland in October 2004. At the same time, they note that our knowledge of the genetic effects of fishing on different populations is very limited still. A comprehensive research effort will therefore be needed before genetics can become an essential part of the management of our common fish resources. The researchers suggest that genetic information should be collected in a joint Nordic action and shared among the Nordic countries.



fishing has a massive influence on the evolution of all fish species. Fotomontage: Lauri Dammert Cod hatchling and dna-string.

For adult individuals of the commercially exploited species fishing is the biggest cause of mortality today. The majority of these species are predators, and fishing does not just mean that these species are reduced in numbers. Fishing also eliminates large segments of the food chain making space for other species. Thus, fishing has a massive influence on the evolution of all fish species - both the ones we fish and those that are not commercially interesting.

Most fish stocks in Nordic waters are over-fished, which in itself is a serious threat to their survival and future development potential. Furthermore, fishing may constitute a threat to the often unique variations that occur between different geographically isolated stocks of the same species. If, as a result, the gene pool of the species is depleted, their potential for adjusting to environmental changes such as the warming of the oceans is also reduced, the participants in the seminar warn.

Local genetic variations under threat

If we look at a fish such as the cod, it is not entirely homogenous in its genetic structure. The cod is divided into a large number of different stocks. These stocks breed and live in defined areas, each with their special living conditions. Therefore, the local cod stocks develop genetic characteristics that distinguish them from other cods and adapt the population to the special conditions of their environment. One example is the Baltic cod which has adapted to the low salinity in the Baltic. Other heavily exploited species such as salmon and herring also demonstrate this locally determined variation of their genetic inheritance.

For numerous species the exchange of genes between the local populations is very limited. This applies to all species where the populations live far away from each other. If a population is over-fished to such a low level that inbreeding and genetic poverty develop, their unique locally adapted characteristics may disappear, and the population will die out.

Does selective fishing produce genetic selection?

All fishing is selective. Over many years gear has been successfully developed to catch fish and other organisms according to species and size. Selective fishing has several advantages and is more sustainable than many of the old methods where everything was caught and anything that was not wanted thrown away. But from a genetic point of view it has several disadvantages, the Hólar report points out. One of the problems may be that the fishing fleet targets the biggest and oldest fish as well as the larges in each annual brood. This is a potential genetic threat: The fishermen may systematically be culling the fish that are genetically “programmed” to grow quickly, and left in the ocean are fish with genes for slow growth into relatively small sizes. Fishing reduces the populations and thus also reduces the number of genetic variables - the gene pool risks erosion into an ever poorer range of qualities, researchers fear.

Another serious threat against the genetic inheritance of fish species is aquaculture and live fish stocking. When these fish are released either deliberately or unintentionally, they may cross-fertilize existing, wild populations and thus disturb their unique locally adapted genetic makeup. This in turn may result in the eradication of the local population or parts thereof.

Extensive research needed

This broad ranging and massive threat to genetic diversity through fishing and aquaculture has been studied far too little, the report points out. There are, however, already several documented cases where fishing has changed the genetic makeup of a stock. The genetic development of a few species in the North Sea has been studied. The studies indicate the loss of genetic variation in cod and salmon over time; others show that selective fishing - targeting size, age and species - has resulted in changes to the genetic inheritance in both cod and plaice.

Genetically sustainable fishing would mean a method and an extent that do not threaten the genetic diversity nor result in unacceptable changes to the genetic composition of defined populations. Researchers do not know, however, where the borderline goes between renewal and collapse of a specific gene pool. The problem is most acute in the defined populations, but even though many species throughout the ocean number several hundred million individuals, it is not possible to determine where the borderline for the genetically sustainable population goes. It is known, however, that species with relatively few individuals such as tuna and ray may well come up against their sustainable limit very soon; and then we should reduce the fishing intensity.

Unlike other predators, we humans prefer the biggest and strongest individuals as our prey. Cods heads in a box, Faroe Islands. . Photo: Lauri Dammert

Eleven Recommendations

The participants in the seminar agreed on 11 recommendations for both immediate action and more long-term research.

1. *In the ICES area the precautionary approach is applied. It means that when the effects of an activity or a tool are not known for certain, they must be considered harmful until otherwise proven. This principle should be evaluated from the perspective of the genetic consequences of current fishing practices.*

2. *Information on the genetic diversity of marine resources should be gathered and reviewed scientifically. Areas where information is missing should be identified.*

3. *The current management methods should be evaluated with respect to the genetic structure of populations. Species whose genetic structure can be defined must be defined. Studies should be made as to whether it is possible to adapt this knowledge with an analysis of mixed fisheries in situations where the harvesting of individual, genetically distinct populations is considered harmful.*

4. *A collection of tissue samples from fish and a data bank should be set up and hosted by Nordic museums or universities. . This action should provide for a system of information sharing. There are already equivalent data banks in other areas, for example the "clearing house mechanism" of the Convention of Biological Diversity (CBG) and Global Biodiversity Information Facility (GBIF). Their applicability should be investigated.*

5. *Strategies should be set up for monitoring genetic diversity both at the molecular and the quantitative level. The strategy should contain identification of genetic indicators for changes in the genetic structure.*

6. *Communication should be extended between different research communities. The same applies to transparency in the decision-making process and contacts between decision makers and researchers. Fora for cooperation between these groups are needed.*

7. *The genetic consequences of selective gear should be evaluated, as well as the possibilities of using gear and methods which enable variable selections to minimize the genetic impact.*

8. *ICES advice on fish quotas provides a minimum protection against over-exploitation. The precautionary approach should mean that the ICES advice on quotas and gear is respected. That is not always the case in reality and therefore there is a need for measures to achieve compliance.*

9. *Aquaculture and stocking of live organisms may result in genetic material being released into wild populations. Therefore these should only be allowed after an evaluation based on genetic conservation principles.*

10. *Information and education in fish biology, conservation genetics and the potential effects of exploitation should be encouraged at all levels. The general public in the Nordic countries often has limited knowledge of these important issues, and a range of information activities are therefore needed.*

11. *Management strategies such as Marine Protected Areas (MPAs) and ecosystem based fisheries management should be investigated and evaluated.* ■

The project coordinator *Teija Aho*, from the Swedish National Board of Fisheries, says that genetic management does not automatically mean limited fishing, but that the risk exists:

- If the "precautionary limits" are raised today then the fishing intensity must be reduced, she says. Or if we conclude that we cannot re-establish the diversity of a population within the framework of the present catch limits.

The problem of by-catches is also brought up:
- But the by-catches of genetically threatened species may be reduced. This can be done by means of more protected areas so fishing can be concentrated where the threatened species are not present. It is also possible to develop the selectivity of gear and methods of catch even more, says Teija Aho.

Nordic Cooperation

The participants at the seminar agreed that questions concerning the genetic effect of fishing may be answered solely through Nordic cooperation and interaction with other international actors. Joint Nordic research projects will be needed in order to map out and collate existing knowledge and initiate research in the area. No single Nordic country has sufficient resources of its own or sufficient researchers for this task.

A joint Nordic approach also stands a better chance of influencing international actors. Between them the Nordic countries are still the biggest fish exporter in the EU - almost half of all fish reaching the tables of Europe comes from the five Nordic countries, the Faeroe Isles and Greenland.

The three suggested workshops are:

- Multi-disciplinary workshop on the genetic consequences of fishing and fisheries management.
- A workshop on the possibilities and the strategies for creating a distributed fish tissue sample and data bank.
- Scientific expert seminar and a workshop on the importance of a neutral versus adaptive genetic variation in the context of fisheries management.

Report from an expert seminar at Hólar College, Iceland, 6-8 October 2004 can be downloaded from: www.norden.org/fisk/sk/publikationer.asp (Genetic Diversity in Commercially Exploited Fish Species). ■

Genetics - a tool in fisheries management

The importance of including genetic information into the management of our fish stocks has been emphasized by geneticists gathered at a seminar at Hólar College, Iceland. A typical example is the observation of genetic differences between trout or salmon even in adjacent water courses, where it has been recognized that stocks must be managed at water course level, and that fish from different water courses should not be released.

It is far more difficult when it comes to marine stocks with a continuous spread over large areas. These stocks are normally managed on the basis of practical, geographically determined divisions (e.g. ICES area definitions) or different migration patterns, but not on the basis of genetic differences. New genetic methods have shown that, in many cases, these traditional marine fish stocks are not genetically homogenous, but often consist of many genetically distinct sub-stocks. It has, furthermore, been demonstrated that genetic diversity may be reduced through fishing which generally reduces the size of the fish in the population or selectively removes certain classes of individuals. Also, the genetic composition may be changed through release and escape of cultured fish.

We have been fascinated by the potential offered by the new genetic technologies where we can investigate and compare DNA compositions in chromosome microsatellites and mitochondria, but we have not yet actually reached the stage of applying this information in management. These methods will show the existence of more and more genetically diversified sub-stocks. The identification of genetic differences does not, however, in itself, mean that all sub-stocks should be individually managed. Evidently, if a fish stock is genetically isolated, e.g. through its adaptation to local environmental conditions, so that it cannot be re-established through immigration from surrounding areas, then the fishing industry must be interested in independent management of this stock.

We have a general duty to protect the genetic diversity in nature, but genes that occur with great frequency in one sub-stock will often be present also in other stocks, though at a lower frequency. Individual management of a large number of small stocks, without outward differences and with overlapping distribution will be very complicated and resource-demanding and thus difficult to gain acceptance for from the industry and administrators.

Therefore, it is just as important to set up criteria for when we can go as far as managing small stocks as individual stocks, and to what extent we will accept the influence of the genetic composition, as it is to get the genetic structure mapped out.

Altogether, this means that there is a need for marine biologists, geneticists and managers jointly to assess the practical possibilities of establishing management systems that also allow for genetic considerations, without panicking over the identification of far more genetically diversified stocks than we have been used to.

Helge Paulsen
Chairman of NAF
Danish Institute for Fisheries Research

Nordic Marine Academy begins operations

With the launching of the Nordic Marine Academy (NMA) on February 28th 2005, new possibilities have opened up in graduate education in the marine sciences.

The aim of NMA, which is supported by NorForsk and NAF, is to strengthen Nordic cooperation in research training and provide students in marine and fisheries sciences with a wide choice of graduate courses. The number of students interested in a particular field may be too limited to run a selection of courses for them on a national basis. By offering the courses to students in the other Nordic countries as well, the economic and practical viability of the enterprise may be secured. This makes it possible to offer a greater variety of courses to students in the Nordic countries and the neighbouring regions.

In addition to supporting graduate courses, the NMA offers mobility grants for researchers and students who wish to spend some time with colleagues elsewhere, e.g. to learn a technique or get access to equipment.

The NMA covers all aspects of marine research, with particular emphasis on the exploitation, utilization and management of marine living resources and the impacts of human activities on marine ecosystems. Following a call for proposals in the spring, the first NMA courses to be held have recently been announced as follows:

Introduction to model-oriented design of experiments for marine sciences.
Coordinated by Prof. *Kari Ruohonen*, Finnish Game and Fisheries Research Institute. September 2005, Finland.

Economic analysis of fisheries management and fish markets.
Coordinated by Prof. *Rögnvaldur Hannesson*, Norwegian School of Economics and Business Administration.
October 2005, Bergen, Norway.

Modelling marine populations from physics to evolution.
Coordinated by Ass. Prof. *Øyvind Fiksen*, University of Bergen. October 2005, Bergen, Norway.

DELTA
- State of the art tool in taxonomical work.
Coordinated by Prof. Jörundur Svavarsson, University of Iceland. November 2005, Sandgerdi, Iceland

Course contents and application procedures will soon be published at www.bio.uib.no/nma under Activities \ Advanced Courses.

Mobility Grants have been granted to a PhD student from Åbo Akademi in Finland to visit the Kristineberg Marine Research-station, and a PhD student from Göteborgs Univesitet to visit a halibut farm in Iceland.

The next application deadlines are August 1 for Mobility Grants and September 1 for proposals for organising Advanced Courses in 2006. ■

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Nordic Council of Ministers

Store Strandstræde 18
DK-1255 København K

www.norden.org

Information on NAF and Nordic fishery cooperation:
Fishery consultant Ásmundur Guðjónsson

www.norden.org/fisk/

Tlf: +45 - 33960255
Fax: +45 - 33932047
E-mail: ag@norden.org

Nordic cooperation on fishery research
The Nordic Working Group for Fishery Research (NAF) co-ordinates joint research projects, takes the initiative to improve Nordic research cooperation, finds suitable areas for Nordic cooperation, and evaluates the technical content of applications for support for research projects.

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