Mariculture Committee

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REPORT OF THE WORKING GROUP ON THE APPLICATION OF GENETICS IN FISHERIES AND MARICULTURE

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TABLE OF CONTENTS

Section Page

1 INTRODUCTION

In accordance with C.Res. 2:25, 1994, adopted at the Annual Science Conference in St. John's, Newfoundland, the Working Group on the Application of Genetics in Fisheries and Mariculture (WGAGFM; Chairman J. Mork, Norway) met at ICES Headquarters in Copenhagen from 30 January to 2 February 1995 to deal with the Terms of Reference (Appendix 1).

1.1 Attendance

There are currently 34 appointed members of the WGAGFM (Appendix 2). Of these, 7 attended the 1995 Working Group meeting in Copenhagen (Appendix 3) (non-member Tiit Paaver from Estonia attended part of the meeting). Five members were absent for practical reasons (collision with application deadlines etc.), six for economical reasons. Countries represented (number of persons in parenthesis) were Canada (1), UK (1), Iceland (1), Denmark (1), and Norway (3).

The sub-group format of the WGAGFM was reflected in the actual division of scientific tasks during the meeting, according to the following structure :

Qualitative genetics sub-group: **G. Dahle** (constituted leader), A.K. Daníelsdóttir, M. M. Hansen, A. Child.

Quantitative genetics sub-group: **G. Friars** (leader), H. B. Bentsen.

1.2 Working Form

Because of the limited number of members attending and the scientific nature of the 1995 ToR, all sessions were plenary. This meeting format functioned very well.

Prior to the meeting, specific members had been asked to collect information and prepare themselves for chairing specific sessions. Thus, A. Child (UK) chaired the session on 'Sterilisation techniques', G. Friars (Canada) chaired the 'Selective gear' session, and G. Dahle (Norway) chaired the 'GMO' session. These persons were also responsible for writing preliminary reports on their respective topics during the Working Group meeting. These preliminary reports were discussed in plenary at the end of the meeting. Before the meeting, all members had been asked to collect national activity reports from their respective countries and bring with them to Copenhagen. A preliminary report on national activities could thus be compiled during the meeting.

Attempts were made to get expertise from outside the WGAGFM to the meeting, in order to join in the discussion on specific agenda items. Thus, A. Beaumont (Bangor, UK) was contacted concerning the 'sterilisation technique' item. Unfortunately, lack of travel funds did not allow him to join the meeting, but he gave a very significant contribution in the preparation of the item materials before the meeting. WGAGFM greatly appreciates his interest and helpfulness.

The Working Group decided that, as in 1994, the preparation of the Working Group Report should mainly be done by members attending the Copenhagen meeting.

2 TERMS OF REFERENCE 1995

2.1 «Basic Population Genetics Topics»

The annual Working Group meeting is a forum for members to discuss all kinds of population genetics topics in a not-too-formal atmosphere. While such discussions often take place outside the meeting rooms and -hours, time was also allocated on the meeting agenda for such topics this year. Maybe especially for members from small institutions, this is a valuable possibility to enlighten questions or solve problems in a milieu with a broad population genetic competence. The broadened genetic scope of the WGAGFM has clearly been a benefit in this respect. Also, the sessions for discussion of basic population genetics topics have oiled the process of circling in areas and topics of such general interest and importance that they deserve a place in the Terms of Reference for the coming year. The discussions this year resulted in a list of topics which WGAGFM wishes to focus on in 1996 (refer to suggested Terms of Reference for 1996 in section 3.3).

2.2 «Genetic Effects from Selective Fisheries»

WGAGFM restricted its discussion on this topic to a principal level, recognising that a more detailed treatment will require contribution from external expertise. It was agreed, however, that it was desirable to keep this important topic on the agenda for future work, with an aim to establish the necessary specialist contacts for expanding the list of recommendations.

2.2.1 Introduction

Most variable traits in fish have some degree of heritability. The genetic variability accommodates natural selection and adaptation. The discussions in this chapter are centred on selective fisheries as one aspect of selection.

All fishing activity, which causes non-random harvesting in a population, can result in genetic change as a response to direct or indirect selection. Unlike natural selection, these effects may reduce the fitness of a

population and consequently reduce its productivity as a human food resource. In practice, however, some genetic change is an inevitable consequence of harvesting. Therefore, it is important that the selective mechanisms of harvesting are studied in order to avoid genetic changes that may seriously disturb the productivity of populations.

2.2.2 Selective mechanisms in fisheries

2.2.2.1 Fishery regulations

- *Type of gear.* Different gear (e.g., gill nets, seines) may result in nonrandom harvesting with respect to size, behaviour etc.;
- *Mesh size* (e.g., large mesh remove large fish disproportionally);
- *Fishing season* (e.g., early versus late runs and/or spawnings will result in different parts of the population being caught, depending on the timing of the fishing season);
- *Fishing grounds* (e.g., restrictions on areas where fishing may result in selective harvesting of individuals following certain migration routes or seeking specific spawning grounds).

2.2.2.2 Market demands

E.g., differentials in price frequently allow premiums for large fish.

2.2.3 Consequences of selective harvesting

Fishery regulations and market demands that result in a selective harvesting of the large individuals are expected to lead to a gradually lowered mean size over generations in the population. There are strong indications that this has happened in four Pacific salmon species (Ricker *et al.*, 1978; Ricker, 1980a, 1980b, 1980c). The genetic component of variation in fish size is also evident from the successful artificial selection for body size which has been documented in aquacultural programs (e.g., Kincaid *et al.*, 1977; Gjerde, 1986; Hershberger, 1990; Friars and Bailey, 1990). Selection for size may also give correlated responses in other traits (e.g., grilsification and return rates in Atlantic salmon (O'Flynn *et al.*, 1991; Jónasson, 1994)).

Fishery regulations resulting in a selective harvesting of individuals with particular behavioural patterns (e.g., spawning time and place, migration time and routes, etc.) would be expected to change later generations with respect to these traits.

2.2.4 Problems and possible solutions

Theoretical considerations leave little doubt that current fishery practices will normally change the genetic properties of populations. However, evidence from the literature indicates that the main problem in detecting and measuring responses to selective harvesting, in a natural environment, is the large and uncontrolled environmental variation masking the genetic components of variation. This effect is expected to introduce large errors in the estimates of genetic parameters, selection intensities, etc., and consequently make the prediction and measurement of response to selection difficult. Here the estimates from aquaculture may be of some use. Additionally, pilot experiments could be established to measure certain effects and provide estimates of required parameters such as genetic correlations between traits. The controlled environments in aquaculture and pilot experiments may, however, affect the applicability of these estimates in a natural environment.

One possibility of monitoring long term effects of selective harvesting is to collect and cryopreserve milt for the production of control groups, representing the genetic status of the population at earlier stages of selection. This allows the comparison of performance to contemporaries that have been subjected to intervening years of selective harvesting.

The combined effects of natural selection and those imposed by fishery practices may be very complex. Designs of experiments to test such effects have been proposed by McAllister *et al.* (1992). Since the net result of many simultaneous processes can be very difficult to estimate, particularly where the cascading of effects is involved, computer simulation and modelling can be a valuable aid in exploring possible outcomes of selective fisheries (e.g., Blythe and Stokes, 1991; Stokes and Blythe, 1991). Also, opportunities for the procurement of data from scenarios such as banned fisheries should be considered.

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2.3 «Sterilisation Techniques»

2.3.1 Introduction

One of the requirements of this working group was to review sterilisation techniques (such as triploidy) for use in mariculture and field experiments relative to efficacy and justifications for the techniques, and the risk involved (e.g., relative to reversion to a reproductive state). This requirement stemmed from a recommendation to this working group put by the Working Group on Introductions and Transfers of Marine Organisms which had a specific problem relating to the introduction of non-indigenous Pacific oysters (*Crassostrea gigas*) to the open waters of Delaware Bay and Chesapeake Bay.

Several methods have been proposed to produce sterile organisms and are reviewed by Donaldson *et al.* in Genetic Conservation of Salmonid Fish (1993). The methods include surgical removal of gonads, induction of autoimmunity, chemosterilisation, gamma or X-ray sterilisation and treatment with androgens, however this report will concentrate on the more generally used method of genetic manipulation, namely triploidy.

2.3.2 Techniques

Ploidy manipulation can be achieved by three main methods, namely heat shock, hydrostatic pressure shock and chemical treatment, all of which interfere with the formation of polar bodies in the female gamete. Meiosis undergoes two chromosome reduction steps which each result in the elimination of a haploid set of chromosome material into a polar body. Timing of the treatment which is carried out after fertilisation of the egg results in either stopping the formation of the first or second polar body. Each of these alternatives results in the retention of one additional haploid set of chromosomes resulting in a doubling-up of the female chromosomes and the formation, with the male gamete of a triploid. Chemical methods used to achieve triploidy include the use of cytochalasin B (CB), 6-dimethylaminopurine (6-DMAP) and nitrous oxide. By far the most frequently used of the chemical methods is cytochalasin B.

2.3.3 Efficacy

Heat shock and pressure shock have been principally used in fish species and are particularly successful in salmonids. It is possible to get 100% triploidy with

pressuré shock providing some losses are allowed. Heat treatment may in some circumstances result in lower percentages of triploidy. Pressure shock in shellfish has not been very successful, possibly due to the small size of the eggs. Chemical treatments have been successful although the use of nitrous oxide requires the eggs to be in a monolayer and presents problems for large scale production. Cytochalasin B generally produces around 80% triploids and 6-DMAP produced 90% triploids in Pacific oyster and giant scallop (*Pecten maximus*).

2.3.4 Justification for use of sterile organisms

The production in aquaculture of sterile and all-female triploid salmonids has been suggested to provide animals which do not reach sexual maturity. In addition it will prevent escaped cage-farmed salmon from contributing genetic material to the wild population. This will be a considerable advantage over the use of diploid salmon in aquaculture.

Sterile triploid shellfish are produced because they continue growing at a time when fertile diploids are ripening gonads, furthermore they retain high levels of glycogen in the tissues which improves the taste of the meat. Thus there can be a commercial supply of high quality shellfish throughout the year.

Introduction of non-indigenous species to natural areas requires that they should not breed and they should be prevented from becoming established as breeding populations in the wild. This has been a requirement of the introduction of Manila clam (*Tapes philippinarum*) into the British Isles and Pacific oyster into Delaware Bay and Chesapeake Bay.

2.3.5 Risks associated with the use of sterile organisms

Triploidy has been seen as an ideal method to produce sterile individuals. However it has been found that triploids are not completely sterile. Some species do not produce gonads e.g., *Mya* and bay scallop, whereas in many other species triploids produce gonad tissue and gametes. It is expected that any gametes will be abnormal and carry 1.5 x the haploid number of chromosomes. As such the probabilities of production of anything but highly aneuploid zygotes in the event of fertilisation is low.

One drawback reported in fish was the production of mosaic tissues when using CB. This fact has recently been reported in triploid production in bivalve molluscs.

The reported production of mosaics and reversion to diploids in previously triploid Pacific oysters tested individually by flow cytometry must shed some considerable doubt on the use of triploidy as a means of sterilising non-indigenous species.

The production of sterile, all-female triploid salmon was originally suggested to prevent early sexual maturation in aquaculture. Later experience has shown that sterile fish have other disadvantages in culture. The technique has also been suggested to prevent escaped farmed salmon from interacting genetically with wild salmon stocks. However, experiments have shown that sterile salmon will not terminate their life cycle at the time when normal salmon spawns and dies, but may continue to feed and grow at the rate of immatures and reach an extreme age and body weight. Little is known about their behaviour and the ecological impacts of such individuals in the wild, or about the biomass that may accumulate in open waters. There are also risks associated with the presence of shellfish, such as Manila clams if they are raised freely in the substrate since they could alter the ecology and there is associated disturbance of the benthic community at harvesting.

2.3.6 Recommendations

When tests for triploidy are being carried out, the possibility of mosaic tissues should be investigated by examining more than one tissue from the animals involved. The reversion of triploid Pacific oysters to diploid and the formation of mosaics should be investigated at regular intervals.

Work should be carried out to test if mosaic formation and reversion to diploidy is a specific response to cytochalasin B and comparisons should be made with the use of 6-DMAP to see if this is a better chemical to induce triploidy without the drawbacks. Mosaicism and reversion to diploidy may not be a problem with triploids produced by heat or pressure shock if it is established that the formation of mosaics/reversion to diploid state is associated with cytochalasin B treatment.

2.3.6.1 Field experiments with exotic species

Field experiments with sterilised exotic species should be considered in the same way as other introductions under the guidance of the ICES Code of Practise unless the sterilisation techniques have been proved to result in 100% sterility and that there is proof that reversal to the reproductive state is not possible.

2.3.6.2 Commercial use of exotic species

In all circumstances the commercial production of sterile exotic species should be treated as any other introduction under the guidance of the ICES Code of Practice because it is not feasible to monitor individual animals and sterilisation by any method on a large scale.

2.3.6.3 Field experiments with indigenous species.

The occurrence of animals which revert to diploidy is not seen as a particular problem as small scale field experiments might be easier to monitor and control. The numbers of any escapee would most likely be relatively low when compared to a commercial activity.

2.3.6.4 Commercial use of indigenous species

In the case of fish species risk assessments should be carried out to acquire information on the environmental/ecological impact of large numbers of sterile escapees. Similar assessments should be conducted in the case of sessile shellfish culture and associated harvesting methods which may have an impact on the benthic fauna.

2.4 «Genetically Modified Organisms (GMO)»

2.4.1 Background

The Working Group on Introductions and Tranfer of Marine Organisms (WGITMO, Chairman J. T. Carlton, USA) is currently finalising the ICES «Code of Practice on the introductions and transfers of marine organisms». In the final stages it was decided to include a new section V concerning «Recommended procedure for the consideration of the release of genetically modified organisms (GMOs)». By C.Res. 1994/2:7:10 the WGITMO is advised to consult WGAGFM concerning guidelines for evaluating the ecological effects of the release of GMOs.

Since such consultations were not mentioned in the 1995 ToR of WGAGFM, Chairman R. Cook of the Mariculture Committee as well as Chairman J.T. Carlton of the WGITMO were contacted to get more information as to what kind of input was expected from WGAGFM on this topic.

The specific need of the WGITMO, as communicated by Dr. Carlton to WGAGFM, concerns their work to develop guidelines on research to evaluate the ecological effects of the release of GMOs, i.e., what types, levels, and categories of ecological effects could be or should be anticipated in relation to GMOs. Any additional comments, however, would be welcomed by the WGITMO on how ICES member countries should or could go about assessing a GMO release. WGAGFM was advised not to feel limited to strictly ecological questions in its treatment of this topic.

Questions concerning potential environmental effects of GMOs is a very large scientific field in which national research programmes are underway in several countries. Having already scheduled several other heavy agenda items, WGAGFM could not go into an extensive discussion on GMOs at its Working Group meeting in Copenhagen. WGAGFM is, however, very interested in the 'genetical' part of the GMO questions, and should be able to give substantial advice on how to conduct risk analysis concerning the spreading of genes through GMOs. A Theme Session on GMO at a future Annual Science Conference would seem appropriate from the point of view of the WGAGFM.

2.4.2 Discussion

Concerning section V in the «Code of Practice» and the 'risk assessment' that is requested in its point (b), WGAGFM feels that to this end, a GMO release should be regarded equivalent to the introduction of an Exotic Species or Exotic Stock. In this way, relevant guidelines would already be present in the ICES 1994 «Code of Practice».

With respect to the additions to the «DEFINITIONS» section in the «Code of Practice», WGITMO seems to have adopted the GMO definition from EC Directive 90/220.

The WGAGFM feels that this definition does not clearly include organisms manipulated with its own genomic material (e.g., introducing multicopies of salmon growth hormone gene in salmon) as GMO's, since multiplication, especially duplication, could be the result of a "normal" recombination. We will also point to the fact that polyploidy manipulation (triploids and tetraploids) would not be regarded as GMOs by this definition, since polyploidy is occurring naturally in some species.

The WGAGFM feels that the possibility for exclusion of these important cases is a shortcoming with the current definition.

2.5 «Scope for International Co-Operation»

The forum created by the annual WGAGFM meetings, especially the possibility for informal discussions among the members, has proven fruitful for international co-operation. Since the 1994 meeting several co-operation projects have been discussed within the Working Group, and some have materialised as joint applications for EU-projects this year. Practical agreements for the exchange of samples between WGAGFM members have also been achieved.

Information about relevant activities going on in the various countries is important for triggering international co-operation, and WGAGFM sees it as important to include an updated protocol of relevant activities in the different countries in the annual Reports. The protocol this year has been substantially increased compared to 1994 (Appendix 1).

3 WORKING GROUP BUSINESS

3.1 Comments on Working Group Function in 1995

This year, the WGAGFM had considerably better time for dealing with its Terms of Reference than in 1994. This was due to the fact that the internal organisation of the group was completed, that the members have had a better chance to prepare for the specific agenda items, and that the meeting lasted for 4 days compared to 3 days in 1994.

Nevertheless, there is room for improvements in the working format. One significant improvement would be that all appointed members supply the Chairman with their telephone, fax and E-mail numbers. Distributing such a list would ease the contact between members, and simplify and hasten all administrative functions in connection with the Working Group meeting and preparation of the annual Report. Such information is currently available for only about half of the Working Group. Experience shows that communication by ordinary mail is not efficient enough with 34 members distributed on both sides of the Atlantic.

3.2 Comments on Travel Funds for Working Group Members

Lack of travel funds continues to be a major obstacle for members to attend the annual Working Group meeting. WGAGFM noted this problem in the 1994 Working Group Report. During the 1995 Working Group Meeting, WGAGFM agreed upon the contents of a letter on this problem. The letter was sent to the General Secretary, with copies to Chairmen of the Consultative Committee, ACME, ACFM, and the Mariculture Committee.

3.3 Suggestions for Working Group ToR and Meetings in 1996

The low attendance in 1995 suggests that the Working Group meeting should not be held close to important deadline dates for research applications. Two such important dates are 1 February and 15 March. The WGAGFM considers four days in week 8 (19–25 February) to be a suitable period for the 1996 meeting. On account of the difficulties many members have with travel funds, it was decided to try a shift in the geographic location of the meeting. While North-Europeans have benefited from the short travel distance to Copenhagen in the two former years, placing the meeting in a southern European country in 1996 might help to increase the number of participants from those parts of Europe.

Dr. Margarida Castro at the University of Algarve in Faro, Portugal has kindly offered to host the Working Group meeting in 1996.

Concerning Terms of Reference for 1996, it is suggested that the WGAGFM will meet at the University of Algarve in Faro, Portugal, from 19 to 23 February, 1996, to:

- continue the review of population genetic topics in fisheries and mariculture, including the questions of selective fisheries and GMOs (Genetically Modified Organisms), with emphasis on a combination of qualitative and quantitative genetics;

- review the contents of the terms «Genetic resources» and «Management units» with a view to establish adequate working definitions, suitable criteria, and methods for identification and characterisation of such entities;

- review the question of Genetic Brood Stock Management with a view to create protocols and recommendations for genetically adequate regimes;

- prepare updated protocols of fishery and mariculture genetic research in the member countries, and identify scopes for enhanced international co-operation.

Justifications

With the increasing weight that the international community places on the conservation of biodiversity and genetic resources, one practical problem in resource management will be to decide which biological entities deserve to be classified as, e.g., genetic resources. Today there is no general agreement on criteria and definitions in this field. WGAGFM feels that there is a strong need to develop a set of criteria as well as recommended procedures and choice of genetic markers for the identification and characterisation of such entities.

Likewise, there is a strong need for a clarification of the relation between the term 'Population' in a population genetic context and the term 'Management Unit' in practical stock management. With the development of new genetic markers with very high evolutionary rates and thus 'sensitivity', geneticists can now discriminate between groups on an evolutionary scale which approaches the few-generation level. Both from a conservation and a resource management point of view there is need for a set of criteria for deciding which level of differentiation is relevant for practical stock management. Also, there is a need to calibrate sets of

molecular marker for use in identification and discrimination purposes at various levels of genetic differentiation.

WGAGFM feels that the topic of selective fisheries is a very important one which deserves broad attention in fisheries biology. While the Working Group did consider the question on a more principal basis this year, the complexity of the problem suggests that it should be attacked on a broader front in ICES, e.g., as a joint approach by geneticists, fishery statisticians and modellers. WGAGFM therefore wants to keep this topic on its agenda also in 1996, with a view to create a basis for a broader approach to the problem.

The rapid increase in fish farming in ICES countries and the inclusion of new species in such activities highlights the need for adequate protocols for genetic Brood Stock Management. It is especially important that such protocols be evaluated and implemented at the very start of fin- and shellfish farming projects which implies artificial selection for production traits. While there is no lack of general knowledge on this topic, it is important that this knowledge is provided in a format, and through channels, which secures its availability for the practical acteurs in this industry. WGAGFM wants to compile such a set of protocols and recommendations.

4 NATIONAL ACTIVITY REPORTS

4.1 Studies Reported in Standard Format (see also Section 4.2)

BELGIUM

Study 1

LABORATORY/RESEARCHER: F. Ollevier and F. Volckaert, Zoological Institute, Katholieke Universiteit Leuven, Leuven, Belgium, with a Greek and a French group.
SPECIES: African catfish, sea bream, and sea bass.
PROJECT FUNDING: EC FAR AQ.375.
OBJECTIVE: To develop and use microsatellite markers in the above mentioned species.
DESIGN: Know-how on a common DNA technology is shared by the three labs and is implemented in the three different species.
METHODOLOGY: Development of primer pairs for PCR of di- and trinucleotide nuclear DNA microsatellites.
STATUS: Contract in progress (completion in June 1995).
COMMENTS: So far, a total of 15 microsatellites have been tested and developed in the above mentioned species.

Study 2

LABORATORY/RESEARCHER: F. Volckaert, Zoological Institute, Katholieke Universiteit Leuven, Leuven, Belgium, with the co-operation of one Italian, one Spanish, one German, and one French group.
SPECIES: European eel, sea bass, and several model fish species.
PROJECT FUNDING: EC AIR2.1467.
OBJECTIVE: To isolate sex-specific DNA markers in these species.
DESIGN: Various techniques to isolate DNA sequences are optimised in model fish and then applied in European eel and sea bass (until now no specific sex marker was known in the literature).
METHODOLOGY: Molecular DNA methods and in situ hybridisation.
STATUS: Contract in progress till December 1996.

Study 3

LABORATORY/RESEARCHER: F. Volckaert and E. Daemen, Zoological Institute, Katholieke Universiteit Leuven, Leuven, Belgium, with the co-operation of T. Cross, University College, Cork, Ireland.
SPECIES: European eel.
PROJECT FUNDING: EU graduate student grant and university grants.
OBJECTIVE: To characterise the genetic structure of the European eel.
DESIGN: Five populations of glass eel will be studied in detail for genetic variation.
METHODOLOGY: Allozymes, mitochondrial DNA, and microsatellite DNA markers.
STATUS: Ph.D. project in progress.
COMMENTS: 10 DNA microsatellite markers have been developed. Sampling is in progress.

CANADA (see also section 4.2)

Study 1

LABORATORY/RESEARCHER: B. Desrosiers and J.-M. Sevigny*, Centre Océanographique de Rimouski, Département d'Océanographie, Université du Quebec à Rimouski, Quebec, Canada G5l 3A1. *Department of Fisheries and Oceans, Maurice Lamontagne Institute, Mont-Joli (QC), Canada G5H 3Z4.
SPECIES: Redfish (*Sebastes* spp.)
PROJECT FUNDING: Department of Fisheries and Oceans.
OBJECTIVE: To detect molecular markers to distinguish the different species of redfish in the Gulf of St. Lawrence.
DESIGN: Redfish are classified according to the criteria described below to determine the congruence among the 3 different approaches.

METHODOLOGY: rDNA, allozymes, morphology.
STATUS: Three year project that will end in 1996.

Study 2

LABORATORY/RESEARCHER: J.-M. Sevigny and B. Sainte-Marie, Dept. of Fisheries and Oceans, Maurice Lamontagne Institute, Mont-Joli (QC), Canada G5H 3Z4.
SPECIES: Snow crab (*Chionoecetes opilio*)
PROJECT FUNDING: Dept. of Fisheries and Oceans.
OBJECTIVE: Description of the population genetic structure of the snow crab in the eastern Canada.
DESIGN: Several (16) populations were sampled throughout eastern Canada from Labrador coast to Cap Breton and from west Newfoundland to the Saguenay fjord (Gulf of St. Lawrence). In bay Sainte-Marguerite (Gulf of St. Lawrence) several cohorts were also sampled in order to assess the temporal variability of the observed genetic variation.
METHODOLOGY: Allozymes, mtDNA, morphometry.
STATUS: Four year project that will end in 1995.
COMMENTS: Results will be used to review management units.

Study 3

LABORATORY/RESEARCHER: J.-M. de Sevigny, Dept. of Fisheries and Oceans, Maurice Lamontagne Institute, Mont-Joli (QC), Canada G5H 3Z4.
SPECIES: Greenland halibut (*Reinhardtius hippoglossoides*)
PROJECT FUNDING: Dept. of Fisheries and Oceans.
OBJECTIVE: Determine the importance of gene flow between the Atlantic and the Gulf of St. Lawrence stocks.
DESIGN: Specimens of Greenland halibut were collected at various sites of the Gulf of St. Lawrence (4 sites) and of the Northwest Atlantic (3). Individuals from different age classes were also sampled to assess the temporal variability of the observed genetic variation.
METHODOLOGY: Allozymes.
STATUS: Laboratory analyses are completed. End in 1995.

Study 4

LABORATORY/RESEARCHER: J.-M. de Sevigny, L. Lavard, and D. Parsons*, Dept. of Fisheries and Oceans, Maurice Lamontagne Institute, Mont-Joli (QC), Canada G5H 3Z4. *Dept. of Fisheries and Oceans, St. John's, Newfoundland, Canada A1C 5X1.
SPECIES: Northern shrimp (*Pandalus borealis*)
PROJECT FUNDING: Dept. of Fisheries and Oceans.
OBJECTIVE: Describe the genetic structure of the northern shrimp in the Gulf of St. Lawrence and the Northwest Atlantic and assess the temporal variation of the observed variation.
DESIGN: Different developmental stages (male, primiparous and multiparous females) of the northern shrimp were collected at 6 sites from the Saguenay fjord to the west coast of Newfoundland, in the Gulf of St. Lawrence and at 2 sites off the Labrador coast.
METHODOLOGY: Allozymes.
STATUS: Laboratory analyses are completed. End in 1995.
COMMENTS: Results of this study were used for the evaluation of the shrimp management units in the Gulf of St. Lawrence.

DENMARK

Study 1

LABORATORY/RESEARCHER: L.-E. Holm, National Institute of Animal Sciences.
SPECIES: Rainbow Trout.
PROJECT FUNDING: In house/Agricultural Science Research Council.
OBJECTIVE: Development and use of genetic markers to be used for identification of hatchery strains and for markers of commercially important traits.
DESIGN: Screening of rainbow trout from a number of Danish hatchery strains using relevant molecular techniques.
METHODOLOGY: Microsatellites (most of which are developed during this study), RFLP analysis of PCR amplified mtDNA segments.
STATUS: Ongoing.

Study 2

LABORATORY/RESEARCHER: E. E. Nielsen, Dept. of Ecology and Genetics, University of Aarhus.
SPECIES: Atlantic salmon, brown trout.
PROJECT FUNDING: The Faculty of Natural Sciences, University of Aarhus/Inland Fisheries Laboratory.
OBJECTIVE: Estimation of effective population sizes in natural salmon and trout populations from observed temporal changes in allele/haplotype frequencies (and, possibly, gametic phase disequilibria). Studies of long-term temporal changes in allele frequencies in Atlantic salmon populations and, if possible, estimation of genetic relationships among Danish salmon populations which are now extinct.
DESIGN: Selected populations are sampled at certain time intervals and screened using relevant techniques. Data from extinct populations will (hopefully) be obtained by amplifying microsatellites from old scale samples.

METHODOLOGY: RFLP analysis of PCR amplified mtDNA segments, microsatellites, possibly other DNA techniques and allozyme electrophoresis.
STATUS: Starting 1995 (Ph.D. project).

Study 3

LABORATORY/RESEARCHER: M. M. Hansen, Inland Fisheries Laboratory, Silkeborg.
SPECIES: Brown trout.
PROJECT FUNDING: In house.
OBJECTIVE: Estimation of genetic variability and differentiation in and among Danish brown trout populations on both a geographical and temporal scale, studies of extinction/recolonisation patterns.
DESIGN: Sampling of trout from various localities, repeated sampling of trout from selected populations, amplification of microsatellites from old (20–60 years old) scale samples.
METHODOLOGY: RFLP analysis of PCR amplified mtDNA segments, microsatellites, allozymes.
STATUS: Ongoing.
COMMENTS: Publication:
Hansen, M.M. and Loeschcke, V.: Temporal variation in mitochondrial DNA haplotype frequencies in a brown trout (*Salmo trutta* L.) population that shows stability in nuclear allele frequencies. Evolution (in press).

Study 4

LABORATORY/RESEARCHER: M. M. Hansen, Inland Fisheries Laboratory, Silkeborg, in collaboration with L.-E. Holm, National Institute of Animal Sciences.
SPECIES: Brown trout.
PROJECT FUNDING: In house.
OBJECTIVE: Estimation of the impact of stocking activity (using non-native hatchery trout) on natural brown trout populations.
DESIGN: Controlled stocking experiments in which genetic data will be obtained from donor and recipient populations prior to stocking. Two–three natural populations will be stocked with hatchery trout while one–two populations which are known to have been founded by hatchery trout will be stocked with offspring of natural, wild trout. The development in the stocked populations will be followed through several generations.
METHODOLOGY: RFLP analysis of PCR amplified mtDNA segments, microsatellites, possibly other DNA techniques.
STATUS: Ongoing.
COMMENTS: Publication: Hansen, M.M., Hynes, R.A., Loeschcke, V. and Rasmussen, G. (1995). Assessment of the stocked or wild origin of anadromous brown trout (*Salmo trutta* L.) in a Danish river system, using mitochondrial DNA RFLP analysis. Molecular Ecology (in press).

Study 5

LABORATORY/RESEARCHER: M. M. Hansen, Inland Fisheries Laboratory, Silkeborg.
SPECIES: *Coregonus lavaretus, C. oxyrhynchus, C. albula.*
PROJECT FUNDING: In house.
OBJECTIVE: Estimation of genetic variability, differentiation, and gene flow among populations. The main emphasis will be on anadromous/brackish populations of *C. lavaretus* and *C. oxyrhynchus* in order to define genetically meaningful units for conservation.
DESIGN: Screening of samples from both geographically distinct populations and from populations spawning in different rivers with outlets in the same fiord.
METHODOLOGY: RFLP analysis of PCR amplified mtDNA segments, allozymes.
STATUS: Starting in 1995.

ESTONIA

Study 1

LABORATORY/RESEARCHER: R. Gross, Dept. of Fish Farming, Institute of Animal Husbandry, Estonian Agricultural University, Tartu, in co-operation with J. Nilsson, Dept. of Aquaculture, Swedish Agricultural University.
SPECIES: Brown trout.
PROJECT FUNDING: Estonian Science Foundation.
OBJECTIVE: Detection of genetic variability in growth hormone genes in sea trout.
DESIGN: Populations of sea trout from some Swedish and Estonian rivers will be screened for variability in growth hormone genes.
METHODOLOGY: Heteroduplex analysis of PCR amplified fragments of growth hormone coding DNA.
STATUS: Project initiated in Umeå 1993, will be completed 1995.

Study 2

LABORATORY/RESEARCHER: T. Paaver, Dept. of Fish Farming, Institute of Animal Husbandry, Estonian Agricultural University, Tartu.
SPECIES: Wide variety of fish species incl. clupeids, salmonids, cyprinids, percids etc.
PROJECT FUNDING: Estonian Science Foundation.
OBJECTIVE: To reveal species-specific patterns of egg yolk proteins and the genetic variability in them in order to use them as genetic markers.
DESIGN:

METHODOLOGY: Mature egg samples were analysed by polyacrylamide gel electrophoresis and stained for proteins.
STATUS: One year project, completed in the end of 1994.

Study 3

LABORATORY/RESEARCHER: T. Paaver, Dept. of Fish Farming, Institute of Animal Husbandry, Estonian Agricultural University, Tartu
SPECIES: Sea trout, Atlantic salmon.
PROJECT FUNDING: In house.
OBJECTIVE: To follow the genetic stability of the wild and stocked populations of salmonids in Estonian coastal rivers and estimate the genetic differences between them.
DESIGN: The relatively occasional samples from test fishings and hatcheries are monitored for genetic variability of proteins.
METHODOLOGY: Allozymes, (6 polymorphic enzymes for brown trout, 3 polymorphic enzymes for Atlantic salmon), egg yolk proteins.
STATUS: Ongoing.

FINLAND

Study 1

LABORATORY/RESEARCHER: M.-L. Koljonen, J. Koskiniemi, L. Siitonen, Finnish Game and Fisheries Research Institute, Helsinki.
SPECIES: Baltic salmon, brown trout
PROJECT FUNDING: In house
OBJECTIVE: Mapping genetic resources (conservation and enhancement projects)
DESIGN: Mapping allele frequencies
METHODOLOGY: Allozymes
STATUS: Ongoing.

Study 2

LABORATORY/RESEARCHER: M.-L. Koljonen, J. Koskiniemi, L. Siitonen, Finnish Game and Fisheries Research Institute, Helsinki.
SPECIES: Atlantic salmon
PROJECT FUNDING: In house.
OBJECTIVE: Genetic stock identification (GSI)
DESIGN:
METHODOLOGY: Allozymes.
STATUS: Ongoing.

Study 3

LABORATORY/RESEARCHER: K. Elo, Agricultural Centre, Dept. of Animal Breeding.
SPECIES: Coregonids.
PROJECT FUNDING: In house.

OBJECTIVE: Species identification, phylogenetic analyses, and genomic variation in Coregonids.
DESIGN: Gene frequency mapping.
METHODOLOGY: RAPD.
STATUS: Ongoing.

Study 4

LABORATORY/RESEARCHER: J. Vuorinen, University of Joensuu, Dept. of Biology.
SPECIES: Coregonids.
PROJECT FUNDING: In house.
OBJECTIVE: Coregonid evolution.
DESIGN: Mapping gene frequencies.
METHODOLOGY: Electrophoresis.
STATUS: Ongoing.

Study 5

LABORATORY/RESEARCHER: H. Mölsä, University of Kuopio, Dept. of Physiology.
SPECIES: Rainbow trout.
PROJECT FUNDING: In house.
OBJECTIVE: Growth hormone gene transfer.
DESIGN:
METHODOLOGY:
STATUS: Ongoing.

Recent Finnish publications of relevance are:

Bodaly, R.A., Vuorinen, J.A., Reist, J.D. and Reshetnikov, Y.S. 1994. Genetic relationships of five Siberian coregonid fishes. J. Fish. Biol. (in press).

Elo, K., Vuorinen, J.A., and Niemelä, E. 1994. Genetic resources of Atlantic salmon (*Salmo salar* L.) in Teno and Näätämö Rivers, northernmost Europe. Hereditas 120 (in press).

Elo, K. 1993. Gene flow and conservation of genetic variation in anadromous Atlantic salmon (*Salmo salar* L.). Hereditas 119: 149–159.

Koljonen, M.-L. and Huusko A. 1993. Genetic variation of brown trout stocks in the Koutajoki rivers system. Oulanka Reports 12: 131–143.

Koljonen, M.-L. 1993. Genetic stock composition analyses of Baltic salmon catches. ICES, C.M. 1993/M:28.

Koljonen, M.-L. 1995. Distinguishing between resident and migrating Atlantic salmon (*Salmo salar* L.) stocks by genetic stock composition analysis. Can. J. Aquat. Sci. (in press).

Vuorinen, J.A., Bodaly, R.A. and Reist, J.D. 1993. Genetic and morphological differentiation between

dwarf and normal size forms of lake whitefish (*Coregonus clupeaformis*) in Como Lake, Ontario. Can. J. Fish. Aquat. Sci. 50: 210–216.

ICELAND

Study 1

LABORATORY/RESEARCHER: I. Benediktsson and Ó. S. Andrésson, Institute for Experimental Pathology, University of Iceland.
SPECIES: Atlantic salmon.
PROJECT FUNDING: National Research Council 94115.
OBJECTIVE: Transfer of cloned genes into fish.
DESIGN: Random integration of autologous growth hormone gene.
METHODOLOGY: Gene cloning and sequencing, gene transfer, PCR.
STATUS: Three year project ending in December 1997.

Study 2

LABORATORY/RESEARCHER: I. Benediktsson and Ó. S. Andrésson.
SPECIES: Atlantic salmon.
PROJECT FUNDING: Icelandic Science Fund.
OBJECTIVE: Isolation of CD2 (T-cell marker) cDNA.
DESIGN: Screen cDNA library with oligonucleotides corresponding to conserved amino acid stretches.
METHODOLOGY: cDNA library, PCR, protein expression, antibodies.
STATUS: Two year project starting December 1994.

Study 3

LABORATORY/RESEARCHER: E. Eythórsdóttir, Agric. Research Institute, Reykjavík.
SPECIES: Arctic charr.
PROJECT FUNDING: The National Research Council in Iceland and the Agricultural Productivity Fund in Iceland.
OBJECTIVES: To determine genetic parameters, i.e. heritability and genetic correlations of economically important traits of Arctic charr in Aquaculture. The results will be utilised in a national breeding program of Arctic charr.
DESIGN AND METHODOLOGY: Data are collected from charr in the first 2 or 3 year classes of the Arctic charr breeding program. Each year class is made up of 100–120 full sib families, with two or three families pr. sire. The families are reared for two and a half year from hatching. Data are collected on growth, sexual maturity at different life stages, flesh coloration and possibly fat content of fish. Data are analysed after standard methods in animal breeding.
STATUS: The project started in 1993 and is planned for four years. Preliminary results for the first year class are currently under analysis.
COMMENTS: The project is in co-operation between the Agricultural research institute, The Institute of Freshwater Fisheries and the Agricultural school at Hólar in North Iceland, that is in charge of the actual breeding program for Arctic charr.

Study 4

LABORATORY/RESEARCHER: A. K. Daníelsdóttir *et al.* Marine Research Institute, c/o Biotechnology department, IceTech, Reykjavík.
SPECIES: Cod and redfish (*Sebastes mentella*).
PROJECT FUNDING: MRI, others pending.
OBJECTIVE: Eluciating cod stock structure in Icelandic waters. Study the genetic differentiation between oceanic and deep-sea redfish.
DESIGN: Mapping of gene frequencies. Cod samples from different locations off Iceland and West and East Greenland. Redfish samples from different locations Southwest of Iceland and Irminger Sea.
METHODOLOGY: Allozymes and cDNA.
STATUS: Cod sampling has started, analysis to start autumn 1995. Redfish sampling to start spring 1995 and analyses summer 1995.
COMMENTS: Report references on request.

Daníelsdóttir, A.K., Duke, E.J., Joyce, P. and Árnason, A. 1991. Preliminary studies on the genetic variation at enzyme loci in fin whales (Balaenoptera physalus) and sei whales (Balaenoptera borealis) from North-eastern Atlantic. Rep. int. Whal. Commn (special issue 13):115–124.

Daníelsdóttir, A.K., Duke, E.J. and Árnason, A. 1992a. Genetic variation at enzyme loci in North Atlantic minke whales, Balaenoptera acutorostrata. Biochem. Genet. 30(3/4):189–202.

Daníelsdóttir, A.K. 1994. Genetic variation among different species and populations of baleen whales from the North Atlantic Ocean. Ph.D. Thesis, University College Dublin, Ireland. 308 pp.

Daníelsdóttir, A.K., Halldórsson, S.D., Sigfríður Guðlaugsdóttir and Árnason, A. 1995. Genetic variation at enzyme loci in North-Eastern Atlantic minke whales (*Balaenoptera acutorostrata*). Paper submitted to the Elsevier Scientific DMB-IV.

Study 5

LABORATORY/RESEARCHER: A.K. Daníelsdóttir, S. Guðlaugsdóttir and S. Guðjónsson, Institute of Freshwater Fisheries, Reykjavík.

PROJECT FUNDING: In house and the Icelandic Science fund.
OBJECTIVE: Genetic variation in wild populations of brown trout (Landlocked and Anadromous) in Iceland.
DESIGN: Mapping of gene frequencies.
METHODOLOGY: Allozymes.
STATUS: Samples from 13 locations have been analysed and it is planned to continue the study later this year.
COMMENTS: Report references on request.
Poster:
Daníelsdóttir, A.K., Marteinsdóttir, Sverrison, S. and Guðjónsson, S. 1993. Genetic variation in Atlantic salmon populations in Iceland. Population Genetic Group Meeting, Cardiff, January 1993.

Study 6

LABORATORY/RESEARCHER: E. Árnason, University of Iceland.
SPECIES: Cod, salmon, brown trout, Arctic charr.
PROJECT FUNDING: In house and the Icelandic Science fund.
OBJECTIVE: Genetic population structure and species variation.
DESIGN: Mapping of gene frequencies and sequence variation.
METHODOLOGY: RFLP of mtDNA and mtDNA cytochrome b sequencing.
STATUS: Ongoing.
COMMENTS: Report references on request.

Árnason, E., Pálsson, S. and Arason, A. 1992a. Gene flow and lack of population differentiation in Atlantic cod, *Gadus morhua* L., from Iceland, and comparison of cod from Norway and Newfoundland. Journal of Fish Biology 40:751–770.

Árnason, E. and Rand, D. M. 1992. Heteroplasmy of short tandem repeats in mitochondrial DNA of Atlantic cod, *Gadus morhua*. Genetics 132:211–220.

Pálsson, S. and Árnason, E. 1994. Sequence variation for cytochrome b genes of three salmonid species form Iceland. Aquaculture 128:29–39.

Study 7

LABORATORY/RESEARCHER: S. Sigurdardóttir and J. Svavarsson, University of Iceland.
SPECIES: Marine isopods (Crustacea).
PROJECT FUNDING: The Icelandic Science fund.
OBJECTIVE: To establish phylogenetic tree for marine isopods and to study relationship between Arctic and North Atlantic isopod fauna.
DESIGN: Samples have been collected from the deep and shallow Arctic and from the deep and shallow North Atlantic.
METHODOLOGY: Nuclear DNA.
STATUS: Started in 1992.

Study 8

LABORATORY/RESEARCHER: Holar. Saudarkrokur, Inst. of Freshwater Fisheries in co-operation with three Icelandic reserachers. J. Palsson.
SPECIES: Arctic charr.
PROJECT FUNDING: Iceland Research Council, Grant 92135.
OBJECTIVE: To prevent maturation of arctic charr in aquaculture
DESIGN: Effect of triploidy and hormone castration.
METHODOLOGY: (I) triploidy induction by heat shock to newly inseminated eggs, (II) alevins fed with food containing methyltestosterone.
STATUS: 3 year project completed November 1994.

Study 9

LABORATORY/RESEARCHER: E. Svavarson, Agricultural College, Holar, Saudarkrokur.
SPECIES: Arctic charr.
PROJECT FUNDING: The Agricultural Productivity Funding.
OBJECTIVE: To estimate genetic and phenotypic parameters for size and proportion of sexual maturity at different ages.
DESIGN: Broodfish of one strain, Laxarvatn, were used. A hierarchical mating system was used where sperm from each male (19 males) fertilised eggs from three females (i.e., 57 females).
METHODOLOGY: Size and proportion of sexual maturity 13, 15, 24, and 34 months after fertilisation were recorded.
STATUS: Project will be completed in November 1995.

Study 10

LABORATORY/RESEARCHER: Holar, Agricultural College. E. Svavarson in co-operation with E. Eyorsdóttir, Inst. of Agricultural Research and Inst. of Freshwater Fisheries.
SPECIES: Arctic charr.
PROJECT FUNDING: The Agricultural Productivity Funding.
OBJECTIVE: To develop a productive stock for aquaculture in Icelandic farming environment.
DESIGN: Broodfish of 10 strains are used. A hierarchical mating system is used where sperm from each male (30 males yearly) fertilise eggs from three females (i.e., 90 females yearly).

METHODOLOGY: Size and proportion of sexual maturity 24 months after fertilisation are recorded. The broodfish are selected from the most promising subgroups (i.e., combined family and individual selection)
STATUS: Project started in 1992. Ongoing.

IRELAND

Study 1

LABORATORY/RESEARCHER: P. McGinnity, Salmon Research Agency of Ireland, T. Cross, University College Cork, with two UK and two Spanish partners.
SPECIES: Atlantic salmon.
PROJECT FUNDING: EU AIR 1 30003 92 719.
OBJECTIVE: To study the genetic impact of introduced non native Atlantic salmon on natural populations.
DESIGN: (a) Simulation of a farm escape to a natural stream contained by high specification fine screened trap, individual fish identified to family using DNA minisatellites. (b) A study of temporal changes, a consequence of farm escapes, in the genetic composition of juvenile salmon populations from selective rivers in North-West Ireland. (c) Pan European study of variability in wild populations using allozymes, minisatellite DNA SLPs and transcribed sequences.
METHODOLOGY: Establishment of experimental population, hatchery control, trap and field monitoring, sampling, (at SRA) minisatellite DNA, allozymes and MHC (at UCC).
STATUS: Three year project to be completed January 1996.

Study 2

LABORATORY/RESEARCHER: P. McGinnity, Salmon Research Agency of Ireland.
SPECIES: Atlantic salmon.
PROJECT FUNDING: Atlantic Salmon Trust, Salmon Research Agency of Ireland.
OBJECTIVE: To study the adaptive significance of genotypic variation at the Malic Enzyme locus MEP-2*.
DESIGN: Establishment of hatchery population, monitoring of a number of West of Ireland populations, relate MEP-2* genotype and performance.
METHODOLOGY: Allozyme analysis.
STATUS: Four year part-time project to be completed June 1995.

Study 3

LABORATORY/RESEARCHER: P. McGinnity, Salmon Research Agency of Ireland.
SPECIES: Atlantic salmon.
PROJECT FUNDING: Institutional.
OBJECTIVE: To determine the genetic impact of ocean ranch salmon on natural populations.
DESIGN: Two scenarios are being studied where (a) the ocean ranch population as originated from the recipient wild population and (b) where there is no relationship between the ocean ranch population and the recipient population.
METHODOLOGY: Allozyme analysis.
STATUS: Ongoing study.

Study 4

LABORATORY/RESEARCHER: R. Poole, Salmon Research Agency of Ireland.
SPECIES: Atlantic salmon, anadromous and resident brown trout.
PROJECT FUNDING: AIR 3 PL942484
OBJECTIVE: To quantify and understand the effects of hybridisation between Atlantic salmon and brown trout, particularly as it relates to escapes from aquaculture.
DESIGN: Quantify interspecific hybridisation and introgression in unspoiled and genetically compromised rivers.
METHODOLOGY: Application of mini-satellite and mtDNA identification techniques.
STATUS: Two year project to be completed in 1996.

Study 5

LABORATORY/RESEARCHER: Deirdre Cotter, Salmon Research Agency of Ireland, N. Wilkins, University College Galway, Ireland, with two Scottish and one Norwegian partners
SPECIES: Atlantic salmon.
PROJECT FUNDING: AIR programme.
OBJECTIVE: A comprehensive evaluation of the use of sterile triploid Atlantic salmon in reducing the interaction between wild and farm stocks.
DESIGN: Characterisation of the performance of triploids in culture.
METHODOLOGY: Setting up experimental population, control population, ocean ranching, rearing experiments, tagging, simulation of escapes from sea-cages.
STATUS: Four year project to be completed October 1988.

Study 6

LABORATORY/RESEARCHER: E.J. Duke, University College Dublin (UCD).
SPECIES: Bream, roach, and bream x roach hybrids.
PROJECT FUNDING: Institutional.
OBJECTIVE: A biochemical genetic characterisation of the bream, roach and the bream x roach hybrid in the Erne catchment.

DESIGN: Batches of each species and their hybrids were analysed for molecular level and morphological variation. Results were compared both on inter- and intraspecific level.
METHODOLOGY: Isozyme and mtDNA analysis.
STATUS: Ongoing.
COMMENTS: The two species and the hybrid show characteristic isozyme profiles for xanthine oxidase, superoxide dismutase, lactate dehydrogenase and malate dehydrogenase. The mtDNA analysis shows that the hybrid results from female bream x male roach.

Study 7

LABORATORY/RESEARCHER: T. Cross, University College Cork (UCC) with two groups.
SPECIES: Whiting (Merlangus merlangus)
PROJECT FUNDING: EC FAR MA-3.781.
OBJECTIVE: To detect DNA markers for use in stock discrimination.
DESIGN: Samples taken from the southern and northern North Sea, Baltic, Norwegian coast and Irish Sea are being investigated for differences at two hypervariable PCRable minisatellite loci.
METHODOLOGY: PCRable minisatellite DNA loci.
STATUS: Three year project to be completed in September 1995.
COMMENTS: Ongoing work. Further minisatellite SLP will be developed and other areas sampled. Interspecific applicability of probes will be tested (those already developed work well for cod and haddock and show variability).

Study 8

LABORATORY/RESEARCHER: L Byrnes, Dept. of Zoology, University College Dublin.
SPECIES: Atlantic salmon.
PROJECT FUNDING: Fobairt.
OBJECTIVE: To determine the genetic structure and regulation of expression of transferrin during Atlantic salmon smoltification.
DESIGN: Transferrin gene expression appears to be indices as salmon moves from fresh to salt water. This differential gene expression will be examined at a molecular level.
METHODOLOGY: The salmon transferrin gene will be cloned and sequenced. Tissue samples will be collected from salmon at different stages of the parr-smolt transformation and from sea salmon. Transferrin RNA leels will be determined by Northern blot analysis. Protein:DNA interactions at the transferrin promotor will be analysed using electrophoretic mobility shift assays and DNAase footprint assays.
STATUS: Two year project started in October 1994.

NORWAY

Study 1

LABORATORY/RESEARCHER: K. Hindar, Norwegian Institute for Nature Research (NINA).
SPECIES: Atlantic salmon.
PROJECT FUNDING: Directorate for Nature Management, Norway and NINA.
OBJECTIVE: Establish baseline information about the population genetic structure of Atlantic salmon in Norway.
DESIGN: Samples from all over Norway to analyse spatial and temporal variation in gene frequencies.
METHODOLOGY: Allozymes.
STATUS: Ten-year project to be completed 1996.

Study 2

LABORATORY/RESEARCHER: K. Hindar, NINA in collaboration with two UK and one Irish group.
SPECIES: Atlantic salmon and brown trout.
PROJECT FUNDING: EU AIR3 94 2484.
OBJECTIVE: Quantify and understand hybridisation between Atlantic salmon and brown trout, especially in the light of an increasing tendency of escaped farmed salmon to hybridise with trout.
DESIGN: Index samples from Ireland, Scotland and Norway including undisturbed and «genetically polluted» rivers; behavioural studies of spawning; estimates of fitness components in artificially produced hybrids.
METHODOLOGY: Genetic markers (allozymes, nuclear and mitochondrial DNA); feeding history markers (natural and synthetic pigments); constructed spawning arenas; rearing and release studies.
STATUS: 27 month study to be completed December 1996.

Study 3

LABORATORY/RESEARCHER: I. Fleming, B. Jonsson, K. Hindar, NINA.
SPECIES: Atlantic salmon.
PROJECT FUNDING: Research Council of Norway.
OBJECTIVE: Quantify reproductive success of farmed and sea ranched fish relative to wild fish.
DESIGN: Behavioural-ecological analysis of reproduction in artificial spawning arenas; release of genetically marked wild and farmed fish into a river.
METHODOLOGY: Video recording and direct observation of spawning; ecological and genetic analysis of spawners and their offspring.
STATUS: Seven-year project to be completed December 1996.

Study 4

LABORATORY/RESEARCHER: I.B. Mjølnerød and K. Hindar; University of Oslo, NINA and U.H. Refseth and K.S. Jakobsen.
SPECIES: Atlantic salmon.
PROJECT FUNDING: Research Council of Norway.
OBJECTIVE: Analyse genetic variation detected by allozymes and nuclear DNA markers.
DESIGN: Compare levels of genetic variation in two wild and one farmed population.
METHODOLOGY: Allozymes; multi-locus and single-locus minisatellites.
STATUS: Three-year project to be completed 1996.

Study 5

LABORATORY/RESEARCHER: Dept. of Aquaculture, Inst. of Marine Research, Bergen. G. Dahle.
SPECIES: Cod.
PROJECT FUNDING: Institutional.
OBJECTIVE: Study the population structure of cod along the Norwegian coast and adjacent areas.
DESIGN: Extensive sampling has taken place in part of the distribution area. This will be supplemented with samples from other areas, especially from Norwegian fjords during the spawning season.
METHODOLOGY: DNA Microsatellite analysis.
STATUS: Three year project started in 1994.
COMMENTS: The project has revealed large genetic variation between cod samples from the Faroe Islands, the Barents Sea and the Norwegian coast.

Study 6

LABORATORY/RESEARCHER: Dept. of Aquaculture, Inst. of Marine Research, Bergen. G. Dahle.
SPECIES: Herring, lobster and halibut.
PROJECT FUNDING: Institutional.
OBJECTIVE: Identify and isolate useful primers for microsatellite analysis of the mentioned species.
DESIGN: Samples of herring and lobster from different locations along the Norwegian coast has taken place, and DNA from broodstock halibut at the Austevoll Research Station has been isolated.
METHODOLOGY: Cloning, sequencing and extensive testing of possible primers.
STATUS: New project started in 1995.
COMMENTS: The project is planned to initiate several new projects on population genetics and monitoring of the mentioned species from 1996.

Study 7

LABORATORY/RESEARCHER: Dept. of Fisheries and Marine Biology, University of Bergen (DFMB), G. Nævdal, in collaboration with Zoological Dept., O. Brix.
SPECIES: Cod.
PROJECT FUNDING: The Norwegian Research Council.
OBJECTIVE: Compare the oxygen-binding capacity of haemoglobins of different genotypes and subgroups. Study the geographic distribution of cod subgroups.
DESIGN: Samples from localities from Northern Norway to Øresund have been analysed for distribution of haemoglobin subgroups. Samples for physiological studies are samples in and near Bergen.
METHODOLOGY: Gel electrophoresis and isoelectric focusing for genetic studies. Tonometric techniques for physiological measurements.
STATUS: Three year project completed in December 1994.
COMMENTS: The results from this project have triggered an application for funding of new projects on the biological background for biochemical genetic variation.

Study 8

LABORATORY/RESEARCHER: Dept. of Fisheries and Marine Biology, University of Bergen (DFMB), G. Nævdal, in collaboration with Marine Laboratory, Aberdeen, and Reading University, UK.
SPECIES: Sandeels (*ammodytidae*)
PROJECT FUNDING: The Norwegian Research Council/University of Bergen (International Office).
OBJECTIVE: Study the genetic variation between morphologically similar species, and the population structure within the most abundant species of sandeels.
DESIGN: Samples from localities from the North Sea, Iceland and Scotland have been analysed in a pilot study by a student under the ERASMUS co-operation. The main project starts in 1995.
METHODOLOGY: Gel electrophoresis and isoelectric focusing of allozymes.
STATUS: Three year project started in January 1995.
COMMENTS: The main project demands a close co-operation with Marine Laboratory, Aberdeen and with the Inst. of Marine Research.

Study 9

LABORATORY/RESEARCHER: Dept. of Fisheries and Marine Biology, University of Bergen (DFMB), G. Nævdal, in collaboration with Inst. of Marine Research, Bergen (IMR), and Møreforskning, Ålesund.
SPECIES: Redfish, *Genus Sebastes.*
PROJECT FUNDING: The Norwegian Research Council, IMR, and the University of Bergen.
OBJECTIVE: Study the genetic variation between morphologically similar species, and the genetic population structure within the species.
DESIGN: Extensive sampling has taken place throughout the distribution areas of the redfish species, except for Canadian waters. In later years sampling

has concentrated on the western areas in collaboration with Møreforskning.
METHODOLOGY: Gel electrophoresis and isoelectric focusing of allozymes.
STATUS: Studies on haemoglobins and allozymes have been going on since 1987. In recent years the main emphasis has been on Icelandic and Greenlandic waters. From 1995 DAN-analysis will be included with the main emphasis on studying the oceanic *S. Mentella*. A new three year project started in 1995.
COMMENTS: The project has revealed a relative simple species and population structure for redfish in the eastern North Atlantic, while the picture seems very complicated in Greenland waters, and very little is known on the structure west of the Danish Strait.

Study 10

LABORATORY/RESEARCHER: Dept. of Fisheries and Marine Biology, University of Bergen (DFMB), G. Nævdal, in collaboration with the Inst. of Marine Research (IMR), and Møreforskning, Ålesund.
SPECIES: Ling, blue ling and tusk.
PROJECT FUNDING: The Norwegian Research Council, IMR, and the Nordic Council.
OBJECTIVE: Study the genetic population structure of the mentioned species as part of a larger project for studies on the biological resources of these species.
DESIGN: Samples from localities around Greenland, the northern North Sea, and the Norwegian coast have so far been analysed.
METHODOLOGY: Gel electrophoresis and isoelectric focusing of allozymes and haemoglobins.
STATUS: Three year project started in 1993.
COMMENTS: The project has revealed rather little genetic variation within these species, especially in ling. Haemoglobin variation is found in tusk and blue ling.

Study 11

LABORATORY/RESEARCHER: Inst. of Marine research, Bergen (IMR), Ø. Skaala.
SPECIES: Atlantic salmon.
PROJECT FUNDING: The Norwegian Research Council.
OBJECTIVE: (I) Study the genetic implications of transgenic fish by using genetically marked multigeneration cultivated salmon as a model organism. (II) To quantify gene flow from the model group to wild salmon populations. (III) To estimate growth and survival of different genotypes (wild, introduced, and hybrids). (IIII). To investigate the extent of genetic introgression from the model group to sympatric salmonid species, i.e., brown trout.
DESIGN: Release of genetically marked multigeneration farmed salmon in a river with salmon and brown trout stocks.
METHODOLOGY: Allozymes and minisatellite DNA.
STATUS: Genetically marked smolt were produced and released in 1994. Baseline data on wild stocks were established.
COMMENTS: The study does not use transgenic fish, but employ multigeneration farmed salmon as a model organism to investigate impacts from transgenic fish potentially used in fish farming in the future.

Study 12

LABORATORY/ RESEARCHER: The Norwegian College of Fishery Science, Tromsø, S. Fevolden.
SPECIES: Cod (*Gadus morhua*)
PROJECT FUNDING: The Norwegian Research Council.
OBJECTIVE: To study recruitment patterns of Norwegian coastal cod with possible influx from Northeast Arctic cod.
DESIGN: Samples of spawning cod and of 0-group cod from various areas are compared for variation at nuclear DNA loci.
METHODOLOGY: Restriction fragment length polymorphisms (RFLP) using specific cod cDNA clones as probes.
STATUS: Three year project starting in 1995.

Study 13

LABORATORY/RESEARCHER: Norwegian College of Fishery Science, Tromsø, S. Fevolden.
SPECIES: Icelandic scallop.
PROJECT FUNDING: The Norwegian Research Council.
OBJECTIVE: To investigate the geographic population structure of the species, and to study correlations between heterozygosity and growth.
DESIGN: Samples of scallops from various regions in the Barents Sea/North Atlantic are compared for allozymic variation.
METHODOLOGY: Allozymes and mtDNA.
STATUS: Ongoing.

Study 14

LABORATORY/RESEARCHER: Univ. of Trondheim, Biological Station, J. Mork.
SPECIES: Indifferent.
PROJECT FUNDING: Institutional.
OBJECTIVE: General, interactive PC simulation program for, e.g., prediction and analysis of genetic effects of interaction between cultured and wild populations.
DESIGN: Simultaneous handling of combined genetic effects from random genetic drift, gene flow (model-independent), and selection (additive effects) at mul-

tiple loci on a genetically pre-characterised set of populations. Any number of generations can be run.
METHODOLOGY: Theoretical population genetics, mathematical modelling, computer, Monte Carlo simulations.
STATUS: Functional version is being tested.

Study 15

LABORATORY/RESEARCHER: Univ. of Trondheim, Biological Station, J. Mork. and M. Giæver.
SPECIES: Blue whiting (*Micromesistius poutassou*)
PROJECT FUNDING: The Norwegian Research Council, grant NF 108 093/110.
OBJECTIVE: To enlighten the genetic population structure in the blue whiting, with special emphasis on the north-eastern parts of its distribution range (the Norwegian Sea and the Barents Sea).
DESIGN: Genotyping of a large number of individuals from a tight sampling net in the relevant areas, during and outside the spawning season.
METHODOLOGY: Allozymes and DNA markers.
STATUS: Two year project started in 1995.
COMMENTS: Allozyme allele frequencies in a previous study indicated a separate stock in the north-east part of the blue whiting distribution area.

Study 16

LABORATORY/RESEARCHER: Univ. of Trondheim, Biological Station, J. Mork.
SPECIES: Cod (*Gadus morhua*).
PROJECT FUNDING: Institutional.
OBJECTIVE: Study of the long term stability of haemoglobin and allozyme allele frequencies in a local population of cod, and test for correlations between genotype and growth/survival.
DESIGN: Bi-annual sampling (research vessel) of about 200 specimens from a local cod population with no commercial exploitation.
METHODOLOGY: Collection of biological data (length, age, sex etc.), and genotyping for polymorphic haemoglobins and tissue enzymes.
STATUS: Haemoglobin analysis started in 1974 and is ongoing; allozymes from 1980 and ongoing.
COMMENTS: DNA mini- and microsatellites may be included from 1995.

Study 17

LABORATORY/RESEARCHER: J. Mork, Biological Station, University of Trondheim. Collaboration with T. Cross and P. Galvin (University College, Cork, Ireland), G. Carvalho and C. Turan (University of Wales, Swansea, UK), and J.E. Eliassen (The Norwegian Institute of Fisheries and Aquaculture, Tromsø, Norway).
SPECIES: Cod, haddock, whiting, saithe, blue whiting, Norway pout, capelin, herring.
PROJECT FUNDING: The Norwegian Research Council & The Directorate for Nature Management
OBJECTIVE: Baseline studies of genetic population structures in Norwegian coastal waters
DESIGN: Collection of ~100 specimens from each Norwegian fjord from the Kola peninsula to Aalesund, storing tissue samples at -84 °C, and analysing them using allozymes and various others techniques when such become available. Sample collection during intensive research vessel cruises along the Norwegian coast 6–7 weeks each year 1992–1994.
METHODOLOGY: Allozymes, haemoglobins, DNA mini- and micro-satellites.
STATUS: Haddock, cod and blue whiting allozyme analyses are a jour (2–3000 specimens each). DNA minisatellite analyses ongoing for whiting and (as pilot studies) some other species.
COMMENTS: The genetic studies are co-ordinated with biological studies on the same material by The Norwegian Institute of Fisheries and Aquaculture, Tromsø, in its Coastal Resource Program. All specimens are biologically characterised (sex, length, age etc.). Tissue samples can be made available for researchers with interesting projects.

POLAND

Study 1

LABORATORY/RESEARCHER: K. Goryczko, S. Dobosz, Kohlman, K., Zynczinski, A., Inland Fisheries Institute, Salmonid Lab. Rutki (IFISLR), Institute of Freshwater Ecology and Inland Fisheries, Berlin (IFEIF B), and Warsaw University of agriculture.
SPECIES: Rainbow trout.
PROJECT FUNDING: Committee of Scientific Research (CSR), IFI Statutory activity.
OBJECTIVE: To improve the breeding value of rainbow trout.
DESIGN: RT family selection, from outbred broodstock the 100 F1 families were started in 1991. From the 10 selected ones the 100 F2 families were produced in 1994. In November 180 fish from each family were tagged.
METHODOLOGY:
STATUS: The first year of the F2 cycle.
COMMENTS: Passive integrated transponders (PIT tags) enabled the precise evaluation of individual fish and family breeding value and facilitated the data processing.

Study 2

LABORATORY/RESEARCHER: K. Goryczko, S. Dobosz, H. Kuzminski, IFI salmonid Lab. Rutki.
SPECIES: Sea trout.

PROJECT FUNDING: CSR, IFI statutory activity.
OBJECTIVE: Vistula outbred sea trout as a gene bank.
DESIGN: Freshwater broodstock produced from representative group of river ascending sea trout.
METHODOLOGY: A random sample of presmolts (1200) were PIT tagged. Smoltification, growth and age at maturity were monitored.
STATUS: Third year of life, first females spawned.
COMMENTS: Project aimed at preserving genetic diversity in a valuable strain of sea trout maintained by stocking.

Study 3

LABORATORY/RESEARCHER: S. Dobosz, K. Goryczko, K. Kohlman, IFI Salmonid Lab. Rutki, IFEIF Berlin.
SPECIES: Rainbow trout.
PROJECT FUNDING: CSR, IFI statutory activity.
OBJECTIVE: Colour inheritance in rainbow trout.
DESIGN: Six pairs of RT of known colour genotype were mated. The colour of the progeny within each family was analysed. One summer old fish were tagged. Growth and mortality until the end of the second year of life was analysed.
METHODOLOGY:
STATUS: Project completed in 1994.
COMMENTS: The pattern of the yellow and palomino colour inheritance and the biological characteristics of different coloured fish were described.

Study 4

LABORATORY/RESEARCHER: M. Kuczynski, University of Agriculture and Technology, Olsztyn, Dept. of Basic Fishery Sciences.
SPECIES: Sea trout.
PROJECT FUNDING: CSR ZO22/S3/94/01.
OBJECTIVE: To detect genetic markers to distinguish the two sea trout stocks ascending two Pomeranian rivers.
DESIGN: Two index samples of 90 fish from each river were analysed.
METHODOLOGY: Allozyme electrophoresis (13 loci).
STATUS: Second year of realisation.
COMMENTS: The genetic status of the analysed populations were described.

Study 5

LABORATORY/RESEARCHER: M. Jankun, M. Kuczynski, P. Rab, J. Vuorinen, University of Agriculture and Technology, Olsztyn, Dept. of Basic Fishery Sciences, Czech Academy of Sciences, Laboratory of Fish Genetics, University of Joensuu, Dept. of Biology, Finland.
SPECIES: Whitefish, *Coregonus lavaretus*.
PROJECT FUNDING: Program of Joint Investigation of Holarctic Fishes among Russia, Canada, Finland, and Poland, contribution no. 14.
OBJECTIVE: To detect chromosomal markers in two separate whitefish populations.
DESIGN: Chromosome complement of two populations were analysed.
METHODOLOGY: Chromosomes, C banding.
STATUS: Completed, in press (Archiv für Hydrobiologie).
COMMENTS: In some fish minute supernumerary chromosomes were revealed. Variation in size, number, and location of NORs was demonstrated.

Study 6

LABORATORY/RESEARCHER: M. Kuczynski, University of Agriculture and Technology, Olsztyn, Dept. of Basic Fishery Sciences.
SPECIES: Bream (*Abramis brama*).
PROJECT FUNDING: CSR ZO22/S3/94/02.
OBJECTIVE: To resolve the question if bream in Vistula Firth belongs to one panmictic population or if population subdivision is present.
DESIGN: Fish sampled from different localities in Vistula Firth were used for biological, morphological, and biochemical analysis.
METHODOLOGY: Allozymes, morphometric and biometric analysis.
STATUS: Project completed.
COMMENTS: No population subdivision was revealed.

SPAIN

(Reported by Eric Verspoor, Marine Lab., Aberdeen)

Study 1

LABORATORY/RESEARCHER: Xunta de Galicia, Lurizan, C. Garcia de Leaniz and collaborators
SPECIES: Atlantic salmon
PROJECT FUNDING: Xuntia de Galicia and EC AIR1-CT92-0719
OBJECTIVE: to assess if genetic differences between native Spanish and non-native northern European Atlantic salmon affect the fitness of the two stock types in the wild in Spanish rivers.
DESIGN: Pure stock groups of Spanish and Scottish Atlantic salmon ova will be planted out at the eyed egg stage in the River Ulla in Spain and various performance parameters compared e.g. egg and juvenile mortality, hatching and emergence timing and condition, smolt production and growth performance.
METHODOLOGY: Non-native stock groups will be artificially selected to fix a RFLP variant detected in a PCR amplified mtDNA fragment which is absent in Spanish stocks.

STATUS: Currently underway and due for completion in 1995.
COMMENTS: This represents an experimental study.

Study 2

LABORATORY/RESEARCHER: Xunta de Galicia, Lurizan, C. Garcia de Leaniz
SPECIES: Atlantic salmon
PROJECT FUNDING: Xuntia de Galicia and EC AIR1-CT92-0719
OBJECTIVE: To assess differences in freshwater performance and return rate among native Spanish and non-native northern European Atlantic salmon stocks planted out as pre-smolt juveniles in the River Eo.
DESIGN: Pure and hybrid stock groups of Spanish and northern European Atlantic salmon reared in the hatchery to the pre-smolt stage have been released into the river. Mortality and growth are being compared and return rates to the angling fishery will be monitored.
METHODOLOGY: Stock groups will be micro-tagged and adipose fin clipped. Fish will be monitored in freshwater by electrofishing stocked areas. Returning adults will be monitored with respect to tagged fish caught in subsequent years by anglers.
STATUS: Currently underway and due for completion in 1995.
COMMENTS: This represents an experimental study.

Study 3

LABORATORY/RESEARCHER: University of Oviedo, E. Garcia Vasquez.
SPECIES: Atlantic salmon.
PROJECT FUNDING: EC AIR1-CT92-0719.
OBJECTIVE: to determine if native Spanish stocks have been genetically changed as a result of historical stocking with imported Atlantic salmon ova from northern Europe.
DESIGN: data on population numbers, stocking levels and allozyme variation in Atlantic salmon from stocked and unstocked Atlantic salmon rivers in northern Spain will be assessed in relation to allozyme variation in northern European rivers to determine whether genetic changes have taken place due to stocking.
METHODOLOGY: Analysis of existing data bases.
STATUS: Currently underway and due for completion in 1995.
COMMENTS: This represents an opportunistic study.

SWEDEN

Study 1

LABORATORY/RESEARCHER: H. Jansson, Salmon Research Institute.
SPECIES: Atlantic salmon.
PROJECT FUNDING: The Swedish National Board of Fisheries.
OBJECTIVE: To study genetic variation among Atlantic salmon populations at the Swedish west coast.
DESIGN: Samples of salmon from twelve rivers will be analysed for spatial and temporal genetic variation.
METHODOLOGY: Allozymes.
STATUS: Three year project started in 1994.

Study 2

LABORATORY/RESEARCHER: H. Jansson, Salmon Research Institute.
SPECIES: Atlantic salmon and brown trout.
PROJECT FUNDING: The Swedish National Board of Fisheries and power companies.
OBJECTIVE: Genetic monitoring of hatchery stocks to detect possible genetic changes.
DESIGN: The hatchery stocks used for the Swedish compensatory program are sampled and analysed for genetic variation at regular intervals.
METHODOLOGY: Allozymes.
STATUS: Long term study.

Study 3

LABORATORY/RESEARCHER: J. Dannewitz, Department of Genetics, Uppsala University and H. Jansson, Salmon Research Institute.
SPECIES: Atlantic salmon and brown trout.
PROJECT FUNDING: Internal funds.
OBJECTIVE: To study the extent of hybridisation between Atlantic salmon and brown trout in Sweden.
DESIGN: Spatial and temporal variation in hybrid frequencies are examined. The maternal species of the hybrids is determined.
METHODOLOGY: Allozymes and mitochondrial DNA.
STATUS: Long term study.

Study 4

LABORATORY/RESEARCHER: Dept. of Aquaculture, Swedish University of Agricultural Sciences, Umeå. J. Nilsson and M. Schmitz. Co-operation with R. Gross, Estonian Institute of Veterinary Sciences and Animal Breeding, Tartu, Estonia.
SPECIES: Brown trout (anadromous and non-anadromous).
PROJECT FUNDING: Institutional and regional funds.

OBJECTIVE: To find new DNA markers in trout and to use these markers in studies of population genetic structure and in studies of population mixing.
DESIGN: A number of European sea trout and brown trout populations are screened for variation at DNA level. Microgeographic population genetic structure is studied in River Ammerån, N. Sweden. Effects of introducing migratory trout in a stationary trout population is studied in Låktabacken Creek, N. Sweden.
METHODOLOGY: Variation in single copy genes, microsatellites.
STATUS: Project started in 1994, will go on to 1997.

Study 5

LABORATORY/RESEARCHER: Dept. of Animal Ecology, University of Lund, T. von Schantz, and The Wallenberg Laboratory, University of Lund, B. Widergren.
SPECIES: Atlantic salmon.
PROJECT FUNDING: The Swedish Council for Forestry and Agricultural Research, and The Swedish Environmental Protection Agency.
OBJECTIVE: To study the genetic variation in MCH and Cytochrome P450s in different salmon populations to see whether variation at these loci affects disease resistance and the ability to process different persistent organochlorine pollutants.
DESIGN: DNA from three different populations is analysed for typing of genotypes and haplotypes.
METHODOLOGY: RFLP analyses, DNA sequencing, and DGGE analyses.
STATUS: The project started in summer 1993. New funding was applied for in January 1995.

UNITED KINGDOM

Study 1

LABORATORY/RESEARCHER: SOAFD Marine and Freshwater Fisheries Laboratories, E. Verspoor and collaborators
SPECIES: Atlantic salmon
PROJECT FUNDING: SOAFD and EC AIR1–CT92–0719
OBJECTIVE: to assess whether the documented interbreeding of farm Atlantic salmon, which ascended the River Polla in 1989 and 1990, with the wild stock has resulted in genetic changes to the juvenile populations in the river.
DESIGN: Samples of juvenile Atlantic salmon from two year classes were collected from the lower, middle and upper reaches of the river pre-spawning of farm fish in 1989. The genetic composition of these fish will be compared with post spawning juvenile samples from the same locations taken in 1991 and differences related to the genetic make-up of adult farm Atlantic salmon ascending the river.
METHODOLOGY: Allozymes, RFL analysis of PCR amplified mtDNA, mini- and micro-satellite analysis of nuclear DNA, PCR amplification of structural gene nDNA.
STATUS: Currently underway and due for completion in 1995.
COMMENTS: This represents an opportunistic study.

Study 2

LABORATORY/RESEARCHER: SOAFD Marine and Freshwater Fisheries Laboratories, E. Verspoor and collaborators
SPECIES: Atlantic salmon
PROJECT FUNDING: SOAFD and EC AIR1-CT92–0719
OBJECTIVE: to assess whether genetic differences among stocks are relevant to their biological performance during the juvenile freshwater phase in the wild in ways that relevant to their fitness.
DESIGN: Simultaneously spawned eggs of different regional stocks and their hybrids have been planted out within 48 hrs of fertilisation in artificial redds using a random stratified planting strategy in a small experimental river where natural spawning is precluded. Performance parameters such as egg mortality, hatching and emergence timing, developmental state, maturation, growth and smoltification will be compared among groups.
METHODOLOGY: Stock groups will be genetically marked using RFLP's PCR amplified mtDNA and single locus minisatellite fingerprinting.
STATUS: Currently underway and due for completion in 1996.
COMMENTS: This represents an experimental study.

Study 3

LABORATORY/RESEARCHER: SOAFD Marine and Freshwater Laboratories, A. Youngson, J. Webb
SPECIES: Atlantic salmon
PROJECT FUNDING: SOAFD and Atlantic Salmon Trust
OBJECTIVE: to determine the geographical distribution and relative extent of spawning of escaped Farm Atlantic salmon in Scottish rivers.
DESIGN: sampling of eggs in salmon redds in lower reaches of representative rivers across Scotland.
METHODOLOGY: Identification of farm eggs on basis of canthaxanthine; allozyme analysis to detect hybrids and trout eggs.
STATUS: Completed in 1992. Two papers have been produced (below).
COMMENTS: This represents an opportunistic study.

Webb, J.H. *et al.* 1993. Spawning of escaped farmed Atlantic salmon, *Salmo salar* L., in western and northern Scottish rivers: egg deposition by females. Aquaculture and Fisheries Management 24: 663–670.

Youngson, A.F. *et al.* 1993. Spawning of escaped farmed Atlantic salmon (*Salmo salar*): hybridisation of females with brown trout (*Salmo trutta*). Can. J. Fish. Aquat. Sci. 50: 1986–1990.

Study 4

LABORATORY/RESEARCHER: SOAFD Marine and Freshwater Laboratories, A. Youngson, J. Webb.
SPECIES: Atlantic salmon.
PROJECT FUNDING: SOAFD and Atlantic Salmon Trust.
OBJECTIVE: to determine the frequency of farm escapes among Atlantic salmon in the coastal Atlantic salmon fisheries in Scotland.
DESIGN: regular sampling of Atlantic salmon taken by four representative coastal net fisheries off Scotland.
METHODOLOGY: Identification of farm fish on basis of body morphology and scale analysis.
STATUS: Started in 1992 and ongoing.
COMMENTS: This represents an opportunistic study.

Study 5

LABORATORY/RESEARCHER: SOAFD Marine and Freshwater Laboratories, E. Verspoor.
SPECIES: Atlantic salmon.
PROJECT FUNDING: SOAFD.
OBJECTIVE: To determine the nature and extent of population structuring of Atlantic salmon in Scotland within and among rivers so as to assess the impact of farm escapes on natural structure.
DESIGN: geographic sampling of within and among river genetic variation and statistical analysis of differentiation.
METHODOLOGY: Allozymes, mtDNA, mathematical modelling.
STATUS: Started in 1989 and ongoing.

Study 6

LABORATORY/RESEARCHER: G. R. Carvalho & C. Turan; Marine & Fisheries Genetics Laboratory, School of Biological Sciences, University of Wales, Swansea, Singleton Park, Swansea SA2 8PP, UK
SPECIES: Atlantic herring *Clupea harengus*
PROJECT FUNDING: Overseas postgraduate studentship (Turkey) + in-house funding
OBJECTIVE: To develop novel molecular markers for stock discrimination in herring.
DESIGN: Examine molecular markers in widely-separated populations of herring from the North Sea (esp. Norwegian fjords), Baltic and Canadian waters using novel approaches (Polymerase chain reaction (PCR)-based analysis of the mitochondrial and nuclear DNA genome). Data will be compared with other approaches (allozymes, morphometrics, otoliths, meristics) and published work.
METHODOLOGY: PCR-based analysis of DNA, allozymes, morphometrics (truss) and meristics.
STATUS: April 1994–April 1997
COMMENTS: The study will form the substance for a PhD thesis and is part of an on-going programme of research on the genetic management of capture fisheries (past studies include Adriatic clupeids).

Study 7

LABORATORY/RESEARCHER: G. R. Carvahlo; Marine & Fisheries Genetics Laboratory, School of Biological Sciences, University of Wales, Swansea, Singleton Park, Swansea SA2 8PP, UK
SPECIES: Squid (*Illex argentinus*)
PROJECT FUNDING: In-house funding (application pending)
OBJECTIVE: To examine stock structure and species identity in South Atlantic *Illex* populations.
DESIGN: To examine genetic differentiation among putative stocks (seasonal spawning groups) and possible cryptic species.
METHODOLOGY: To develop novel DNA markers for use in stock structure analysis, and to integrate molecular genetic approach with morphological and meristic analysis. Possible new species description.
STATUS: 1994 and on-going (initial samples collected and awaiting analysis.)
COMMENTS: The project involves collaborative efforts with the Falkland Islands Fisheries, Dr Paul Rodhouse (British Antarctic Survey) and Dr C. Nigmatullin (AtlantNIRO, Russia).

Study 8

LABORATORY/RESEARCHER: A. R. Child, MAFF, Directorate of Fisheries Research, Fisheries Laboratory, Benarth Road, Conwy, Gwynedd, LL32 8UB.
SPECIES: Pacific oyster (*Crassostrea gigas*).
PROJECT FUNDING: MAFF in-house.
OBJECTIVE: Genetic variation in commercial populations of *C. gigas*.
DESIGN: Examine genetic variation in commercial and natural spat of *C. gigas*.
METHODOLOGY: Allozyme variation.
STATUS: On-going.
COMMENTS: Paper in preparation, A R Child, P Papageorgiou & A R Beaumont. Identification of Pa-

cific oysters (*Crassostrea gigas*) of possible French origin in natural spat in the British Isles.

Study 9

LABORATORY/RESEARCHER: A. R. Child, MAFF, Directorate of Fisheries Research, Fisheries Laboratory, Benarth Road, Conwy, Gwynedd, LL32 8UB.
SPECIES: King scallop (*Pecten maximus*).
PROJECT FUNDING: MAFF in-house.
OBJECTIVE: Genetic variation in geographic stocks of scallop.
DESIGN: Examine variation in mtDNA.
METHODOLOGY: PCR of mtDNA fragments. Restriction enzyme analysis.
STATUS: Complete 1996.

Study 10

LABORATORY/RESEARCHER: Dr D O F Skibinski, School of Biological Sciences, University of Wales Swansea, Singleton Park, Swansea, SA2 8PP.
SPECIES: Mussels (*Mytilus*).
PROJECT FUNDING: NERC.
OBJECTIVE: To analyse growth and gene flow in mussel populations.
DESIGN: Allozyme, nuclear DNA and mitochondrial DNA analysis of diverse populations and species.
METHODOLOGY: As above.
STATUS: On-going.

Study 11

LABORATORY/RESEARCHER: Dr D O F Skibinski, School of Biological Sciences, University of Wales Swansea, Singleton Park, Swansea, SA2 8PP.
SPECIES: Aquatic animals.
PROJECT FUNDING: NERC.
OBJECTIVE: To analyse causes of genetic diversity in aquatic animals.
DESIGN: Use of allozyme database.
METHODOLOGY: Statistical and simulation analyses of database.
STATUS: On-going.

Study 12

LABORATORY/RESEARCHER: Dr D O F Skibinski, School of Biological Sciences, University of Wales Swansea, Singleton Park, Swansea, SA2 8PP.
SPECIES: *Tilapia.*
PROJECT FUNDING: ODA.
OBJECTIVE: To produce improved strains for aquaculture in Africa and the Far East.
DESIGN: Selective breeding and chromosome manipulation.
METHODOLOGY: DNA and transgenic technology.
STATUS: On-going.

4.2 Studies Reported in Other Formats

The Atlantic Salmon Federation
P.O. Box 429, St. Andrews, N.B. Canada EOG 2XO
(Reported by G. Friars)

1. Establishment of four separate strains of Atlantic salmon for aquaculture. G.W. Friars, J.K. Bailey, and F.M. O'Flynn.

2. Controlled selection for growth in grilse. F.M. O'Flynn, G.W. Friars, and J.K. Bailey.

3. Sex-reversed females and triploidy. T.J. Benfey and S.A. McGeachy (University of New Brunswick), F.M. O'Flynn, G.W. Friars.

4. Family variation in bacterial kidney disease resistance. G.W. Friars, F.M. O'Flynn, and K.J. Melville (Research and Productivity Council).

5. Occurrence of aquaculture escaped Atlantic salmon in the Magaquadavic River, N.B. and their interactions, with special emphasis on genetic impact, on the native salmon. J.M. Anderson and J.W. Carr (Atlantic Salmon Federation), T.G. Dilworth (University of New Brunswick), G. Lacroix and V. Zitko (Dept. of Fisheries and Oceans).

6. Use of microsatellites DNA fingerprinting to determine effects on fitness of the progeny of the markings between wild Atlantic salmon and aquaculture escapees in the Magaquadavic River, N.B.R.W. Doyle (Dalhousie University) and J.M. Anderson.

7. Genetics and ecology of early and late runs of Atlantic salmon from the Ponoi River, Kola Peninsula, Russia. F.G. Whoriskey.

8. Fate of satellite reared fish of genetic origin from wild native stocks in the Upsalquitch River, New Brunswick. F.G. Whoriskey.

The University of British Columbia, Dept. of Animal Science,
Vancouver, BC, Canada V6T 1Z4
(Reported by R. Peterson)

1. Selection for growth, survival and smoltification in coho;

    a) Estimation of genetic parameters for survival and smoltification;

b) Development of genetic analyses for these traits (AM-BLUP);
c) Development of multi-trait selection indives for coho;
d) Genetic trends, control populations, genetic parameters for coho market weight;
e) Use of reproductive strategies for selection programs in coho.

2. Development of selection program(s) for Rain bow trout. In co-operation with the B.C. Trout Farmers Association;

   a) Estimation of genetic parameters
   b) Development of AM-BLUP models for genetic analysis
   c) Strain evaluation

3. Feasibility study for B.C. selection program in Atlantic salmon

The University of Guelph, Dept. of Animal and Poultry Science
Guelph, ON, Canada N1G 2W1
(Reported by I. McMillan)

1. Use of triploidy induction in the improvement of Rainbow trout production traits;

2. Rainbow trout spawning study;

3. Simulation of breeding programs in farmed salmonids.

Fisheries and Oceans Canada
4160 Marine Drive, West Vancouver, B.C., Canada
(Reported by R. Devlin)

1. Production of transgenic salmon with enhanced growth and altered reproductive capability using «all-salmon» gene constructs;

2. Characterisation of Y-chromosomal DNA probes from salmon for use in monosex all-female culture;

3. Development of DNA-based diagnostics for several Microsporean and Myxosporean parasites to assist with management of infection in sea-farm facilities;

4. Examination of the potential for hybridisation between Atlantic and Pacific salmon with regard to the possible reproductive interaction between escaped farmed Atlantic salmon and wild Pacific salmon stocks;

5. Development of a RAPD linkage map for chinook salmon;

6. Development of a sensitive PCR-based assay for CYPIA1 gene expression to evaluate the biological effects of xenobiotic exposure.

Huntsman Marine Science Centre
St. Andrews, Canada, A/F Protein Canada Inc.
(Reported by G. Goff)

1. The development of a transgenic salmon broodstock for aquaculture.

University of Toronto
Departments. of Clinical Biochemistry & Biochemistry, Toronto, Canada
(Reported by C.L. Hew)

Studies on the biochemistry, molecular biology of fish antifreeze proteins, pituitary hormones and selected transcription factors by the use of gene transfer, cell ablation techniques. These include:

1. Development of transgenic salmon with freeze resistance, enhanced growth and disease resistance;

2. Development of transgenic salmon overexpressing prolactin or somalactin;

3. Development of transgenic salmon depleting in prolactin, somalactin or gonadotropin-producing cells.

Marine Gene Probe Laboratory
Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1
(Reported by C. Herbinger)

This is a list of the various fish/shellfish genetic projects that the MGPL is included in. Every project uses microsatellite fingerprinting probes to generate some of the needed information, even when the title does not specify it. All personnel listed are from the Marine Gene probe Laboratory, Dept. of Biology, Dalhousie University, except where specified.

1. Selective breeding for a steelhead (*Onchorynchus mykiss*) aquaculture operation, using microsatellite based pedigree. C.M. Herbinger, R.W. Doyle, D. Paquet, E. Pitman;

2. Microsatellite based analysis of the gene diversity present in Canadian Arctic Charr (*Salvelinus alpinus*) strains, to create a base population for a selective breeding program. C.M. Herbinger, R.W. Doyle, E. Pitman, D. Paquet;

3. Comparison of Atlantic salmon early family growth performance in mixed family or isolated

family rearing. C.M. Herbinger, R.W. Doyle, P. O'Reilly, and G.W. Friars/Atlantic Salmon Federation);

4. Mechanisms and rates of mutation in Atlantic salmon microsatellite fingerprinting probes. P. O'Reilly, J.M. Wright;

5. Temporal changes in genetic variability in released and returned salmon from the Atlantic Salmon Federation sea-ranching program. G.E. Hamond, R.W. Doyle, G.W. Friars (Atlantic Salmon Federation), C.M. Herbinger;

6. Genetic analysis of growth behaviour and stress in a microsatellite-based pedigreed Rainbow trout population. S.L.C. Lang, R.W. Doyle;

7. Genetic variability among Nova Scotia and European salmon populations. S. McConnel, J.M. Wright, L. Hamilton;

8. Comparison of genetic variability in contemporary and historical cod (*Gadus morhua*) populations. R.W. Doyle, C.T. Taggart (Dept. of Fisheries and Oceans, NW Atl. Fisheries Centre, St. John's, NF), D. Cook, G.L. Maillet, S. Neale;

9. Selective breeding for a scallop (*Plagopecten magellanicus*) aquaculture operation, using microsatellite based pedigree. A. Mallet (Mallet Research Service, Dartmouth, N.S.) R.W. Doyle, C.M. Herbinger, B. Gjetvaj;

10. Development and evaluation of genetic tools for the identification of natural and cultured stocks of the commercial scallop (*Placopecten magellaneus*). E. Zouros, E. Kensington (Dept. of Fisheries and Oceans, Halifax, N.S. Canada);

11. Genetic variability in Shiranus tilapia (*Orechromis shiranus*) populations in Malawi, and breeding program evaluation. A. Ambali, R.W. Doyle;

12. Sicial behaviour and growth rate in Nile *tilapia (Orechromis niloticus)*. S. Gadadkar, R.W. Doyle;

13. Survey of genetic diversity of the Thai silver barb (*Puntius gonionotus*) stocks in Thailand. W. Kamonrat, R.W. Doyle;

14. Genetic diversity in aquaculture: A programme for economically and socially sustainable conservation and development. Inbreeding and genetic variability in cultivated carp populations in China and Indonesia. Y. Hong Shi, R.W. Doyle, T. Charles (Dept. of Finance and Management Science, St. Mary's University, Halifax), J. Leith (School for Resource and Environmental Studies, Dalhousie University, Halifax), A.O. Ball, B. Gjetvaj.

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(Reported by B. McKeown)

1. Thyroid hormone control of transcription of growth hormone mRNA in Rainbow trout pituitary (in collaboration with B. Moav, Israel);

2. Expression of the myc proto-oncogene in Rainbow trout (transcription and replication factors for signal transduction);

3. Expression of the gene coding for the growth hormone receptor in Rainbow trout;

4. Expression of the erbA proto-oncogene in Rainbow trout (thyroid hormone receptor).

APPENDIX 1

TERMS OF REFERENCE 1995 (C. Res. 2:25, 1994).

The Working Group on the Application of Genetics in Fisheries and Mariculture (Chairman: Prof. J. Mork, Norway) will meet at ICES Headquarters from 30 January–2 February 1995 to:

a) continue the review of knowledge of basic population genetic topics in fisheries and mariculture, with emphasis on a combination of qualitative and quantitative aspects;

b) review the question of selective fishery with a view to proposing studies to identify possible long term genetic effects;

c) review sterilisation techniques (such as triploidy) for use in mariculture and field experiments relative to efficacy and justification for the techniques, and the risks involved (e.g., relative to reversion to a reproductive state;

d) prepare updated protocols of fishery and mariculture genetic research in the member countries, and identify scope for enhanced international co-operation.

APPENDIX 2

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APPENDIX 3

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