COOPERATIVE RESEARCH REPORT

No. 70

Recommended format for purposes of citation:
Tiews, K. (ed.) 1977. Report on the present research activities in the field of mariculture in ICES Member Countries. ICES Cooperative Research Report No. 70. pp. 72. https://doi.org/10.17895/ices.pub.4527

REPORT ON THE PRESENT RESEARCH ACTIVITIES IN THE FIELD OF MARICULTURE IN ICES MEMBER COUNTRIES

Edited

by

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ISSN 2707-7144

ISBN 978-87-7482-513-5

International Council for the Exploration of the Sea
Charlottenlund Slot, DK-2920 Charlottenlund
Denmark

October 1977

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1. INTRODUCTION

At the 62nd Statutory Meeting of ICES a Working Group on Mariculture was set up with the terms of reference to collect information about relevant activities in member countries and to suggest fields in which there could be a fruitful international scientific collaboration. Following the example of the European Inland Fisheries Advisory Commission (EIFAC) of the FAO, a first Report on the Present Research Activities in the Field of Mariculture in those ICES member countries participating in the Working Group was prepared and submitted to the 63rd Statutory Meeting of ICES in Montreal in 1975. At that meeting it was recommended to complete the report as much as possible. Until the 64th Statutory Meeting in 1976, 4 countries, which had not reported previously, submitted reports, i.e. Finland, German Democratic Republic, Iceland and Spain, and three others amended their previous reports, i.e. Canada, Denmark and U.S.A.

This information was included in a first revision of the Report submitted to the 64th Statutory Meeting, where it was decided to publish it in the ICES Cooperative Research Reports series to give it a wider distribution. Meanwhile information was obtained also from the U.S.S.R., and amendments were made by Belgium and the United Kingdom.

In Chapter 2, the work of some 100 institutes from the 18 member countries of ICES has been summarised. At present, there are more than 900 scientists and technicians employed in the field of mariculture; half of them have been trained as scientists. It should be mentioned here that the personnel listed under each institute represents only the staff working in the field of mariculture. In most cases, institutes employ additional staff for other work.

In Chapter 3, the work being carried out and planned is listed according to major research topics in order to show which institutes work on similar major research topics. It is obvious from Chapter 3 that work in the field of mariculture in ICES member countries is spread over a wide variety of topics. One can expect that the efficiency of research could be increased, if closer cooperation between institutes working in the same field would be established. Closer co-operation must, however, grow systematically and should start with better information of each others' programmes, methodology and results obtained. To start with, it is expected that all institutes listed should send annually lists of their publications through the appropriate channels to the Chairman of the Fisheries Improvement Committee of ICES for preparation of a recommended Annual Bibliography on Mariculture and at the same time forward information on the progress of their work for inclusion in the Administrative Report of that Committee. If ICES could provide sufficient copies of these reports to be distributed to all institutes listed, it would be very beneficial for future work, since, in general, the published articles on the results of research are so widely spread in national journals that hardly anyone is able to keep track.

The most sincere thanks are expressed to all those who have so effectively contributed to this survey.

2. WORK DONE IN THE FIELD OF MARICULTURE BY COUNTRIES AND INSTITUTES

2.01 BELGIUM

by G Persoone, State University of Ghent, Lab. for Biological Research in Environmental Pollution

2.011 Instituut voor Zeewetenschappelijk Onderzoek (I.Z.W.O.)
(Institute for Marine Scientific Research)
Postal address: Prinses Elisabethlaan 69,
8401 Bredene, Belgium

1. Research facilities

1.1 Personnel
2 scientists
2 technicians
1 secretary
Several scientists and technicians working part-time at the Institute on programs in collaboration with Belgian universities and research institutes

1.2 Laboratories and other installations
1 chemical laboratory
1 biological laboratory
2 controlled temperature culturing laboratories with running sea water and compressed air
Several indoor sea-water tanks (30 m^3)

1.3 Plans for expansion
None at the present time

2. Research programmes

2.1 Current programmes
- Recycling of biodegradable wastes by mass culturing of algae
- Utilisation of heated effluents for high density culturing of molluscs and small crustaceans (Artemia), fed on live algae

2.2 New work planned
Expansion of the administrative and coordinating activities of the European Mariculture Society, the registered Office which is located at the Institute

2.012 State University of Ghent, Laboratory for Biological Research in Environmental Pollution
Postal address: J. Plateaustraat 22
9000 Ghent, Belgium

1. Research facilities

1.1 Personnel
9 scientists
4 technicians
1 secretary

1.2 Laboratories and other installations
Normal laboratory space for chemical and biological research with temperature controlled rooms for algal and invertebrate culture; sea-water tanks and race-ways of several m^3

1.3 Plans for expansion
None at the present time

2. Research programmes

2.1 Current programmes
- A research team is focusing on fundamental and applied aspects of culturing the brine shrimp Artemia salina as a live food for aquaculture purposes
- Another research team is dealing with the problems of mass culture of microscopic algae on biodegradable wastes

Both groups work in close cooperation with the Belgian Institute for Marine Scientific Research

- Mass culture of Fabrea salina (Ciliata heterotricha) as live food for fish larvae

2.2 New work planned
Continuation of the above programme

2.02 CANADA

by E G Bligh, Halifax Laboratory

2.021 Environment Canada, Fisheries and Marine Service
Postal address: Hollis Building, Hollis St., Halifax, N.S. B3J 2S7

2.0211 Resource Branch, Invertebrates & Plants Division
Postal address: Hollis Building, Hollis Street, Halifax N.S. B3J 2S7

1. Research facilities

1.1 Personnel
6 man years

1.2 Laboratory and other installations
Miminegash, P.E.I., Marine Plant Experimental Station

1.3 Plans for expansion
None known

2. Research programmes

2.1 Current programmes
- Develop the biological information base necessary to manage and increase the oyster stocks
- Development of a comprehensive plan for soft-shelled clam depuration
- Development of base line information on standing crops of marine algae; assessing the effects of various harvesting methods and gear on the population of Chondrus; undertaking small cultivation experiments in Gracilaria and Porphyra.

2.2 New work planned
Continuation of above projects

2.0212 Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory)
Postal address: 1707 Lower Water Street, P.O.Box 429, Halifax, Nova Scotia B3J 2R3

1. Research facilities

1.1 Personnel
14 man years

1.2 Laboratories and other installations
A major part of the laboratory and live-holding facilities of the Halifax Laboratory are devoted to aquaculture.
Mobile laboratory and floating pen enclosures at Boitilier's Point

1.3 Plans for expansion
It is hoped to have a totally new facility by 1980.
The present building is 50 years old.

2. Research programmes

2.1 Current programmes
- To determine the nutritional requirements of lobsters, and
- to identify the biochemical mechanisms and hormones associated with lobster moulting
- To develop a highly sensitive method to determine the reproductive status of salmonids several months before spawning
- To develop standard field survey procedures, standard diagnostic protocols and the drawing up of plans for a comprehensive diseases control programme
- To determine the nutritional requirements of salmonids in salt water

- To acquire a comprehensive understanding of the diseases of aquatic animals and plans amenable to culture or on which an industry is currently based. The diseases under study at present or immediately contemplated are those of lobsters, oysters, salmonids and eels.
- Determination of technical feasibility of salt-water rearing of Atlantic salmon in floating enclosures to marketable size of 6 pounds
- A joint venture of the Cape Breton Development Corporation and the Fisheries and Marine Service has comprised three major areas of effort:

  (i) the description of Cape Breton marine areas in terms of their physical, chemical and biological parameters, and an assessment of their mariculture potential

  (ii) investigation of the biology of selected target species, development and testing of production and marketing technology and its economic evaluation. Species currently under study include: oysters, salmonids, mussels, eels and marine algae

  (iii) commercial, through pilot to full commercial scale production and marketing of species for which applicable and economically promising rearing technology is available

2.0213 Resource Branch, Fisheries and Environmental Sciences Division (St. Andrews Biological Station)
Postal address: St. Andrews, New Brunswick

1. Research facilities

1.1 Personnel
12 man years

1.2 Laboratories and other installations
Part of a major biological research facility (with live-holding facilities) located at St. Andrews, New Brunswick

1.3 Plans for expansion
None at present

2. Research programmes

2.1 Current programmes
Continuing investigations on the physiological manipulation of salmonids and lobsters so that growth reproduction, moulting or smoltification can be manipulated in controlled artificial and semi-natural conditions in relation to diet, pH, salinity, and temperature. Work towards a research project on site at Coleson Cove using waste heat is continuing, as are efforts to cage-rear salmonids to pan size in one year

2.2 New work planned
Continuation of above

2.0214 Resource Branch, Fisheries and Environmental Sciences Division (Nanaimo Biological Station)
Postal address: P.O.Box 100, Nanaimo, British Columbia

1. Research facilities

1.1 Personnel
20 man years

1.2 Laboratories and other installations
Part of a major biological research facility located at Nanaimo, British Columbia. Extensive live-holding facilities are available

1.3 Plans for expansion
None are known at this time

2. Research programmes

2.1 Current programmes

- To determine the basis for rearing fast-growing healthy salmon (all species) by optimizing environmental conditions. Studies include:
  (i) early feeding and initial growth of sockeye and chum salmon
  (ii) best combination of temperature, salinity and photoperiod for growth
  (iii) nitrogen excretion of sockeye salmon
  (iv) salinity adaptation and response.
- Provide the biological and technical basis for successful fish farming. Pilot plant fish farm studies include incubation of these species of salmonids in an environmentally controlled fish hatchery utilising heated water and saline solutions, transfer of the young fish to floating sea pens, rearing to market size, and testing their quality to demonstrate the practicability of fish farm methods. Pertinent environmental factors will be correlated with fish growth, mortality and health, and suitability of newly designed fish pens will be assessed
- The Fish Health Programme includes research related to:
  (i) microbial diseases
  (ii) parasitic diseases and conditions

2.2 New work planned
Continuation of above

2.0215 Fisheries Technology Branch, Industrial Development Division
Postal address: Environment Canada, Fisheries and Marine Service, P.O.Box 429, Halifax, Nova Scotia B3J 2S7

The Industrial Development Branch, working through individuals, companies and Provincial Governments, is financially supporting a wide variety of mariculture ventures. These include:

- Efforts to determine the relative merits of raising scallops and mussels from spat in favourable, pre-determined areas to commercial size or for release over established beds before reaching maturity for later commercial harvesting. Raft culture is involved with some experiments
- Design of flotation collars and trays for off-bottom rearing of oysters. It is also planned to institute growth and survival experiments with the European oyster, O. edulis
- Work is continuing in the Bras d'Or Lakes with the rearing of speckled and rainbow trout in salt water. Plans are developing for the building of a small experimental and demonstration trout farm using both fresh and salt water
- Various seaweed projects are underway, including culture work on Gracilaria sp., Chondrus crispus, Laminaria, and Rhodymenia palmata
- An experimental eel culture farm is now functioning in New Brunswick

2.022 National Research Council of Canada

2.0221 Atlantic Regional Laboratory
Postal address: 1411 Oxford Street, Halifax, Nova Scotia

1. Research facilities

1.1 Personnel
10 scientists full time, of whom 6 have a Ph.D;
5 technicians

1.2 Laboratories and other facilities
The laboratory maintains a herbarium (8 000 specimens), has growth chambers and facilities for culturing marine plants on a laboratory scale and in greenhouses on a relatively large scale. The latter are at a Seaweed Culture Station on the shore of the Atlantic Ocean. The scientists work in collaboration as the work requires, with physical chemists who provide access to physical-chemical techniques: NMR, IR and Mass Spec.

1.3 Plans for expansion
The Seaweed Culture Station is being slowly developed as funds permit

2. Research programmes

2.1 Current programmes
- Investigations on taxonomy, morphology, life cycles and growth of marine algae that live on the Atlantic coast
- Studies on the genetics of marine algae
- Determination of the chemical constituents in marine algae and studies on biosynthetic processes and control mechanisms
- Studies on the physiology and growth of marine algae

2.2 New work planned
Establishment of an analytical center for cooperative research and development of standards and procedures for analysis of substances in sea water.

2.03 DENMARK

by E Hoffmann, Danmarks Fiskeri- og Havundersøgelser, Charlottenlund

2.031 Danish Institute for Fishery and Marine Research,
Postal address: Charlottenlund Castle, 2920 Charlottenlund

1. Research facilities

1.1 Personnel
2(3) scientists, 3 technicians

1.2 Laboratories and other installations
One laboratory equipped for common analytical work
12 indoor 1m^3 concrete aquaria
4 indoor 2m^3 concrete aquaria
The aquaria are connected with the circuit of "Danmarks Aquarium" and for the 12, there are possibilities for cold fresh and cold sea water; for the 4 there are cold and warm sea water. 1 closed temperature-regulated hatching system, volume 800 l.

1.3 Plans for expansion
Additional research laboratories including a new closed aquarium-system to be constructed in 1976-77.

2. Research programmes

2.1 Current programmes
Maturation of eels and energy requirements for gonad ripening

2.2 New work planned
Further work on maturation of eels. Consideration of the use of thermal effluents for aquaculture. A pilot experiment will start in 1976.

2.04 FINLAND

by P Tuunainen, Finnish Game and Fisheries Research Institute, Fisheries Division, Korkeavuorenkatu 21, SF-00130 Helsinki 13

2.041 Finnish Game and Fisheries Research Institute
Postal address: P.O.Box 193, SF-00131 Helsinki 13

1. Research facilities

1.1 Personnel
20 scientists and biologists (on mariculture research 2 scientists on part-time basis)

1.2 Laboratories and other installations
6 state fish farms and one experiment fish farm using cooling water from an electric power plant; main stocks for mariculture are Baltic salmon and sea trout

1.3 Plans for expansion
Plans for increasing salmon smolt production have been made. No plans for expansion of research facilities of mariculture

2. Research programmes

2.1 Current programmes
- Preservation of genetically valuable anadromous fish stocks
- Rearing technique for salmon, sea trout, rainbow trout and migratory whitefish and testing the suitability of produced fish for stocking purposes

2.2 New work planned
Extension of experiments on rearing migratory fish species in cooling water

2.05 FRANCE

by Jacques Le Noan, Chef du Département "Ressources vivantes", Centre National pour l'Exploitation des Océans

Remarque générale

La recherche française en matière d'aquaculture marine est basée sur la distinction entre une aquaculture marine traditionnelle(dans notre pays la mytiliculture et l'ostréiculture) dont l'état du savoir faire a permis depuis longtemps d'obtenir une production importante, et une aquaculture marine nouvelle caractérisée à la fois par le renforcement de l'intervention de l'Homme au cours du cycle biologique, et par les espèces abordées, autres que les huîtres et les moules.

L'Institut Scientifique et Technique des Pêches Maritimes (ISTPM), sous tutelle du Ministère des Transports, est orienté principalement sur la recherche qui concerne la conchyliculture traditionnelle dont les apports représentent de 20 à 30% de la valeur de la production nationale en ressources vivantes océaniques.

Le Centre National pour l'Exploitation des Océans (CNEXO), sous tutelle du Ministère de l'Industrie et de la Recherche Scientifique, a développé depuis 1967 un effort de recherche en aquaculture marine nouvelle, soit directement avec ses structures et moyens propres, soit à l'aide de

contrats ou associations de recherche passés avec différents laboratoires universitaires, ou organismes spécialisés publics ou privés (Institut National de la Recherche Agronomique, Direction des Services Vétérinaires).

Depuis 1967, les outils de travail mis en place en France sont:

- le hall d'aquaculture marine du Centre Océanologique de Bretagne (COB) (CNEXO)
- la station expérimentale de terrain de l'Ile Tudy (COB) (CNEXO)
- le hall d'aquaculture de la Station de Biologie Marine et Lagunaire de Sète (Université de Montpellier)
- l'écloserie de homards de l'Ile d'Yeu (ISTPM)
- le hall d'aquaculture et les bassins d'essais du Centre Océanologique pour la Pacifique (COB) (CNEXO)
- deux stations de démonstration, d'expérimentation et de valorisation de l'aquaculture, l'une dans le nord de la Bretagne et l'autre sur les côtes du Languédoc (CNEXO)
- le Laboratoire de Pathologie des Animaux Aquatiques (Direction des Services Vétérinaires, Ministère de l'Agriculture) en cours de construction au COB à Brest et dont la mise en service est prévue en automne 1975.

2.051 Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports

Adresse postale: B.P. 1049, rue de l'Ile d'Yeu, 44037 Nantes Cédex

1. Moyens de recherche

1.1 Personnel
25 chercheurs permanents
15 techniciens

1.2 Laboratoires et autres installations

a - Roscoff

Salles d'aquarium et système de régulation des températures; écloserie de homards à l'Ile d'Yeu (bassin de 50 et 100 m^3)

b - La Trinité-sur-Mer

Salles d'aquarium et système de régulation des températures; station expérimentale en estuaire pour huîtres et vénéridés

c - La Rochelle

Pour étude de la moule

d - Claires à huîtres expérimentales

e - Arcachon

Station expérimentale à Neyrau pour études sur les huîtres

f - Sète

Aquaria et station expérimentale de Thau (moules); suivi scientifique d'une ferme à truite de mer à Leucate

1.3 Projets d'extension

a - Implantation en cours d'une station expérimentale en Vendée pour étude des marais

b - Construction en cours d'un nouveau laboratoire à La Tremblade avec salles d'aquarium

2. Programmes de recherche

2.1 Programmes courants

a - Reproduction et élevage de crustacés; acclimatation d'espèces étrangères; pathologie

b - Hydrobiologie des régions ostréicoles; reproduction, croissance et affinage d'Ostrea edulis, Crassostrea gigas, et des moules (Mytilus edulis et M. galloprovincialis); verdissement des huîtres par Navicula ostrearia; engraissement et essais de fertilisation des claires; pathologie des coquillages; captage de pecténidés; élevage de vénéridés

c - Adaptation des truites arc-en-ciel à l'eau de mer; essais d'élevage de la daurade en cage

3. Analyse des travaux faits ou projetés par l'ISTPM

3.1 Par espèce

7 - truite de mer
2.8 - daurade
3.2 - moules (M. edulis et M. galloprovincialis)
3.3 - huîtres (O. edulis et Crassostrea gigas)
3.4 - clams et autres vénéridés
3.6 - homards
crevettes
pectenidés

3.2 Travaux faits, par principaux objets de recherche

3.2.1 Type de culture

1 - en étang, marais, estuaires et baies
3 - en cages, en eau de mer
5 - en bassins en milieu insubmersible
6 - en bassins en général
7 - en polyculture
10 - culture verticale des moules et autres techniques
11 - culture verticale des huîtres et élevage des huîtres en en général selon d'autres techniques

3.2.2 Ecosystème

1 - écosystème des marais, étangs
écosystème des estuaires et baies
5 - fertilisation des claires à huîtres
10 - productivité primaire des marais, étangs, claires, estuaires et baies affectés à la conchyliculture

3.2.3 Reproduction d'élévage

1 - technique de reproduction
2 - technique d'élevages
3 - élevages pour repeuplement
6 - maladies et leur contrôle
7 - contrôle des parasites

2.052 Centre National pour l'Exploitation des Océans (CNEXO)
Ministère de la Recherche et du Développement Industriel
Adresse postale du siège: 39, avenue d'Iéna, 75016 Paris

Adresse postale des Centres:

Centre Océanologique de Bretagne, B.P.337, 29273 Brest Cédex

Centre Océanologique pour le Pacifique, VAIRAO, Ile de Tahiti (Polynésie française)

Base Océanologique pour la Méditerranée, La Bastide Verte, Zone Industrielle de Toulon-Est, 83130 La Garde

2.0521 Centre Océanologique de Bretagne

2.05211 Equipe de recherche appliquée de l'unité d'aquaculture

1. Moyens de recherche

1.1 Personnel
9 chercheurs
11 techniciens

1.2 Equipement
Bâtiment couvert de 500 m^2 avec trois ensembles, thermorégulés de 10 à 30°C en circuit ouvert (chaque ensemble, alimenté à 10 m^3/h comporte une cuve de 20 et une autre de 50 m^3)

2 ensembles expérimentaux pour nutrition des poissons (40 bacs de 500 à 2 000 litres chacun)

Ensemble de bacs pour production de plusieurs milliers de larves de mollusques et grossissement du naissain

Salles de cultures d'algues phytoplanctoniques (production quotidienne 400 litres en continu et 200 litres en discontinu de culture contenant de 1 à plusieurs millions de cellules par millilitre selon l'espèce

Salle de production d'herbivores: Rotifères, Copépodes, Artemia

16 bacs de 10 à 20 m^3 pour maintien de géniteurs et expériences de croissance

Une station de terrain implantée dans un étang à marée de 17 hectares comportant un laboratoire de terrain, un bassin de 500 m^2 et une série de 12 bacs de 20 m^2 chacun

2. Programme de recherche

2.1 Programme en cours:

a) Production primaire:
technique de production "en bloom" en sacs de polyéthylène pour nutrition larvaire (en 1974 production de 116 m^3 de culture de Tetraselmis suesica à 1 M/C/ml)

technique de concentration par centrifugation et réviviscence

conservation par congélation et réviviscence
utilisation comme inoculum

extension à d'autres algues phytoplanctoniques

b) Herbivores:

nutrition de Artemia par spirulines et diverses proies inertes

c) Reproduction artificielle et grossissement de mollusques:

techniques de reproduction en volume de 20 m^3 et en continu pour:

- huîtres (Ostrea edulis, Crassostrea gigas)
- palourdes, Venerupis spp.
- coquilles Saint-Jacques, Pecten maximus
- ormeaux, Haliotis tuberculata

maturation induite de géniteurs d'ormeau - essai de grossissement sur un parc naturel

d) Crevettes:

- pénéidés - maturation de Penaeus japonicus
- bouquet Leander serratus - maturation, synchronisation des pontes, obtention de post-larves - nutrition et élevage en bassin - élevage associé

e) Poissons:

- bar: reproduction naturelle en captivité, fécondation, ponte induite, survie larvaire et grossissement
- sole: ponte induite - survie larvaire
- turbot: ponte induite - survie larvaire - grossissement

2.2 Programmes futurs
Développement et amélioration des techniques appliquées
Création d'une écloserie expérimentale

2.05212 Unité régionale pour le Développement de l'Aquaculture dans la région Nord (Urda/Nord)

1. Moyens de recherche

1.1 Personnel
3 chercheurs ou ingénieurs
4 techniciens

1.2 Equipement
Etang à marée de 10 000 m^2 pour élevage dans 16 cages de 80 m^3 chacune

Cages expérimentales en rade de Brest et dans le Jaudy

Suivi scientifique d'une exploitation de truites en mer en Rance maritime (25 tonnes/an)

2. Programme de recherche

2.1 Programmes en cours
Reproduction, alevinage, passage en mer, croissance d'Oncorhynchus kisutch en cages en milieu semi-fermé (étang à marée), en cages en milieu estuarien (production 1974: 30 tonnes)

Application de cette technique au Salmo salar

2.2 Programmes futurs
Biotechnique et évaluation financière des voies d'élevage des salmonidés à l'échelle de la production (prévision 1975: 50 tonnes)

Etudes de l'élevage en bassins et raceways

2.0522 Base Océanologique pour la Méditerranée - Unité régionale pour le Développement de l'Aquaculture pour la région sud (Urda/Sud)

1. Moyens de recherche

1.1 Personnel
6 chercheurs
6 techniciens

1.2 Equipement
2 bâtiments couverts d'écloserie et de grossissement de juvéniles de 700 m^2 chacun équipés de 15 bassins et bacs intérieurs
6 bacs extérieurs de 80 m^3
2 500 m^2 de bassins extérieurs

2. Programme de recherche

2.1 Programme en cours:

1. Pénéidés: Reproduction obtenue en 1974 de P. japonicus - fiabilité de la technique de reproduction
Croissance de P. japonicus (une tonne produite en 1973 et 1974)

2. Bar Dicentrachus labrax: Maturation, ponte induite et alevinage (150 000 bars de 3 mois obtenus début 1975)

3. Daurade: Maintien et maturation - ponte induite, obtention de larves en grands volumes

2.2 Programme prévu
Extension des programmes en cours

2.0523 Centre Océanologique pour le Pacifique (COP)

1. Moyens de recherche

1.1 Personnel
6 chercheurs
10 techniciens

1.2 Equipement
Hall d'aquaculture de 250 m^2 équipé de 20 bassins
Ecloserie pour crevettes Pénéidés.
6 bassins de grossissement (6 000 m^2 en tout)

2. Programme de recherche

2.1 Programmes en cours
Reproduction, croissance et production de Pénéidés du Pacifique (Penaeus merguiensis, Metapenaeus ensis, P. semisulcatus, P. aztecus, P. japonicus). Elevage de Carangidae spp. Reproduction et production de Pinctada margaritifera

2.2 Programme prévu
Extension à une station de production

2.053 Laboratoires associés au CNEXO pour l'Aquaculture Marine

2.0531 Laboratoire de Pathologie des Animaux Aquatiques - Ministère de l'Agriculture
Adresse postale: Direction des Services Vétérinaires - Centre Océanologique de Bretagne, B.P.337, 2o273 Brest Cédex

1. Moyens de recherche

1.1 Personnel
Equipe provisoire de 4 chercheurs et 1 technicien depuis 1974.
Développement prévu de l'effectif en 1975; 22 en 1976

1.2 Equipement
Laboratoire de 1 700 m^2 (mise en service prévue automne 1975)

2. Programme de recherche

2.1 Protection sanitaire des élevages (appliquée dès maintenant aux salmonidés en mer)

1. Prophylaxie sanitaire:
Contrôle sur septicémie hémorragique virale, nécrose pancréatique infectieuse, furonculose

2. Prophylaxie médicale:
Mise au point effectuée de vaccination antivibriose et et de stock-vaccin pour développer la résistance à des infections non spécifiques

3. Contrôle sanitaire des échanges internationaux

2.2 Lutte contre les maladies dans les élevages marins

1. Identification des agents pathogènes et histologie: parasites des bars (vers) et des saumons (microsporidés)
- bactéries: salmonidés (Aeromonas salmonicida), myxobactéries des bars
- virus par cultures cellulaires

2. Traitements
Programme actuel par antibiogrammes et essais thérapeutiques dans élevages. Des traitements spécifiques seront testés lors de la disponibilité des bassins expérimentaux

Contrôle de salubrité

Contrôle des moules et des huîtres à la vente
Recherche et dosage des métaux lours (mercure, cadmium)
Recherche et dosage des pectioides
Recherche et dosage des résidus médicamenteux.

2.0532 Station de Biologie Marine et Lagunaire de Sète

1. Moyens de recherche

1.1 Personnel
6 chercheurs
4 techniciens

1.2 Equipement
480 m^2 couvert comportant:
1 hall d'aquaculture avec un bassin de 30 m^3
6 bassins de 8 à 12 m^3 et 10 bacs expérimentaux en eau thermorégulée pouvant aller de 13 à 28°C
1 compartiment pour cultures phytoplanctoniques et zooplanctoniques thermorégulé

Bassins extérieurs, réservoir à géniteurs de 50 m^3
2 bassins de 15 m^3 chacun

1.3 Perspectives de développement
Agrandissement du hall jusqu'à 1 000 m^2

2. Programme de recherche

2.1 Programmes actuels
Maintien, maturation de géniteurs de bars et de daurades en captivité
Evolution de la gamétogénèse chez les géniteurs captifs
Induction de la ponte
Ovogénèse et survie larvaire
Alimentation larvaire naturelle et composée
Ovogénèse du bar - détermination de la période de fécondation en fonction du développement de l'ovocite et de sa membrano-génèse

2.2 Programmes futurs
Poursuite du programme en cours en développant la survie larvaire et en abordant la génétique du bar

2.0533 Centre National de Recherches Zootechnique
Adresse postale: Institut National de la Recherche Agronomique, Ministère de l'Agriculture, Domaine de Vilbert, 78350 Jouy-en-Josas

1. Moyens de recherche

1.1 Personnel
6 chercheurs
3 techniciens

1.2 Equipement
50 bacs de 150 litres en circuit fermé

2. Programme de recherche

2.1 Programmes en cours
Laboratoire de Nutrition:

Recherche sur la ration alimentaire du bar, turbot et sole.
Bar: recherche de l'aliment composé pour juvéniles et adultes.
Turbot et Sole: mise au point d'un granulé humide et de la distribution de l'aliment - Alevins du turbot: essais d'adaptation des juvéniles au régime synthétique.
Salmonidés: besoins en arginine. Etude de l'alimentation du saumon en mer

Laboratoire de Physiologie:

Physiologie de la reproduction des salmonidés - conservation des sperms
Génétique
Etude de l'hétérabilité des caractères sur la truite arc-en-ciel et les saumons
Essais d'hybridation de saumon Coho et de truite arc-en-ciel

2.2 Programmes futurs
Renforcement de l'action de la recherche génétique

2.06 GERMAN DEMOCRATIC REPUBLIC
by B Schreiber, Institute for Deep Sea Fisheries and Fish Processing, Rostock
Postal address: DDR 251, Rostock 5

2.061 VEB Fischwirtschaft des Bezirkes Rostock
Postal address: Am Bahnhof, DDR 253 Warnemünde

1. Research facilities

1.1 Personnel
11 scientists
4 technicians

1.2 Laboratories and other installations
- Tanks with normal temperature water and with warm water
- Hatcheries in open waters

1.3 Plans for expansion
New research station for species in warm water

2. Research programmes

2.1 Current programmes
- Hatching and culture of salmonids and other fish in Baltic Sea water and in brackish water
- Technology of hatching and culture

2.2 New work planned
None

2.07 GERMANY, FEDERAL REPUBLIC OF

by K Tiews, Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei, 2 Hamburg 50, Palmaille 9

2.071 Biologische Anstalt Helgoland (Biological Station of Heligoland)
Postal address: 2000 Hamburg 50, Palmaille 9

1. Research facilities

1.1 Personnel
3 scientists
3 technical assistants

1.2 Laboratories and other installations

a) several laboratories with equipment for the rearing and culture of fish and food animals under different conditions (salinity, temperature, oxygen, pH, etc.)

b) 3 round tanks, each of 20 m^3

c) 1 small hot house for the culture of food animals

d) open and closed sea water circulation, including treatment of sea water (filtering basin, ozonization, temperature adjustment)

Laboratories are at the Marine Station at Heligoland, the littoral station at List/Sylt, and the head office at Hamburg.

1.3 Plans for expansion
Construction of new culture rooms in the new laboratory on Heligoland

2. Research programmes

2.1 Current programmes
- Rearing and culture of garfish, grey mullets (Mugil sp.), Siganus spp.
- Search for new fish species suitable for marine culture
- Development of methods for rearing and culture
- Hatching techniques for spawning of fish
- Development physiology and metabolic physiology of the fry
- Investigations on the food intake, food conversion and growth of larvae and juveniles
- Control of fish diseases and parasites

2.2 New work planned
Development of optimal feeds for other fish species suitable for aquaculture

2.072 Institut für Ernährungsphysiologie an der Tierärztlichen Fakultät der Universität München (Institute for Nutritional Physiology in the Veterinarian Faculty of the University of Munich)

Postal address: 8 München 22, Veterinärstrasse 13

1. Research facilities

1.1 Personnel
2 scientists
1 technician on part-time basis

1.2 Laboratories and other installations
a) normal laboratory space
b) equipment for pelleting experimental feed

1.3 Plans for expansion
None

2. Research programmes

2.1 Current programmes
Development of optimal rainbow trout feeds (also in the economic sense) in cooperation with the Institut für Küsten- und Binnenfischerei at Hamburg

2.2 New work planned
Development of optimal feeds for other fish species suitable for aquaculture

2.073 Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery)

Postal address: 2000 Hamburg 50, Palmaille 9

1. Research facilities

1.1 Personnel
5 scientists
7 technicians

1.2 Laboratories and installations

a) experimental station Eckernförde (Baltic coast); 30 net cages, each of 16 m^3, in the western Baltic under a bridge well protected against rough sea, equipped with automatic feeders,etc.

b) experimental station Hamburg Bahrenfeld; 20 net cages, each of 8 m^3

c) 2 brackish-water ponds at the Cuxhaven sub-station of the Institute, each of 100 m^3

d) rafts for vertical mussel farming in the Flensburger Förde (western Baltic)

e) rafts and submersed container systems for vertical oyster farming in coastal waters off the Island of Sylt (North Sea) and at various places on the Baltic coast

f) experimental station Emden for fish culture in heated brackish-water effluents of a conventional power station. A series of culture basins of different sizes, round (6-8 m in diameter) and rectangular (3-15 m^3), total water capacity 100 l/sec.

1.3 Plans for expansion
None at present

2. Research programmes

2.1 Current programmes
- Development of optimal rainbow trout and other fish feeds (also in the economic sense) in cooperation with the Institut für Ernährungsphysiologie in der Tierärtzlichen Fakultät der Universität München
- Experiments on the introduction of coastal net cage farming in the western Baltic (rainbow trout, brown trout, sea trout and development of respective technologies, including considerations of antifouling, feeding techniques, behaviour studies)
- Studies on the autecology of brackish-water ponds
- Experiments on the introduction of vertical mussel culture (Mytilus edulis) in the western Baltic
- Experiments on the introduction of vertical culture of Pacific oyster and others in German coastal waters of the North Sea and Baltic
- Experiments on the use of heated brackish water effluents from power stations for fish farming (eel, rainbow trout, flat fish, others)
- Development of a closed salt water circulation fish farm system with biological water purification (method Ahrensburg)

2.2 New work planned
None at present

2.074 Institut für Meereskunde, Fischereibiologische Abteilung an der Universität Kiel (Institute for Oceanography, Dept. of Fisheries Biology at the University of Kiel)

Postal address: 23 Kiel, Düsternbrooker Weg 20

1. Research facilities

1.1 Personnel
1 scientist
2 technicians
post-graduate student

1.2 Laboratories and other installations
1 laboratory
1 aquarium room
net cages in the Kiel Bight
fish ponds at the power station Kiel-Ostufer

1.3 Plans for expansion
Installation of an experimental station for rearing aquatic organisms planned at the Kiel sewage station on the Baltic coast

2. Research programmes

2.1 Current programmes
- Rearing of salmonids in net cages
  utilisation of mussels as salmon food
- Physiological investigations on sensory and metabolic aspects of the nutrition of fishes
- Fattening experiments on blue mussels (Mytilus edulis)
- Studies on the feeding value of benthic natural feeds in the Kiel Bight

2.2 New work planned
-

2.08 ICELAND

by Jón Jónsson, Marine Research Institute, Reykjavik

2.081 Veidimálstofnunin (Institute of Freshwater Fisheries)

Postal address: P.O.Box 754, Reykjavik

1. Research facilities

1.1 Personnel
Four scientists, full time

1.2 Laboratories and other installations
1 biological laboratory
1 experimental fishfarm for fresh water and salt water

1.3 Plans for expansion
None at present

2. Research programmes

2.1 Current programmes
- Experiments with rearing techniques of Atlantic salmon, brown trout and char
- Experiments with sea ranching with Atlantic salmon
- Experiment with rearing Atlantic salmon in floating enclosures

2.2 New work planned
None at present

2.082 Hafrannsóknastofnunin (Marine Research Institute)

Postal address: P.O.Box 390, Skúlagata 4, Reykjavik

1. Research facilities

1.1 Personnel
1 part-time scientist

1.2 Laboratories and other installations
Work carried out within the section of the Institute dealing with zooplankton and marine evertebrates.
Biological laboratory and controlled temperature sea water tanks

1.3 Plans for expansion
None

2. Research programmes

2.1 Current programmes
Since 1973 the Institute has been experimenting with rope culture of Mytilus edulis based on larval settlement. These experiments have been carried out at 3 different localities on the southwest coast of Iceland. Although larval settlement has been successful, considerable difficulties have been met with due to severe weather conditions at times in this area. These experiments will be continued.

2.083 Fiskifélag Islands (Fisheries Association of Iceland)

Postal address: Skúlagata 2, Reykjavik

1. Research facilities

1.1 Personnel
1 full-time scientist

1.2 Laboratories and other installations
Laboratory work carried out at the Icelandic fisheries Laboratory, Reykjavik

1.3 Plans for expansion
None at present

2. Research programmes

2.1 Current programmes
Since 1972 rearing and feeding experiments with Atlantic salmon with dry fishfood in floating enclosures

2.2 Continuation of this work is planned

2.09 IRELAND

by F A Gibson, Department of Agriculture and Fisheries, Dublin

2.091 Department of Agriculture and Fisheries, Fisheries Division

Postal address: Agriculture House, Kildare Street, Dublin 2

1. Research facilities

1.1 Personnel
4 (1) scientists. One scientist working on physiological problems with "spin-off" results usable in mariculture
2 technicians

1.2 Laboratories and other installations
a) Fisheries Field Station, Dunmore East, Co.Waterford

b) Fisheries Field Station, Fenit, Tralee, Co.Kerry

c) Laboratory, 3 Cathal Brugha Street, Dublin 2

d) at (a) open and closed circuit circulation in round and square tanks of various sizes; also constant temperature room; instrumentation for physiological measurements

e) Temporary field station at Lough Ine, Co.Cork

1.3 Plans for expansion
- Increasing the size of the Dunmore East Station by 100% to accommodate laboratory experiments on Pecten and Chlamys operculatis
- New intermediate-sized laboratory at Kinsale, Co.Cork, for R and D with Crustacea

2. Research programmes

2.1 Current programmes
- Rearing salmon smolts, to supply semi-state concerns with raw material for salmon culture
- Physiological studies of the requirements of keeping crustaceans alive and healthy in laboratory conditions
- Collection of natural spatfall of O.edulis on French plastic collectors for relaying as yearlings on fattening grounds in Tralee Bay
- Using albino Pecten maximus as a genetic tag to evaluate the potential of rearing this bivalve, in a protected glacial lake, at Lough Ine, Co.Cork
- Raft culture of mussels, collecting natural mussel spatfall, and the evaluation of various coastal bays and inlets as potential farming areas

2.2 New work planned
- Studies of fish diseases and parasites
- Studies of lobster (H. gammarus) farming
- Extension of P.maximus culture to C. opercularis culture, and the holding of a P.maximus Workshop at Lough Ine in May or June 1976

2.092 Shellfish Research Laboratory (in association with University College Galway)

Postal address: Carna. Co.Galway

1. Research facilities

1.1 Personnel
1 biologist
Various graduates working to a higher degree
4 technicians

1.2 Laboratories and other installations
Laboratory constructed and designed for molluscan rearing and related studies

2. Research programmes

2.1 Current programmes
- Hatching, rearing and larval/juvenile biological studies of oysters (two species): Ostrea edulis and Crassostrea gigas
- Hatching, rearing and larval/juvenile biological studies of the clam (Tapes or Venerupis decussata)
- Hatching, rearing and larval/juvenile biological studies of the scallop (Pecten maximus)
- Field studies with the above-mentioned species of molluscs, e.g. on-growing, density and exposure experiments, growth and mortality, ecological requirement for field culture, etc.
- Algal culture: semi-continuous and batch culture of the following species - the flagellates Isochrysis galbana and Tetraselmis, and the diatom Chaetoceros calcitrans
- Redevelopment of disused (derelict) oyster beds, including experimental collection of spat (O. edulis), on-growing studies, experimental clearing of beds and removal of predators, etc.

2.2 New work planned
- Setting up of applied shellfish extension unit (group) to investigate commercial scale development of oyster fishery - to include: development of pilot-scale techniques for production of oyster spat and the economics of such production; design and construction of experimental oyster hatching and rearing facility for semi-commercial production and research work; on-growing experimental work at a number of sites along the west coast and survey of potential oyster development sites; training of technical and post-graduate personnel in oyster hatchery and applied field work
- Expansion of algal culture research to provide better and greater volume of food for semi-commercial scale production of oyster spat - including design and construction of separate experimental algal culture system and unit (building); training of personnel

Problems to be given future attention and priority:

- Basic research work on diseases, parasites and nutrition aspects of mariculture, at the laboratory and field levels

- the economics of mariculture, i.e. costs involved in production of spat, on-growing of juveniles and adults, operation of research facilities for development of mariculture (e.g. algal culture systems), etc.

Fields fruitful for international cooperation:

- At present there is only one - the exchange of information on projects, problems, research techniques and facilities in use, by the various countries interested in possible cooperation. Such an "exchange" would then lead on to what lines of cooperation would best be followed

2.093 Electricity Supply Board (Semi-State)

Postal address: Fisheries Division, Lower Fitzwilliam Street, Dublin 2

1. Research facilities

1.1 Personnel
1 scientist
1 field assistant

1.2 Laboratories and other installations
No laboratory on site, facilities shared with Shellfish Laboratory at Carna. A net cage in a sheltered bay on the west coast. A salmon smolt rearing station on the River Shannon, at Limerick, which is one of the largest of its type in Europe

1.3 Plans for expansion
None reported

2. Research programmes

2.1 Current programmes

Research on the transference of salmon smolts to full salinity (30‰) without acclimatisation. Research with diet requirements using, at present, a ration of 9:1 of sprat (Clupea sprattus) and synthetic pellet. Regular measurements of growth rate at equal intervals of time

2.2 New work planned
None reported

2.094 Bord Iascaigh Mhara (Semi State)

Postal address: P.O.Box 275, Hume House, Ballsbridge, Dublin 4

1. Research facilities

1.1 Personnel
1 biologist

1.2 Laboratories and other installations
No laboratory, use of Norwegian cage in the fjord at Killary on the west coast, which is exposed only to the northwest. Rearing of smolts in an inland salt lake.

1.3 Plans for expansion
None reported

2. Research programmes

2.1 Current programmes
- Rearing salmon smolts and direct acclimatisation of fully smoltified individuals in Norwegian type cages. Diet of high fat content food prepared by Tess of Norway

2.2 New work planned
To investigate available materials and structure for holding and on-growing of salmon smolts and also to study the required diets for this work

2.095 Salmon Research Trust of Ireland (Government and Private Industry)

Postal address: Salmon Laboratory Traenlaur, Newport, Co.Mayo

1. Research facilities

1.1 Personnel
1 biologist
1 assistant biologist
4 field assistants

1.2 Laboratories and other installations
Two working laboratories. Rearing ponds (circular, cement) for juvenile salmon, and acclimatisation ponds for smolts

1.3 Plans for expansion
None reported

2. Research programmes

2.1 Current programmes
Production of acclimatised smolts (1 yr.+). Tests of salinity tolerance at various stages of growth at different population densities. Testing of different feeding regimes. Diagnosis and treatment of diseases in sea water. High priority research on the food and feeding of smolts with particular reference to growth and economics of salmon rearing in sea-cages and fixed ponds

2.096 Atlantic Fisheries Ltd. (Private)

Postal address: Rossmore, Carrigthwohill, Co.Cork

1. Research facilities

1.1 Personnel
1 biologist

1.2 Laboratories and other installations
Field laboratory at Cork Harbour. Artificially-created ponds (circular) on land and lined with plastic. Collection of oyster spatfall (O. edulis) in these ponds. The pond at Cork Harbour is approximately 3 000 m^3. The pond at Bannow, Co. Wexford, is considerably larger.

1.3 Plans for expansion
None reported

2. Research programmes

2.1 Current programmes
Rearing of large quantities of O. edulis spat in ponds to a size when it is safe to transplant them to fattening beds. Culture of algal food for on-growing

2.2 New work planned
To expand and intensify 2.1

2.10 NETHERLANDS
by S J de Groot, Netherlands Institute for Fishery Investigations, IJmuiden

2.101 Netherlands Institute for Fishery Investigations (Ministry of Agriculture and Fisheries)

Postal address: (a) Headquarters (four departments) - P.O.Box 68, Haringkade 1, 1620 IJmuiden

(b) Mussel Experimental Station (Shellfish Dept.) -'Horntje, Texel

1. Research facilities

1.1 Personnel
Several of the scientists and technicians in various departments of the main Institute spend part of their time on problems related to mariculture (aquaculture)

On the other hand, the Mussel Experimental Station at Texel is exclusively devoted to our most important mariculture, the mussel and oyster culture. The Station was built as a pilot-plant for artificial cleaning (rewatering) of mussel and storage.
Staff: 2 scientists, 10 technicians

1.2 Laboratories and other installations
Mussel Experimental Station:
Main features: indoors open and closed aquaria (controlled temperature), analytical support (also by the main Institute).

Outdoors - cleansing and storage basin for operations on a technical scale.
One pumphouse for pumping from the Wadden Sea into the plant, 35, 15, 25 m^3/min.
Large sand catching device and 10 sedimentation tanks and 3 storage tanks (sedimentation tanks' surface 2 500 m^2).
The mussels are stored in two sets of three mussel basins (each 5 x 50 m). If water conditions are poor, the plant can be run on the stored water.
The second pumphouse, also used for pumping the used water back into the sea, is used for the circulation. The pumphouse is equipped with three large pumps 27, 18, 15 m^3/min.

Research vessels: one inshore research vessel "Stern", partly devoted to support the Station. Two inspection vessels "Waddensea" and "Vlieter", also in use for water sampling and current measurements in the Wadden Sea. Several small inspection vessels of the Ministry based in the Scheldt estuary are used for the same purpose. One small motorboat "PPC Hoek" based in the harbour of the Station.

2. Research programmes

2.1 Current programmes
Improved methods of field cultivation and harvesting of mussels (bottom culture). Investigation into diseases, pest-predator relationships of cultivated bivalves. This type of work is mainly carried out at the main Institute.

2.11 NORWAY
by Dag Møller, Institute of Marine Research, Directorate of Fisheries, Bergen

2.111 Fiskeridirektoratet (Directorate of Fisheries), P.O.Box 185-186, N-5001 Bergen

2.1111 Fiskeridirektoratets Havforskningsinstitutt (Institute of Marine Research), P.O.Box 1870-72, N-5011 Bergen-Nordnes

1. Research facilities

1.1 Personnel
10 scientists
9 technicians
4 students

1.2 Laboratory and other installations
Laboratory for growth and energy metabolism studies. 10 special tanks (175 l) and sea water oxygenation tank. 10 special tanks (175 l) for photoperiod studies. Laboratory for disease studies, 8 tanks (200 l) with chlorination of effluent. Laboratory for general studies of the biology of fry and smolt, 28 tanks (200 l).
3 30 m^3 concrete storage tanks (sea water of 9°C). Hatchery units of different types, 50 l eggs.
Water: sea- and fresh water of 5, 10 and 20°C

2.1112 Fiskeridirektoratets Vitamininstitutt (Government Vitamin Institute)

Postal address: Lars Hilles Gt. 26, P.O.Box 187, N-5001 Bergen

1. Research facilities

1.1 Personnel
3 scientists
6 technicians
2 students

1.2 Laboratories and other installations
Laboratory and advanced analytical equipment for nutrient elements.
Microbiological laboratory

2.1113 Fisk og Forsøk (Fish and Research)

Postal address: N-5198 Matredal

1. Research facilities

1.1 Personnel
2 scientists
5 technicians

1.2 Laboratories and other installations
Hatchery for 1 million eggs in groups
40 square tanks (2 m^2)
74 round tanks (1.75 m^2)
40 square floating cages (9 m^2)
Building for administration and laboratories under construction
Water: fresh water 2 000 l/min; heated water 1 000 l/min; sea water 1 000 l/min.

2. Research programmes

2.1 Current programmes
- Comparative growth studies of fish density in floating pens
- Comparative growth studies of rainbow trout and Atlantic salmon in floating pens at different positions from Bergen to North Cape
- Growth and energy metabolism studies
- Analysis of food value of different fish species and fish offals
- Thiamin studies in rainbow trout
- Protein qualities of fish meals
- Silage conservation of fish for salmonid feed
- Behaviour and feed uptake with different feed types

- Studies on salmon lice (Lepeoptheirus salmonis)
- Studies on vibriosis
- Hygienic-bacteriological studies of wet feed and the sea water in fish farms
- Selective breeding of Atlantic salmon from different Norwegian rivers
- Selective breeding of rainbow trout
- Studies of other salmonids (Salvelinus alpinus, Onchorynchus gorbusha and hybrids)
- Photoperiod and saltwater tolerance of Atlantic salmon
- Salt feeding and saltwater tolerance of Atlantic salmon
- Aggression in Atlantic salmon parr
- Semi-culture production of non-salmonid fish fry
- Rearing of halibut through the larval stages
- Multiculture: rainbow trout - different flatfish species

2.112 Institutt for Husdyravl (Department of Animal Genetics and Breeding), Agricultural University of Norway

Postal address: N-1432 Ås-NLH, Norway

2.1121 Forsøksstasjon for Fisk (Fish Breeding Experimental Station)

Postal address: N-6600 Sunndalsøra

1. Research facilities

1.1 Personnel
3 scientists
1 manager
5 technicians
2 students

1.2 Laboratories and other installations
Laboratory and offices 72 m^2
Hatchery for 2 million eggs and 600 groups
Plastic tanks: 1 m^2, 140 units
" " : 2 m^2, 268 units
" " : 4 m^2, 32 units
Concrete ponds: 75 m^2, 36 units
Recirculation unit for smolt production
4 m^2 plastic tanks, 8 units

1.3 Plans for expansion
Laboratory 112 m^2

Water: four different sources including sea water and cooling water from a hydro-electric plant

2.1122 Forsøksstasjon for Laks (Salmon Breeding Experimental Station)

Postal address: N-6530 Bruhagen

1. Research facilities

1.1 Personnel
1 manager
1 technician
1 student

1.2 Laboratories and other installations
Storing house 84 m^2
Floating bridge 220 m
Floating cages: 200 m^3, 16 units
" " : 500 m^3, 10 units
" " : 27 m^3, 24 units

Sea water

2. Research programmes

2.1 Current programmes
- Comparison of species: Atlantic salmon, pink salmon, sea trout, rainbow trout, Arctic char and brown trout
- Crossbreeding between the species mentioned above
- Comparison of production traits of Norwegian salmon strains
- Selection of rainbow trout for growth rate
- Inbreeding experiment with rainbow trout
- Developing polyploidy
- Chromosome studies
- Estimating phenotypic and genetic parameters

2.2 Environmental work:
- Water re-use for smolt production
- Effects of different density of fry and fingerlings on growth rate and mortality rate
- Production of breeding stocks
- Effect of different hormones on growth rate and smoltification of salmon

Nutrition experiments (carried out by the Department of Poultry and Fur Animal Science, Agricultural University of Norway, Ås-NLH-Norway)

- Comparison of different fat content and fat quality in dry diets for rainbow trout and Atlantic salmon
- Comparison of different protein content and protein quality in dry diets for the same species
- Effects of high carbohydrate levels on ten full sub-groups of rainbow trout
- Comparison of different slaughter house by-products in wet diets for salmon
- Pigmentation of rainbow trout by different carotenoids

2.113 Direktoratet for Vilt og Ferskvannsfisk (Directorate for Wildlife and Freshwater Fish)

Postal address: Elgesetergt. 10, N-7000 Trondheim

1. Research facilities

1.1 Personnel
1 chief biologist
4 research scientists (2 biologists, 1 chemist and 1 fish pathologist)
1 station manager
7 assistants and office personnel

1.2 Laboratories and other installations
1 biological laboratory
1 chemical laboratory
Pathological laboratories at the Veterinarian Institute, Oslo
1 field research station (under construction)

1.3 Plans for expansion
The research department will later be moved to Trondheim and will then be expanded.
The field station will get 2-3 assistants

2. Research programmes

2.1 Current programmes
The programme for the research and the field station covers the biology of anadromous and other Norwegian freshwater fishes, fish farming, etc.

2.114 University of Tromsø, Institute of Biology and Geology

Postal address: P.O.Box 790, N-9001, Tromsø

1. Research facilities

1.1 Personnel
Total staff involved in the aquaculture research programme:
3 professors
6 lecturers
8 technicians

1.2 Laboratories and other installations
- Experimental fish farm on Kvaløya (20 km from University campus) with 9 floating ponds (total ca. 800 m^2)
- Experimental hatchery in Forsheim Research Station in Skjomen (some 220 km by road from Tromsø), with 3 floating ponds and hatchery capacity for 50 000 smolts
- Marine Biological Station, Tromsø (8 km from University campus), with open sea water system 30 m^3/hour for laboratory experiments
- Institute building at University campus with laboratory facilities for biochemical and physiological work

Salt and fresh water

2. Research programmes

2.1 Current programmes
- Optimal production in relation to food costs
  Factors influencing growth rate and mortality
  Growth rates and mortality at commercial fish farms in the region
- Technological improvements:
  Submersible floating pen construction
  Heat exchange and heat production
- Biochemistry and physiology of growth and survival of Vibrio anguillarium

2.2 New work planned
Planned research programme is waiting the appointment of professor in aquaculture

2.115 Veterinærinstituttet (National Veterinary Institute)

Postal address: P.O.Box 8156, N-Oslo-Dep, Oslo 1

1. Research facilities

1.1 Personnel
2 scientists
1 technician

1.2 Laboratories and other installations
Laboratories for histology, microbiology, virology
Fresh water

2. Research programmes

2.1 Current programmes
Registration and studies on Vibrio anguillarium and other infectious diseases, botulisme, lipoid liver-degeneration.
Toxicological studies

2.116 Norges Veterinærhøyskole (Veterinary College of Norway)

Postal address: P.O.Box 8146, N-Oslo-Dep, Oslo 1

1. Research facilities

1.1 Personnel
2 scientists

1.2 Laboratories and other installations
Laboratories for histology, microbiology and virology.
Water: freshwater

2. Research programmes

2.1 Current programmes
Farmacological studies

2.117 Selskapet for De Norske Fiskeriers Fremme (Society for Promotion of the Norwegian Fisheries)

Postal address: Nordahl Brunsgt. 9, N-5000 Bergen

1. Research facilities

1.1 Personnel
1 scientist
1 technician

1.2 Laboratories and other installations
Laboratory
Research pool for oyster studies (N-5980 Harbakke, Solund)

2. Research programmes

2.1 Current programmes
Control of oyster pests
Selective breeding of oyster

In addition to the Institutions mentioned above, the Directorate of Fisheries has a Marine Biological Station at the southeastern coast (Flødevigen, N-4800, Arendal), where work is done on cultivation of different flatfish species, lobster and mussels. At present, this Station is heavily involved in research on ecological changes due to thermal pollution and, therefore, it is not possible to state how much effort is put into aquaculture research. At the Station of Marine Biology, University of Trondheim (Professor G Sundnes), work is done on rearing and release of flounder and plaice.

2.12 POLAND

by J Wiktor, Morski Instytut Rybacki

2.121 Morski Instytut Rybacki (Sea Fisheries Institute)

Postal address: 81-345 Gdynia, Aleja Zjednoczenia 1

1. Research facilities

1.1 Personnel
3 scientists
4 technical assistants

1.2 Laboratories and other installations
Marine and Baltic water aquaria with regulated water flow, climatisation and aeration, hatchery installation for fish eggs, rearing tanks

1.3 Plans for expansion
New research station for Baltic fish culture is planned for 1978

2. Research programmes

2.1 Current programmes
- Hatching and culture of salmonids in Baltic sea water
- Hatching of other freshwater fish in Baltic sea water

2.2 New work planned
- Hatching and rearing of Baltic pleuronectids and cod
- Culture of Black Sea gobiids for introduction in Baltic coastal water

2.122 Morski Instytut Rybacki, Oddzial w Swinoujściu (Sea Fisheries Institute, Swinoujście Branch)

Postal address: Swinoujście, Plac Slowianski 11

1. Research facilities

1.1 Personnel
3 scientists
1 technical assistant

1.2 Laboratories and other installations
Normal laboratory space available, no special installations

1.3 Plans for expansion
Aquaria and tanks are planned

2. Research programmes

2.1 Current programmes
Culture and stocking of Hypophthalmichthys molitrix in the Szczecin Lagoon

2.2 New work planned
None

2.123 Pracownia Rzeczna Instytutu Rybactwa Śródladowego w Gdansku-Oliwie (River Laboratory of the Inland Fisheries Institute in Gdańsk-Oliwa)

1. Research facilities

1.1 Personnel
4 scientists
3 technicians and workers

1.2 Laboratories and other installations
Hatchery room
Tanks and ponds (fresh water)
Normal laboratory space available

1.3 Plans for expansion
Plastic tanks and circular ponds at the new Station are planned

2. Research programmes

2.1 Current programmes
- Restocking of Baltic salmon and sea trout
- Tagging of salmonids
- Introduction of rainbow trout in the Baltic

2.2 New work planned
Genetical selection of sea trout for restocking

2.124 Instytut Eksploatacji i Ochrony Biologicznych Zasobów Morza Akademii Rolniczej, Zaklad Rybackiego Zagospodarowania Wod Przybrzeznych (Institute of Exploitation and of Biological Marine Resources of the Agricultural University at Szczecin, Laboratory of Fisheries Management for Coastal Waters)

Postal address: Szczecin, ul. Kazimierza Króblewicza 3

1. Research facilities

1.1 Personnel
2 scientists
2 technicians

1.2 Laboratories and other installations
Normal laboratory space available. Aquarium with regulated water flow at Darłowo

1.3 Plans for expansion
None planned

2. Research programmes

2.1 Current programmes
Intensive rearing of rainbow trout in concrete raceways with sea-water flow, and in floating net cages

2.2 New work planned
None planned

2.13 PORTUGAL
by Maria José de Figueiredo. Ministério da Marinha, Instituto de Biologia Maritima

2.131 Instituto Nacional de Investigação das Pescas, Secção de Aquacultura, Secretaria de Estado das Pescas

Postal address: Algés-Praia, Lisboa 3

1. Research facilities

1.1 Personnel
5 scientists
3 technical assistants

1.2 Laboratories and other installations
1 aquarium room with 2 aquaria of 360 l each and several smaller units for the hatching and rearing of crustaceans and small herbivores
1 controlled temperature room for phytoplankton cultures
1 laboratory for chemical and bacteriological analyses

1.3 Plans for expansion
A new building is to be ready by the end of 1976, including 5 aquaria rooms, 1 controlled temperature room and 2 laboratories for chemistry and bacteriology

2. Research programmes

2.1 Current programmes
- Artificial culture of larvae and post-larvae of Nephrops norvegicus, Palaemonetes varians, Penaeus kerathurus and Palaemon serratus from two different sources, one from the west coast and the other from the south coast of Portugal
- Development of some phytoplankton cultures such as Tetraselmis suecica, Platymonas sp., Nanochloris sp.(?), Dunaliella tertiolecta, Phaeodactylum tricornutum and Manochrysis lutheri

- Development of cultures of some herbivores such as Brachionus plicatilis and copepodes of the genus Tisbe, Cletocamptus and Calanipedia.
- Studies on the quality of aged sea water in aquaria

2.2 New work planned
- Culture of bivalve molluscs (Crassostrea angulata, Ostrea edulis and Tapes decussatus)
- Culture of fishes (Scophthalmus maximus, Chrysophirys aurata and Anguilla anguilla)

2.14 SPAIN
by H Quiroga, Instituto Español de Oceanografía, Laboratorio de La Coruña

Postal address: P.O.Box 130, La Coruña

2.141 Instituto Español de Oceanografía
Postal address: Alcalá 27, 4°, Madrid-14

2.1411 Laboratorio Oceanográfico
Postal address: Lealtad 13, Santander

1. Research facilities

1.1 Personnel
3 scientists
6 assistants

1.2 Laboratories and other installations
Room for experimental aquaria with open sea water circuit. 6 tanks with a total volume of 16 400 l of sea water

1.3 Plans for expansion
A new building for the laboratory is under construction. There will be a big room for shellfish culture, another for plankton, both with open sea water circuit and a sea water reservoir of 25 000 l. Expected to be ready by December 1976

2. Research programmes

2.1 Current programmes
- Growing and feeding of molluscs, Ostrea edulis and Venerupis decussata, and crustaceans, Micropipus sp., Palaemon serratus, Eriphia spinifrons, and experimental culture of their larvae
- Study of the environmental conditions of the red seaweed Gelidiun sesquipedale, culture and artificial substrate

2.1412 Laboratorio Oceanográfico

Postal address: Muelle de Animas s/n. P.O.Box 130, La Coruña

1. Research facilities

1.1 Personnel
5 scientists
4 assistants

1.2 Laboratories and other installations
This laboratory is mostly devoted to mariculture and will be completed during 1976. It has been provided

with rooms for algal culture, larval rearing and conditioning of progenitors. There are 10 x 200 l and 10 x 100 l tanks for larvae and juvenile molluscs; 9 x 3 000 l and 10 x 1 000 l, indoor sea water tanks for adults. A big room with aquaria of different sizes. Automatic heaters. 3 heat exchangers will be installed soon.

2. Research programmes

2.1 Current programmes
- Hatching and rearing of larvae and juvenile molluscs: clams, Venus pullastra and V. decussata; scallop, Pecten maximus, and flat oyster, Ostrea edulis
- Algal culture: the following three species are in culture as food for larvae, juvenile and adult molluscs: Isochrysis, Monochrysis and Tetraselmis

2.2 New work planned
- Rearing of trout and salmon: acclimatisation of smolt to sea water
- Culture of Dicentrarchus labrax
- Culture of rotifers

2.1413 Laboratorio Oceanográfico de Canarias

Postal address: Av. de José Antonio 3, Santa Cruz de Tenerife

1. Research facilities

1.1 Personnel
2 scientists

1.2 Laboratories and other installations
Room for phytoplankton culture
Room with 9 m^3 tanks for sea water

2. Research programmes

Culture of Perna perna, Haliotis and Venerupis aurea

2.1414 Laboratorio Oceanográfico del Mar Menor

Postal address: P.O.Box 22, San Pedro del Pinatar, Murcia

1. Research facilities

1.1 Personnel
3 scientists
1 assistant

1.2 Laboratories and other installations
A big room of 1 000 m^2 with running sea water tanks with a total volume of 324 m^3

1.3 Plans for expansion
An isothermic room for phytoplankton mass culture

2. Research programmes

Reproduction and fish culture: Sparus aurata, Dicentrarchus labrax, Mugil cephalus; crustaceans: Penaeus kerathurus and Palaemon serratus

2.142 Instituto de Investigaciones Pesqueras

Postal address: Paseo Nacional s/n. Barcelona 3

2.1421 Laboratorio de Castellón

Postal address: Monturiol 2, El Grao de Castellón

1. Research facilities

1.1 Personnel
5 scientists
9 assistants

1.2 Laboratories and other installations
A room with 19 tanks and a total sea water volume of 19 000 l
Automatic heaters with thermostats. Room for phytoplankton culture and 12 tanks with a total volume of 12 500 l for zooplankton culture. 11 tanks with a total volume of 12 000 l.
39 plastic bags for phytoplankton culture with 3 300 l capacity.

1.3 Plans for expansion
The facilities in the laboratory are being enlarged. A pilot-plant for mariculture is under construction

2.1422 Laboratorio de Cadix

Postal address: Puerto Pesquero s/n.Cadix

1. Research facilities

1.1 Personnel
3 scientists
3 assistants

1.2 Laboratories and other installations
5 rooms with experimental tanks, sea water open circuit, automatic aeration and special illumination as required
4 tanks of 200 l for spawning of molluscs
2 tanks of 100 l with double bottom for crustaceans
5 tanks of 200 l for fishes
4 tanks of 400 l, one of them for spawning, also for fishes
Automatic heaters
3 special rooms for phytoplankton and zooplankton culture
Outside: 6 tanks of 10 000 l each
1 circular tank of 19 500 l

2. Research programmes

- Growth and feeding of Sparus aurata, Morone labrax and Solea solea
- Study of Penaeus kerathurus, born in the laboratory and reared in the swamps of the salt-pits

2.143 Plan de Explotacíon Marisquera de Galicia

Postal address: Piedras de Coron, Villanueva de Arosa,Pontevedra

1. Research facilities

1.1 Personnel
12 scientists
7 assistants

1.2 Laboratories and other installations
18 tanks of 60 l for crustaceans
20 tanks of 100 l for molluscs
1 room for phytoplankton culture
1 room for zooplankton culture
Outside: 12 pools with a total volume of 453 m^3

2.15 SWEDEN
by Bo Holmberg, National Board of Fisheries

General remarks

Farming of fish for direct consumption is not very common in Sweden. Most farmed fish will be used for stocking purposes.

A few pilot mussel farms are operating on the west coast. The production costs are still too high for the canning industry, so most of the mussels are sold on the fresh market. New products of mussels will be investigated. Farming of oysters (Crassostrea gigas) are under testing.

According to the Water Law about 2 millions of salmon smolts are stocked every year in the Baltic. About 1/3 of the total catch of salmon in the Baltic is based on this stocking programme. Sea trout have been stocked in coastal areas with good results for the local and commercial sport fisheries. Short migrating strains of sea trout have been tested in certain areas. The most important task is to increase the survival of the smolts to increase the yield. The effects of smolt size, time of release, adaption to sea water and natural food are investigated.

Farming of rainbow trout has been tested in floating net cages in some coastal areas. It is not possible to culture fish in net cages during winter because of the low water temperatures. To eliminate this problem fish farming in recirculated systems have been analysed, especially by private companies.

The possibility of using cooling water from nuclear power plants for fish farming is under investigation. A pilot farm has been constructed in connection with the power plant outside Oskarshamn. Brackish water (7‰) is used for cooling, and the increase of the water temperature is 10°C.

2.151 National Board of Fisheries

Postal address: (Head office): P.O.Box, S-403 10 Göteborg

1. Research facilities

1.1 Personnel
2 scientists on part-time basis
2 hatchery biologists on part-time basis

1.2 Laboratories and other installations

A. Statens Fiskodling, Älvkarleby (State Hatchery)
Postal address: S-810 70 Alvkarleby 1

The production capacity is about 125 000 smolts of salmon and sea trout. Most of the production is used for the stocking programme according to the Water Law. Part of the sea trout smolts are used for research.

B. Fiskodlingen, Simpevarp (Pilot fish farm)
Postal address: S-570 92 Figeholm

Experimental fish farm using cooling water from a nuclear power plant. The production capacity is about 10 000 smolts. Rearing units are tanks and net cages.

1.3 Plans for expansion
None

2. Research programmes

2.1 Current programmes
- Tagging experiments to study the migration of certain strains on sea trout
- Selective breeding
- Food experiments
- Rearing technique for salmon, sea trout, rainbow trout and eel using cooling water from a nuclear power plant, growth and nutrition, diseases, testing the suitability of produced fish for stocking purposes or direct consumption

2.2 New work planned
None

2.152 Salmon Research Institute, Laboratory in Älvkarleby (Sweden)

Postal address: S-810-70 Älvkarleby 1

1. Research facilities

1.1 Personnel
4 scientists
1 hatchery manager
1 hatchery biologist
3 technicians
9 others

1.2 Laboratories and other installations
The Institute is organised in laboratories at Älvkarleby, an office at Sundsvall and a tag-recording centre at the Freshwater Research Laboratory, Drottningholm. The laboratories at Älvkarleby consist of three divisions: a fishery biology division, a fish pathology division and a pilot salmon-rearing plant

1.3 Plans for expansion
None

2. Research programmes

2.1 Current programmes
- Tagging experiments in order to study the migrations of salmon, the population dynamics in the Baltic, the effect of the Swedish salmon conservation programme and the effects of breeding experiments
- Selective breeding experiments
- In large-scale food experiments, the nutritional condition of the fish is controlled by means of observation on growth, food conversion factor, etc.,and by analysis, especially of the blood and liver of the fish
- Seasonal and developmental variations in the mineral regulation capacity and the haemoglobin polymorphism of salmon
- The effect of PCBs (polychlorinated biphenyls) on the reproduction of salmon
- Studies of gill hyperplasia in two year old salmon
- Studies of epidermal papilloma in salmon. All work in this field is done only with salmon (Salmo salar).

2.2 New work planned
None

2.153 Department of Geology and Oceanography
Chalmers University of Technology

Postal address: P.O.Box, S-402 20 Göteborg

Special project: evaluate the possibilities for commercial mussel farming in Sweden and select the best technique. Development of new products based on mussel meat

2.154 Kristineberg Marine Biology Station

Postal address: S-450 34 Fiskebäckskil

Special project: studying the relationships between growth and the concentrations of metabolites in recirculated sea water systems

2.16 UNITED KINGDOM

by P R Walne, Ministry of Agriculture, Fisheries and Food, Fisheries Experiment Station, Benarth Road, Conwy, Gwynedd

ENGLAND AND WALES

2.161 Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food

Postal address: Breakwater Road, Port Erin, Isle of Man, via U.K.

1. Research facilities

1.1 Personnel
6 scientists
4 technicians

1.2 Laboratories and other installations
- Controlled temperature facilities with sea water 3 x 13 m^2; 1 x 75 m^2; 1 x 17 m^2. Other indoor sea water tanks 82 m^2
- Algal and invertebrate culture unit, fish pathology unit

2. Research programme

2.1 Current programme
To develop commercially acceptable methods for rearing marine flatfish from egg to market size.
- Development of a rearing technique for larval turbot
- Examination of the dietary requirements of juvenile turbot and Dover sole
- Investigation of environmental and behavioural effects on fish growth in high density culture

2.2 New work planned
To investigate the production of eggs outside the normal spawning season by environmental manipulation

2.162 Fisheries Experiment Station, Ministry of Agriculture, Fisheries and Food

Postal address: Benarth Road, Conwy, Gwynedd

1. Research facilities

1.1 Personnel
10 scientists
10 technicians

1.2 Laboratories and other installations
- Closed and open marine aquaria 1 to 4 x 10^5 l
- Mollusc and crustacean hatcheries, algal culture unit, analytical facilities, inter-tidal growing facilities

1.3 Plans for expansion
Additional research laboratories and tank room facilities under construction

2. Research programmes

2.1 Current programmes
To develop methods for producing seed for stocking bivalve fisheries and to develop methods of culture to market size for prawns. These include:
- Requirements of bivalve larvae
- Methods for cultivation of juvenile bivalves in the sea
- Introduction of new species and selection experiments
- Development of breeding techniques for tropical prawns and their culture in closed systems

2.2 New work planned
Increasing emphasis will be given to selection trials

Note: Additional activity in England and Wales

Marine Science Laboratories, Menai Bridge - Biochemical studies on shellfish

Portsmouth Polytecnic - Oyster culture

Lord Rank Research Laboratories, Whitley Bridge - Prawn culture

Shearwater Fishfarms Ltd., Carlisle - Sole and turbot culture

2.163 Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food

Postal address: Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA

1. Research facilities

1.1 Personnel
2 scientists - Mariculture
1 technician - "
(other scientists engaged on other aspects of fisheries research)

1.2 Laboratories and other installations
Extensive laboratories, open and closed aquaria
Flowing sea water supply
Controlled temperature laboratories
Experimental areas in protected estuary, for littoral and sublittoral experiments
Analytical support
Two research vessels (14 m and 12 m long)

1.3 Plans for expansion
None

2. Research programmes

2.1 Current programmes
Improved methods of field cultivation of bivalve molluscs derived from natural settlement or from hatcheries:
- by traditional bottom culture
- by suspended culture using rafts, trays etc.

Investigations into diseases, pest-predator relationships of cultivated bivalves

2.2 New work planned
Increasing emphasis will be given to the field cultivation of small hatchery-produced bivalves

2.164 Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food

Postal address: Lowestoft, NR33 OHT Suffolk

1. Research facilities

1.1 Personnel
9 scientists
6 technicians

1.2 Laboratories and other installations
- Closed and open aquaria 1 to 7 x 10^4 1
- Fish hatcheries, genetics biochemistry and endocrinology laboratories

1.3 Plans for expansion
Under review

2. Research programmes

2.1 Current programmes
To develop methods for cultivation of fish in sea water environments
- Larval rearing
- On-growing
- Genetics
- Sexual maturation and control

2.2 New work planned
Under review

2.165 Fish Diseases Laboratory, Ministry of Agriculture, Fisheries and Food

Postal address: The Nothe, Weymouth, Dorset, DT4 8UB

1. Research facilities

1.1 Personnel
11 scientists
4 technicians
3 office staff

1.2 Laboratories and other installations
- Saltwater and freshwater laboratories for experimental transmission of disease in marine and freshwater fish, under closely controlled conditions
- Salt and freshwater laboratory for experimental transmission of disease in crustacea, under closely controlled conditions
- Double sterilisation system for inflowing and effluent water
- Diagnostic and research laboratories

1.3 Plans for expansion
Additional research and diagnostic laboratories under construction

2. Research programmes

2.1 Current programmes
Diagnostic work: diagnosis and control of notifiable diseases of fish throughout England and Wales

Research work:
- Continuing programme of research into the aetiology and epizootiology of diseases of marine and freshwater fish and shellfish
- Research into therapy and hygiene for the prevention and control of diseases on fish farms
- Development of diagnostic techniques

Advisory and inspection work: development of advisory and inspection work associated with notifiable diseases of fish in conjunction with regional veterinary laboratories

2.2 New work planned
Further development of research into diseases of marine fish and shellfish, together with improved methods of treatment and control

SCOTLAND

2.166 Marine Laboratory

Postal address: P.O.Box 101, Aberdeen AB9 8DB

and Freshwater Fisheries Laboratory

Postal address: Faskally, Pitlochry, Perthshire PH16 5LB

1. Research facilities

1.1 Personnel
17

1.2 Laboratories and other installations
Closed marine aquaria
OPen freshwater aquaria

1.3 Plans for expansion
An additional 11 staff will be employed between 1975-77 for the running of a freshwater unit having 5 mg/d for rearing salmon and trout and a marine base for rearing both species in sea water. These facilities are currently in the planning stage. It is envisaged that scientific staff from the DAFS laboratories at Aberdeen and Pitlochry and scientists of other Institutes will use the rearing units for experimental work on salmonid cultivation.

2. Research programmes

2.1 Current programmes
On salmonid and flatfish cultivation
- Testing the efficiency of various growth promoting dietary supplements for salmonids
- Evaluating the usefulness of various methods of castration and sex reversal in salmonids
- Investigation of seasonal cycles in thyroidal and steroid hormonal status in rainbow trout and salmon in fresh and sea water
- Studies of the hormonal basis of the smolting process
- Studies of incidence, biology, pathogenesis of infectious pancreatic necrosis virus

- Studies of the immune system in salmonids and flatfish and of the usefulness of immunization in cultivation
- Studies of the incidence of parasites in farmed salmonids and flatfish, and the biology of selected species causing disease

2.2 New work planned
A considerable expansion of the R & D programme on salmonid cultivation is planned as the new cultivation facilities are phased into operation

2.167 Scottish Marine Biological Association

Postal address: Dunstaffnage Marine Research Laboratory, P.O.Box 3, Oban, Argyll PA34 4AD

1. Research facilities

1.1 Personnel
About 60 scientific staff (about 30 graduates) in laboratory (total staff involved in mariculture and fish rearing - 4 graduates, 2 Ph.D. students, 1 technician)

1.2 Laboratories and other installations
- Open circuit aquarium, supply 45 m^3 per hour, floor area of main aquarium 270 m^2; 3 constant temperature rooms total area 46 m^2; 5 air-conditioned wet laboratories total area 67 m^2, 3 associated laboratories total area 41 m^2 - not all this space is used for mariculture etc.
- There are also sea-water cages in bay near laboratory

1.3 Plans for expansion
Possible extension of aquarium, especially for rainbow trout and other salmonid research

2. Research programmes

2.1 Current programmes
- Culture of rainbow trout in cages dealing with growth on different diets; the use of "demand" feeding, acclimation to sea water
- Rearing of teleost larvae for experimental purposes (role of sense organs, ecology of starvation, wound healing and predation, development of behaviour, sublethal effects of toxicants on behaviour)

2.2 New work planned
Collaboration with DAFS on salmonid culture in sea water both at the laboratory and at a planned field site about 10 miles away

2.168 Institute of Marine Biochemistry, Natural Environment Research Council

Postal address: St. Fittick's Road, Aberdeen AB1 3RA

1. Research facilities

1.1 Personnel
3 scientists
2 technicians

1.2 Laboratories and other installations
- Closed system aquarium with 1 x 10^4 l freshwater (14 tanks) with 5% renewal at all times; 2 x 10^4 sea water (20 tanks) with 5% renewal at all times

- Diet preparation equipment (pelleting, milling, mixing, etc.) and comprehensively equipped biochemical laboratory

2. Research programmes

2.1 Current programmes
- Mineral nutrition, rainbow trout
- Vitamin requirements, turbot
- Protein-energy balance and protein sources for rainbow trout

2.2 New work planned
Possible extension of work to Atlantic salmon depending on provision of external facilities or an improved supply of sea water

2.169 Unit of Aquatic Pathobiology, University of Stirling

Postal address: University of Stirling, Stirling

1. Research facilities

1.1 Personnel
5 scientists
5 technicians
10 Ph.D. research students
7 M.Sc. course + research students

1.2 Laboratories and other installations
- Recirculating aquaria for disease work under controlled lighting and temperature
- Extensive pathology and microbiology laboratory facilities

1.3 Plans for expansion
Unable to plan at present because of economic climate which is having a swinging effect on "soft money" groups like ours

2. Research programmes

2.1 Current programmes
- To develop the basic pathology of fish upon which the clinical pathology of aquaculture can be based
- To determine the relationship between husbandry methods and disease in the context of economics
- To study the pathogenesis and immunogenesis of the important diseases of fish and shellfish
- To study the non-specific defense systemsand their relation to organism pathogenicity

2.2 New work planned
Extension of our work to the tropical situation

2.1610 White Fish Authority
Marine Cultivation Units (Fish and Shellfish)

Postal address: Sea Fisheries House, 10, Young Street, Edinburgh, EH2 4JQ

Site addresses: Hunterston Generating Station, West Kilbride, Ayrshire

Ardtoe, Acharacle, Argyll

1. Research facilities

1.1 Personnel
15 scientists
15 technicians

1.2 Laboratories and other installations (Hunterston)
- Closed and open marine tanks, from 20 litre to 54 m^3 capacity
- Marine flatfish hatchery, including breeding stock and egg incubation
- Fattening tanks
- Food preparation and storage space is available for expansion, but no immediate plans for further development
- Office, laboratory and workshop buildings

Laboratories and other installations (Ardtee)
- Closed and open marine tanks from 20 litre to 3 m^3 capacity, 2 ha intertidal pond capable of daily replenishment, and complex of floating cages (3 m^3 to 30 m^3 enclosed volume) in nearby loch
- Smaller marine flatfish hatchery and associated nursery (hatchery also used for molluscs)
- Food preparation and storage
- Office and workshop
- New hatchery and nursery buildings incorporating shellfish laboratory, planned

2. Research programmes

2.1 Current programmes

a. Marine fish
Development of pilot commercial scale hatchery/nursery processes and of subsequent fattening for market, for Dover sole and turbot

b. Shellfish
Growing oysters in the intertidal pond and oysters and scallops in the sea and in association with fish cages. Development of techniques for collecting natural settlement of scallops and of hatchery techniques

c. Engineering
Development of equipment suitable for commercial application for the above processes

2.17 USA

by C Sindermann, National Marine Fisheries Service

General remarks

At present there is a large amount of mariculture research and development activity in the United States but only limited commercial production. The greatest commitment of research effort is by the Federal Government and by Universities with federal (Sea Grant) funding. There is also some participation by state marine research agencies and by private industries with risk capital to invest.

Mariculture R&D is being carried on at many locations in the United States. Sources of funding for research projects are principally the U.S. Department of Commerce (through its National Oceanic and Atmospheric Administration elements - the National Marine Fisheries Service and the National Sea Grant Program) and some venture capital from private industries.

A national aquaculture plan for the United States has been prepared and distributed by the National Oceanic and Atmospheric Administration (NOAA), outlining responsibilities, planning groups, policies and coordination. The document outlines a wide-ranging 10-year programme to encourage culture of fishery products by private enterprises for

sale and by public agencies to increase natural stocks. The plan specifies the role and responsibilities of Federal and State Governments, universities and private industry; and sets priorities on species to receive major attention. Species of greatest current research interest are:

Crustacea:	Penaeid shrimps, American lobster, freshwater shrimps of the genus Macrobrachium
Mollusca:	American and Pacific oysters, hard clams, bay scallops
Teleost fishes:	Atlantic and Pacific salmon

Lesser efforts are directed toward pandalid shrimps, blue crabs, European oysters, abalone, striped bass, mullet, sea turtles, and selected seaweeds.

Mariculture research conducted by the Federal Government is concentrated in three research centers of the National Marine Fisheries Service:

1. The Northwest Fisheries Center,at Seattle, Washington, with facilities at Manchester, Washington; Auke Bay, Alaska; and Seattle, conducts research on ocean rearing of Pacific salmon
2. The Gulf Coastal Fisheries Center at Galveston, Texas conducts research on penaeid shrimp culture
3. The Middle Atlantic Coastal Fisheries Center at Sandy Hook, New Jersey, with facilities at Milford, Connecticut and Oxford, Maryland, conducts research on molluscan culture.

Additionally, the Federal Government funds a large amount of mariculture research at university and state laboratories through three programmes:

1. The National Sea Grant Program, which makes available funds to universities for specific mariculture research projects on a variety of fish, shellfish, and seaweeds
2. Grant-in-aid to states for fisheries programme activities, which makes available funds to coastal states for projects concerned with more practical aspects of mariculture
3. The Economic Development Administration has made limited funds available for mariculture development work to private industry - usually in association with state resource management groups

A number of other federal agencies, such as the Department of Agriculture and the Environmental Protection Agency, fund research which has applications to mariculture.

In addition to federal funding, many colleges and universities support mariculture research by faculty members and students. Also, many coastal state natural resource departments (now generally called Department of Environmental Conservation) support and conduct mariculture research and development projects.

A small number of industries carry out mariculture research and development as a part of their operations - usually to fill gaps in technology, or to establish culture of animals for which suitable technology does not exist. Often these industries work closely with Government and university research people.

It would be difficult to describe adequately, for purposes of this report, all of the projects which are ongoing at present under each of these programmes, although the information is available from each of the agencies involved. Because of this, only that research actually conducted by the Federal Government through the National Marine Fisheries Service of the National Sea Grant Programme is included here. Additional information can be obtained by correspondence with the U.S. representative to the Working Group.

2.171 Middle Atlantic Coastal Fisheries Center, National Marine Fisheries Service (with other research facilities at Milford, Connecticut, and Oxford, Maryland) (Molluscan Culture)

Postal address: Highlands, New Jersey, U.S.A.

1. Research facilities

1.1 Personnel
16 professionals
12 technicians and aides

1.2 Laboratories and other installations
The Milford (Conn.) facility was constructed as a molluscan experimental hatchery, with large-scale water treatment and temperature-salinity control capabilities. It includes a large outdoor tank farm.

The Oxford (Md.) facility contains laboratories for histopathology and electron microscopy. It includes a system of four quarter-acre experimental ponds, and a sub-station with tray facilities for molluscan aquaculture in a high salinity bay at Greenbackville, Va.

1.3 Plans for expansion
Enclosure of a large existing tank farm for grow-out studies and selective breeding is planned for the future

2. Research programmes

2.1 Current programmes
Molluscan mariculture research at the Middle Atlantic Coastal Fisheries Center emphasizes four areas of research:
- Molluscan (oyster) genetics and selective breeding
- Molluscan pathology, with emphasis on larval diseases
- Nutritional requirements of molluscs
- Spawning and rearing of molluscs (scallops and clams)

2.2 New work planned
In future years, economic and engineering aspects of molluscan mariculture will be added to existing programmes, to develop an integrated system for molluscan culture

2.172 Gulf Coastal Fisheries Center, National Marine Fisheries Service (Penaeid Shrimp Culture)

Postal address: Galveston, Texas

1. Research facilities

1.1 Personnel
9 professionals
9 technicians and aides

1.2 Laboratories and other installations
The Galveston Center maintains a large separate sea water facility located on a lagoon, with extensive flow-through capacity. It

has also constructed and operates a pilot-scale controlled system raceway culture facility for shrimp rearing

1.3 Plans for expansion
Additional raceways for controlled system rearing of penaeid shrimps will be constructed in the future

2. Research programmes

2.1 Current programmes
Penaeid shrimp culture research at the Gulf Coastal Fisheries Center emphasizes four areas of research:
- Methods of inducing maturation and spawning of penaeid shrimps
- Controlled system rearing of penaeids, using raceway methods
- Nutrition of penaeids
- Diseases of penaeid shrimps

2.2 New work planned
Additional efforts will be directed towards development of routine methods for maturation and spawning of penaeid shrimps, and towards a more precise technology of controlled system raceway rearing of shrimps

2.173 Northwest Fisheries Center, National Marine Fisheries Service (with other research facilities at Manchester, Washington, and Auke Bay, Alaska) (Salt-water rearing of Pacific salmon)

Postal address: Montlake Boulevard, Seattle, Washington

1. Research facilities

1.1 Personnel
15 professionals
15 technicians and aides

1.2 Laboratories and other installations
A series of floating salt-water pens is located near the Manchester facility, where rearing efforts are concentrated. "Ocean ranching" of salmon is studied at Auke Bay, Alaska. Gravel incubation of salmon eggs is conducted at Auke Bay; floating pens are located there and at Little Port Walter, Alaska.

1.3 Plans for expansion
None at present

2. Research programmes

2.1 Current programmes
- Development of diagnostic methods and vaccines for diseases of salmonids in salt water
- Evaluation of wild and hatchery stocks of salmonids for adaptability to salt water culture
- Development of methods for smolt production adaptable to salt-water culture
- Evaluation of experimental salmonid feed formulas with low-cost protein, single cell protein and carotenoid additives
- Development of polyculture methods based on salmonids, pandalid shrimps, and mussels
- Development of brood stocks for salmonids reared in sea water
- Larval rearing of pandalid shrimps

2.2 New work planned
- Pandalid shrimp culture
- Mussel culture as associated with salt-water culture of salmonids
- Rock scallop culture
- Culture of Macrobrachium in geothermally heated water

2.174 National Sea Grant-funded mariculture research projects conducted by universities or university-associated laboratories in 1975 included the following:

2.1741 California Institute of Technology - Propagation of marine algae

2.1742 Columbia University - Use of artificial upwelling in aquaculture

2.1743 Louisiana State University - Crawfish culture

2.1744 Oregon State University
- Nutrition of rainbow trout
- Animal fats in fish rations
- Aquaculture feasibility studies
- Pilot chum salmon production
- Selective breeding of oysters
- Intensified oyster culture

2.1745 South Carolina Marine Resources Center
- Macrobrachium culture
- Use of algae in crustacean culture
- Oyster culture in coastal impoundments

2.1746 State University System of Florida
- Selective breeding and hybridization of Macrobrachium
- Selective breeding and hybridization of clams and oysters
- Culture of lugworms
- Shrimp reproduction

2.1747 Texas A&M University
- Control of shrimp diseases
- Shrimp culture systems
- Shrimp reproduction

2.1748 University of Alaska
- Aquaculture methods and development
- Economics of salmon culture

2.1749 University of California
- Lobster disease control
- Effects of public regulations on aquaculture
- Lobster culture systems
- Economics of aquaculture
- Use of thermal effluents in aquaculture
- Kelp bed culture
- Red algal culture
- Salt-tolerant plants

2.17410 University of Delaware
- Controlled environment shellfish culture
- Salt-tolerant plants

2.17411 University of Georgia - Genetic studies of oysters

2.17412 University of Guam
- Biological studies of the coconut crab
- Nutrition of Siganus

2.17413 University of Hawaii, Hawaii Dept. Land and Natural Resources, and Oceanic Institute
- Macrobrachium farming
- Masspropagation of marine species
- Tropical aquaculture
- Tropical marine agronomy

2.17414 University of Maine
- Preservation of salmonid gametes
- Shellfish hatchery seed production
- Cytogenetics of marine species
- Radionuclides and aquaculture in heated effluents

2.17415 University of New Hampshire
- Salmonid culture in heated effluents
- Salmonid fishery for coastal areas
- Mussel culture
- Culture of marine algae

2.17416 University of Rhode Island
- Behavioural studies of American lobsters
- Salmonid culture in closed systems
- Macroalgae in silo culture
- Use of crab wastes in salmonid culture

2.17417 University of Washington
- Salmonid aquaculture
- Molluscan culture
- Oyster genetics and diseases
- Culture of marine algae
- Aquaculture feasibility evaluation

2.17418 University of Wisconsin
- Propagation of perch and walleye pike
- Economic analysis of aquaculture systems

2.17419 Virginia Institute of Marine Science - Shellfish culture

2.17420 Woods Hole Oceanographic Institution - Marine polyculture based on recycled wastes

2.18 U.S.S.R.

by S I Doroshov, All-Union Research Institute of Marine Fisheries and Oceanography, Moscow

(In addition to the work done by the Institutes of the U.S.S.R. Ministry of Fisheries, some minor investigations in the field of mariculture are carried out by several Institutes of the U.S.S.R. Academy of Sciences)

2.181 All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the U.S.S.R.

Postal address: 17, Verkhne-Krasnoselskaja, Moscow, 107140, U.S.S.R.

1. Research facilities

1.1 Personnel
20 scientists
4 technicians

1.2 Laboratories and other installations
Laboratory of mariculture
Laboratory of fish physiology and biochemistry
Aquarium room
Scientific station for experimental rearing of salmonids and sturgeons in cages on the Baltic Sea coast (the town of Pyarnu)
Experimental grounds in several pond fish farms

1.3 Plans for expansion
- Scientific station for rearing fish in cages in the Black Sea
- Station for selective breeding of sturgeons
- Reconstruction of aquarium room

2. Research programmes

2.1 Current programmes

- Selection of species and methods for the seas of the U.S.S.R.
- Development of biotechnic of rearing and on-growing of sea fish juveniles (mullet, brill, striped bass, cod, etc.)
- Studies of embryonal and larval development of sea fishes, environmental tolerance of eggs and larvae, physiology and biochemistry, feeding ecology, etc.)
- To improve methods for cultivation of live food (unicellular algae, crustacea, etc.)
- To improve marketing biotechnic for rearing fish in sea-cages (salmonids, sturgeons, etc.), experiments with new species (mullet, common bass, coho salmon)
- To acquire and to improve methods for molluscan culture
- Studies of biological peculiarities and development of biotechnic of Laminaria saccharina culture in the Barents Sea
- Investigations on the problem of transplantation of marine organisms, i.e., studies of the results of transplantation of Pacific salmon to the Barents and White Seas
- Experiments on artificial rearing of new fish items (striped bass, paddlefish, common bass, coho salmon, etc.), growing of breeders
- Hybridization of sturgeons; selection and genetic, practical studies
- Studies of hormonal regulation of maturation of sea fishes and elaboration of methods for production of ripe sex products (mullets)

2.2 New work planned

- Experiments on culturing of higher crustacea
- Experimentson growing and rearing of new items

2.182 Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH)

Postal address: 21/2, Beregovaya Street, Rostov-on-Don, U.S.S.R.

1. Research facilities

1.1 Personnel
30 scientists
10 technicians

1.2 Laboratories and other installations

- Laboratory of artificial reproduction of diadromous and semi-diadromous species
- Laboratory of fish culture for commercial purposes
- Laboratory of fish physiology
- Laboratory of mariculture in the city of Berdyansk
- Parasitological laboratory
- Experimental grounds in several sturgeon farms and coarse fish hatcheries
- Scientific stations for rearing sturgeons for market in fresh-water and salty estuaries and gulfs of the Azov Sea watershed

1.3 Plans for expansion
Experimental station for rearing and on-growing of sea fishes in the city of Berdyansk

2. Research programmes

2.1 Current programmes
- Oceanological and ecological characteristics of the Azov Sea watershed as the region of developing intensive and extensive aquaculture
- Improvement of biotechnic for diadromous and semi-diadromous fish culture
- Improvement of methods of commercial production of sturgeons in summer cages and ponds
- Physiological and biochemical studies of breeders raised from juveniles taken from natural environment
- Improvement of methods of live food (Artemia salina, etc.) culture
- Experimental rearing and studies of species suitable for introduction (striped bass, canal catfish, paddlefish)

2.2 New work planned
- To develop methods for molluscan culture
- To develop methods for sea fish culture (flatfishes, mullets)

2.183 Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO)

Postal address: 2, Sverdlov Street, Kerch, U.S.S.R.

1. Research facilities

1.1 Personnel
34 scientists
30 technicians

1.2 Laboratories and other installations
- Laboratory of fish mariculture
- Laboratory of invertebrate culture
- Laboratory of fish physiology
- Experimental station for sea fish culture (several tanks and troughs for breeders, hatching of eggs and early rearing of larvae, cultivation)
- 3 experimental grounds for oyster and mussel culture in the Black Sea

1.3 Plans for expansion
Reconstruction of experimental station and installation of scientific programmes

2. Research programmes

2.1 Current programmes
- To develop biotechnic of rearing and growing of sea fishes (mullet, brill, Black Sea flounder, etc.), molluscs (oysters, mussel)
- To work out methods for stimulation of sea fish maturation by hypophysal injections and obtaining of sex products of high quality
- To work out methods for mass cultivation of uni-cellular algae and plankton as live food
- To investigate influence of environmental factors and feeding on growth and survival of reared organisms
- To develop methods for artificial rearing of species suitable for introduction (striped bass, Mugil soiny, steelhead, common bass), growing of breeders

2.2 New work planned
To study productive capacity of reared items with regard to more effective application in mariculture (areas, cages, ponds, lagoons)

2.184 Polar Research Institute of Marine Fisheries and Oceanography (PINRO)

Postal address: 6, Knipovich Street, Murmansk, U.S.S.R.

1. Research facilities

1.1 Personnel
20 scientists
20 technicians

1.2 Laboratories and other installations
- Laboratory of reproduction of sea fishes
- Laboratory of commercial invertebrates

1.3 Plans for expansion
Experimental stations

2. Research programmes

2.1 Current programmes
- To work out methods for effective rearing of sea fishes from the shelf zone of the U.S.S.R. seas (cod, flounder)
- To work out methods for effective rearing of salmonids in cages with heated water
- To investigate the effectiveness of transplantation of Pacific salmon to the U.S.S.R. European North
- To work out methods for molluscan culture (mussel)
- To investigate ecological conditions for algal culture in the White Sea for technical purposes (Laminaria saccharina, Anfeltia)

2.2 New work planned
To develop investigations, industrial testing and introduction of methods elaborated

2.185 Pacific Research Institute of Marine Fisheries and Oceanography (TINRO)

Postal address: 20, Leninskaya Street, Vladivostok, U.S.S.R.

1. Research facilities

1.1 Personnel
40 scientists
12 technicians

1.2 Laboratories and other installations
- Laboratory of fish culture
- Laboratory of aquatic equipment, control and management of environment
- Laboratory of modelling culture processes
- Laboratory of molluscan culture
- Laboratory of crustacea and echinoderm culture
- Laboratory of live food culture and management of physiological processes
- Laboratory of macrophyte culture
- Experimental station for sea fish rearing
- Experimental station for molluscan and crustacea culture
- Experimental station for algal culture

1.3 Plans for expansion
Reconstruction and installation of experimental stations

2. Research programmes

2.1 Current programmes
- To work out methods for rearing and growing of sea fishes
- To investigate biology, ecology, feeding of scallop, oyster and trepang in early stages of life with the view of working out methods for mass rearing
- To work out methods for mass rearing of uni-cellular and crustacea as live food
- To investigate reproduction, distribution and growth of sea algae with regard to methods for commercial rearing

2.2 New work planned
To investigate ecology and biology of commercial crustacea with regard to methods for controlled rearing

2.186 Baltic Research Institute of Marine Fisheries (BaltNIIRKH)

Postal address: 6, Daugavgrivas, Riga, 226049 Latvian SSR, U.S.S.R.

1. Research facilities

1.1 Personnel
10 scientists
5 technicians

1.2 Laboratories and other installations
- Laboratory of reproduction of sea fish
- Physiological and biochemical laboratory
- Experimental laboratory for testing of elaborated methods

1.3 Plans for expansion
To supply experimental stations with equipment of working commercial fish farms

2. Research programmes

2.1 Current programmes
- To work out a method of hormonal stimulation of sea fish maturation (pike-perch, etc.) and growing under artificial conditions
- To work out methods for intensive rearing for market in sea-cages (trout, hybrid between beluga and sterlet - "bester", etc.)
- To find out more effective food items and feeding regimes
- To work out methods for mass culturing of zooplankton for food
- To investigate regularities in growth, variability, adaptation and effectiveness of introduction of Pacific salmons

2.2 New work planned
To investigate bioecological peculiarities of valuable sea species as objects for mariculture.

3. ANALYSIS OF WORK DONE AND PLANNED

3.1 WORK DONE BY SPECIES OF AQUATIC ORGANISMS CULTURED AT DIFFERENT INSTITUTES

1. Salmonid fish

- Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
- Resource Branch, Fisheries and Environmental Sciences Division (St. Andrews Biological Station) (Canada) (2.0213)
- Resource Branch, Fisheries and Environmental Sciences Division (Nanaimo Biological Station) (Canada) (2.014)
- Centre National de Recherches Zootechniques (France) (2.053)
- VEB Fischwirtschaft des Bezirkes Rostock (German Democratic Republic) (2.061)
- Institut für Meereskunde, Fischereibiologische Abteilung an der Universität Kiel (Institute for Oceanography, Department of Fisheries Biology at the University of Kiel) (Germany, Federal Republic of) (2.074)
- Morski Instytut Rybacki (Sea Fisheries Institute) (Poland) (2.121)
- Marine Laboratory, Aberdeen (Scotland) (2.166)
- Northwest Fisheries Center, National Marine Fisheries Service (with other research facilities at Manchester, Washington, and Auke Bay, Alaska) (USA) (2.173)
- University of New Hampshire (USA) (2.17415)
- University of Rhode Island (USA) (2.17416)
- University of Washington (USA) (2.17417)
- Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (USSR) (2.184)

2. Salmon species

- Resource Branch, Fisheries and Environmental Sciences Division (Nanaimo Biological Station) (Canada) (2.0214)
- Finnish Game and Fisheries Research Institute (Finland) (2.041)
- Unité régionale pour le Développement de l'Aquaculture dans la région Nord (Urda/Nord) (France) (2.05212)
- Centre National de Recherches Zootechniques (France) (2.0533)
- VEB Fischwirtschaft des Bezirkes Rostock (German Democratic Republic) (2.061)
- Veidimálstofnunin (Institute of Freshwater Fisheries) (Iceland) (2.081)
- Fiskifélag Islands (Fisheries Association of Iceland) (2.083)
- Electricity Supply Board (Semi-State) (Ireland) (2.093)
- Bord Iascaigh Mhara (Semi-State) (Ireland) (2.094)
- Salmon Research Trust of Ireland (Government and Private Industry) (Ireland) (2.095)
- Fiskeridirektoratet (Directorate of Fisheries) (Norway) (2.111)
- Forsøksstasjon for Fisk (Fish Breeding Experimental Station) (Norway) (2.1121)

- Pracownia Rzeczna Instytutu Rybactwa śródladowego w Gdansku Oliwie (River Laboratory of Inland Fisheries Institute) (Poland) (2.123)
- National Board of Fisheries (Sweden) (2.151)
- Laxforskningsinstitutet, Laboratoriet i Älvkarleby (Salmon Research Laboratory) (Sweden) (2.152)
- Marine Laboratory, Aberdeen (Scotland) (2.166)
- Scottish Marine Biological Association (Scotland) (2.167) (pl.)
- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)

3. Rainbow trout and other trout species

- Fisheries Technology Branch, Industrial Development Division (Canada) (2.0215)
- Finnish Game and Fisheries Research Institute (Finland) (2.041)
- Institut Scientifique et Technique des Pêches maritimes, (ISTPM), Ministère des Transport (France) (2.051)
- Laboratoires associés au CNEXO pour l'Aquaculture Marine (France) (2.053)
- Institut für Ernährungsphysiologie an der Tierärtzlichen Fakultät der Universität München (Institute for Nutritional Physiology in the Veterinarian Faculty of the University at Munich) (Germany, Federal Republic of) (2.072)
- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery (Germany, Federal Republic of) (2.073)
- Veidimálstofnunin(Institute of Freshwater Fisheries) (Iceland) (2.081)
- Fiskeridirektoratet (Directorate of Fisheries) (Norway)(2.111)
- Forsøksstasjon for laks (Salmon Breeding Experimental Station) (Norway) (2.1122)
- Pracownia Rzeczna Instytutu Rybactwa śródladowego w Gdansku Oliwie (River Laboratory of Inland Fisheries Institute) (Poland) (2.123)
- Instytut Eksploatacji i Ochrony Biologicznych Zasobów Morza Akademii Rolniczej, Zaklad Rybackiego Zagospodarowania Wod Przybrzeznych (Institute of Exploitation and of Biological Marine Resources of Agricultural University)(Poland)(2.124)
- National Board of Fisheries (Sweden) (2.151)
- Marine Laboratory, Aberdeen (Scotland) (2.166)
- Scottish Marine Biological Association (Scotland) (2.167)
- Baltic Research Institute of Marine Fisheries (BaltNIIRKH)(USSR) (2.186)

4. Sea char species

- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)

- Veidamálstofnun (Institute of Freshwater Fisheries) (Iceland) (2.081)
- Fiskeridirektoratet (Directorate of Fisheries) (Norway)(2.111)
- Forsøksstasjon for laks (Salmon Breeding Experimental Station) (Norway) (2.1122)

5. Eels

- Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
- Fisheries Technology Branch, Industrial Development Division (Canada) (2.0215)
- Danish Institute for Fishery and Marine Research (Denmark)(2.031)
- Institut für Ernährungsphysiologie an der Tierärtzlichen Fakultät der Universität München (Institute for Nutritional Physiology in the Veterinarian Faculty of the University at Munich) (Germany, Federal Republic of) (2.072)
- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- University of Tromsø, Institute of Biology and Geology (Norway) (2.114)
- Veterinærinstituttet (National Veterinary Institute)(Norway) (2.115)
- Instituto Nacional de Investigação das Pescas, Secção de Aquacultura, Secretaria de Estado das Pescas (Portugal)(2.131)
- National Board of Fisheries (Sweden) (2.151)

6. Sole

- Equipe de recherche appliquée de l'Unité d'Aquaculture (France) (2.05211)
- Centre National de Recherches Zootechniques (France)(2.0533)
- Laboratoire de Cadiz (Spain)(2.1422)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Isle of Man (England and Wales) (2.161)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland)(2.1610)

7. Turbot

- Equipe de recherche appliquée de l'Unité d'Aquaculture (France) (2.05211)
- Centre National de Recherches Zootechniques (France)(2.0533)
- Instituto Nacional de Investigação das Pescas, Secção de Aquacultura, Secretaria de Estado das Pescas (Portugal)(2.131)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Isle of Man (England and Wales)(2.161)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)

- Azov-Black Sea Research Institute, Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR)(2.183)

8. Halibut

- Fiskeridirektoratet (Directorate of Fisheries) (Norway)(2.111)

9. Flatfish

- Morski Instytut Rybacki (Sea Fisheries Institute) (Poland)(2.121)
- Marine Laboratory, Aberdeen (Scotland)(2.166)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland)(2.1610)
- Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH)(USSR) (2.182)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)
- Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (USSR) (2.184)

10. Dicentrachus sp.

- Equipe de recherche appliquée de l'Unité d'Aquaculture (France) (2.05211)
- Base Océanologique pour la Méditerranée - Unité régionale pour le Développement de l'Aquaculture pour la région Sud (Urda/Sud) (France) (2.0522)
- Centre National de Recherches Zootechniques (France) (2.0533)
- Laboratorio Oceanográfico (La Coruña)(Spain) (2.1412) (pl.)
- Laboratorio Oceanográfico del Mar Menor (Spain) (2.1414)
- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR)(2.181)
- Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH) (USSR)(2.182)
- Azov-Black Sea Research Institute for Marine Fisheries and Oceanography (AzCherNIRO) (USSR)(2.183)

11. Sparus sp.

- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transport (France)(2.051)
- Base Océanologique pour la Méditerranée - Unité régionale pour le Développement de l'Aquaculture pour la région Sud (Urda/Sud) (France)(2.0522)
- Station de Biologie marine et lagunaire de Sète (France)(2.0533)
- Laboratorio Oceanográfico del Mar Menor (Spain)(2.1414)
- Laboratorio de Cadiz (Spain) (2.1422)

12. Siganus sp.

- Biologische Anstalt Helgoland (Biological Station of Heligoland) (Germany, Federal Republic of) (2.071)

- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- University of Guam (USA) (2.17412)

13. Carangidae

- Centre Océanologique pour le Pacifique (COP) (France) (2.0523)

14. Mugil sp.

- Biologische Anstalt Helgoland (Biological Station of Heligoland) (Germany, Federal Republic of) (2.071)
- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- Laboratorio Oceanográfico del Mar Menor (Spain) (2.1414)
- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
- Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH) (USSR) (2.182)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)

15. Common bass

- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)

16. Sturgeon

- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
- Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH) (USSR) (2.182)
- Baltic Research Institute of Marine Fisheries (BaltNIIRKH) (USSR) (2.186)

17. Paddle fish

- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
- Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH) (USSR) (2.182)

18. Cod

- Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (USSR) (2.184)

19. Lobster

- Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)

- Resource Branch, Fisheries and Environmental Sciences Division, (St. Andrews Biological Station) (Canada) (2.0213)
- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transport (France) (2.051)
- Department of Agriculture and Fisheries, Fisheries Division (Ireland) (2.091)
- University of California (USA) (2.1749)
- University of Rhode Island (USA) (2.17416)

20. Nephrops norvegicus

- Institutt for Husdyravl (Department of Animal Genetics and Breeding) (Norway) (2.112)

21. Penaeus sp.

- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports (France) (2.051)
- Equipe de recherche appliquée de l'Unité d'Aquaculture (France) (2.05211)
- Base Océanologique pour la Méditerranée - Unité régionale pour le Développement de l'Aquaculture pour la région sud (Urda/sud) (France) (2.0522)
- Centre Océanologique pour le Pacifique (COP) (France) (2.0523)
- Instituto Nacional de Investigação das Pescas, Seccão de Aquacultura, Secretaria de Estado das Pescas (Portugal)(2.131)
- Laboratorio Oceanográfico del Mar Menor (Spain) (2.1414)
- Laboratorio de Cadiz (Spain) (2.1422)
- Gulf Coastal Fisheries Center, National Marine Fisheries Service (USA) (2.172)
- South Carolina Marine Resources Center (Macrobrachium culture) (USA) (2.1745)
- State University System of Florida (USA) (2.1746)

22. Pandalus sp.

- Northwest Fisheries Center, National Marine Fisheries Service (with other research facilities at Manchester, Washington, and Auke Bay, Alaska) (USA) (2.173)

23. Palaemon serratus

- Equipe de recherche appliquée de l'Unité d'Aquaculture (France) (2.05211)
- Instituto Español de Oceanografía (Spain) (2.141)
- Laboratorio Oceanográfico (Santander) (Spain) (2.1411)
- Laboratorio Oceanográfico del Mar Menor (Spain) (2.1414)

24. Macrobrachium

- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Essex (England and Wales) (2.163)
- South Carolina Marine Resources Center (USA) (2.1745)
- State University System of Florida (USA) (2.1746)
- University of Hawaii, Hawaii Dept. Land and Natural Resources, and Oceanic Institute (USA) (2.17413)

25. Artemia

- Institut voor Zeewetenschappelijk Onderzoek (IZWO) (Institute for Marine Scientific Research) (Belgium) (2.011)
- Laboratorium voor Biologisch Onderzoek van Milieuverontreiniging, Rijksuniversiteit Gent (Laboratory for Biological Research in Environmental Pollution, State University of Ghent) (Belgium) (2.012)
- Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH) (USSR) (2.182)

26. Oyster

- Instituut voor Zeewetenschappelijk Onderzoek (IZWO) (Institute for Marine Scientific Research) (Belgium) (2.011)
- Resource Branch, Invertebrates and Plants Division (Canada) (2.0211)
- Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
- Fisheries Technology Branch, Industrial Development Division (Canada) (2.0215)
- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transport (France) (2.051)
- Equipe de recherche appliquée de l'Unité d'Aquaculture (France) (2.05211)
- Centre Océanologique pour le Pacifique (COP) (France) (2.0523)
- Institut für Küsten- und Binnenfischerei des Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- Department of Agriculture and Fisheries, Fisheries Division (Ireland) (2.091)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092)
- Atlantic Fisheries Ltd. (Private) (Ireland) (2.096)
- Netherlands Institute for Fishery Investigations (Min.Agr.Fish) (Netherlands) (2.101)
- Selskapet for de Norske Fiskeriers Fremme (Society for Promotion of the Norwegian Fisheries) (Norway) (2.117)
- Instituto Nacional de Investigação das Pescas, Seccão de Aquacultura, Secretaria de Estado das Pescas (Portugal)(2.131)
- Laboratorio Oceanográfico (Santander) (Spain) (2.1411)
- Laboratorio Oceanográfico (La Coruña) (Spain) (2.1412)
- Institute of Marine Biochemistry, Natural Environment Research Council (Scotland) (2.168)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- Middle Atlantic Coastal Fisheries Center, National Marine Fisheries Service (with other research facilities at Milford, Connecticut and Oxford, Maryland) (USA) (2.171)
- Oregon State University (USA) (2.1744)

- South Carolina Marine Resources Center (Macrobrachium culture) (USA) (2.1745)
- State University System of Florida (USA) (2.1746)
- University of Georgia (USA) (2.17411)
- University of Washington (USA) (2.17417)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)
- Pacific Research Institute of Marine Fisheries and Oceanography (TINRO) (USSR) (2.185)

27. Scallops sp.

- Fisheries Technology Branch, Industrial Development Division (Canada) (2.0215)
- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transport (France) (2.051)
- Equipe de recherche appliquée de l'Unité d'Aquaculture (France) (2.05211)
- Department of Agriculture and Fisheries, Fisheries Division (Ireland) (2.091)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092)
- Laboratorio Oceanográfico (Santander) (Spain) (2.1411)
- Laboratorio Oceanográfico (La Coruña) (Spain) (2.1412)
- Laboratorio Oceanográfico de Canarias (Spain) (2.1413)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Isle of Man (England and Wales) (2.161)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Essex (England and Wales) (2.163)
- Pacific Research Institute of Marine Fisheries and Oceanography (TINRO) (USSR) (2.185)

28. Soft shelled clam

- Resource Branch, Invertebrates and Plants Division (Canada) (2.0211)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092)
- Instituto Nacional de Investigação das Pescas, Seccão de Aquacultura, Secretariat de Estado das Pescas (Portugal) (2.131)
- Middle Atlantic Coastal Fisheries Center, National Marine Fisheries Service (with other research facilities at Milford, Connecticut, and Oxford, Maryland) (USA) (2.171)
- State University System of Florida (USA) (2.1746)

29. Haliotis sp.

- Equipe de Recherche Appliquée de l'Unité d'Aquaculture (France) (2.05211)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092)

- Laboratorio Oceanográfico de Canarias (Spain) (2.1413)

30. Blue mussel

- Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
- Fisheries Technology Branch, Industrial Development Division (Canada) (2.0215)
- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports (France) (2.051)
- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- Institut für Meereskunde, Fischereibiologische Abteilung an der Universität Kiel (Institute for Oceanography, Department of Fisheries Biology at the University of Kiel) (Germany, Federal Republic of) (2.074)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092)
- Netherlands Institute for Fishery Investigations (Min. Agr.Fish) (Netherlands) (2.101)
- Department of Geology and Oceanography, Chalmers University of Technology (Sweden) (2.153)
- Institute of Marine Biochemistry, Natural Environment Research Council (Scotland) (2.168)
- University of New Hampshire (USA) (2.17415)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)
- Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (USSR) (2.184)

31. Bivalves

- Laboratorio Oceanográfico de Canarias (Spain) (2.1413)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Essex (England and Wales) (2.163)
- Unit of Aquatic Pathobiology, University of Stirling (Scotland) (2.169)

32. Lugworms

- State University System of Florida (USA) (2.1746)

33. Trepang

- Pacific Research Institute of Marine Fisheries and Oceanography (TINRO) (USSR) (2.185)

34. Unicellular algae

- Instituut voor Zeewetenschappelijk Onderzoek (IZWO) (Institute for Marine Scientific Research) (Belgium) (2.011)
- Laboratorium voor Biologisch Onderzoek van Milieuverontreiniging, Rijksuniversiteit Gent (Laboratory for Biological Research in Environmental Pollution, State Univ. of Ghent)(Belgium)(2.012)

- Equipe de Recherche appliquée de l'Unité d'Aquaculture (France) (2.05211)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092)
- Atlantic Fisheries Ltd. (Private) (Ireland) (2.096)
- Instituto Nacional de Investigação das Pescas, Seccão de Aquacultura, Secretaria de Estado das Pescas (Portugal) (2.131)
- Laboratorio Oceanográfico (La Coruña) (Spain) (2.1412)
- Laboratorio de Castellón (Spain) (2.1421)
- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)
- Pacific Research Institute of Marine Fisheries and Oceanography (TINRO) (USSR) (2.185)

35. Marine algae

- Resource Branch, Invertebrates and Plants Division (Canada) (2.0211)
- Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
- Fisheries Technology Branch, Industrial Development Division (Canada) (2.0215)
- Atlantic Regional Laboratory (Canada) (2.0221)
- Laboratorio Oceanográfico (Santander) (Spain) (2.1411)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- California Institute of Technology (USA) (2.1741)
- University of California (USA) (2.1749)
- University of Delaware (USA) (2.17410)
- University of New Hampshire (USA) (2.17415)
- University of Rhode Island (USA) (2.17416)
- University of Washington (USA) (2.17417)
- Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (USSR) (2.184)

3.2 WORK DONE BY MAJOR RESEARCH TOPICS

3.21 Type of Culture

1. Floating pen

- Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
- Resource Branch, Fisheries and Environmental Sciences Division (St. Andrews Biological Station) (Canada) (2.0213)
- Resource Branch, Fisheries and Environmental Sciences Division (Nanaimo Biological Station) (Canada) (2.0214)
- Fisheries Technology Branch, Industrial Development Division (Canada) (2.0215)

- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transport (France) (2.051)
- Unité Régionale pour le Développement de l'Aquaculture dans la Région Nord (Urda/Nord) (France) (2.05212)
- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- Institut für Meereskunde, Fischereibiologische Abteilung an der Universität Kiel (Institute for Oceanography, Department of Fisheries Biology at the University of Kiel) (Germany, Federal Republic of) (2.074)
- Veidimálstofnunin (Institute of Freshwater Fisheries) (Iceland) (2.081)
- Fiskifélag Islands (Fisheries Association of Iceland) (Iceland) (2.083)
- Electricity Supply Board (Semi-State) (Ireland) (2.093)
- Fiskeridirektoratets Havforskningsinstitutt (Institute of Marine Research) (Norway) (2.111)
- University of Tromsø, Institute of Biology and Geology (Norway) (2.114)
- Instytut Eksploatacji i Ochrony Biologicznych Zasobów Morza Akademii Rolniczej, Zaklad Rybackiego Zagospodarowania wod Przybrzeznych (Institute of Exploitation and of Biological Marine Resources of Agricultural University) (Poland) (2.124)
- Scottish Marine Biological Association (Scotland) (2.169)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH) (USSR) (2.182)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)
- Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (USSR) (2.184)
- Baltic Research Institute of Marine Fisheries (BaltNIIRKH) (USSR) (2.186)

2. Ponds

- Institut für Meereskunde, Fischereibiologische Abteilung an der Universität Kiel (Institute for Oceanography, Department of Fisheries Biology at the University of Kiel) (Germany, Federal Republic of) (2.074)
- Salmon Research Trust of Ireland (Government and Private Industry) (Ireland) (2.095)
- Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH) (USSR) (2.182)

3. Tanks

- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports (France) (2.051)

- VEB Fischwirtschaft des Bezirkes Rostock (German Democratic Republic) (2.061)
- Department of Agriculture and Fisheries, Fisheries Division (Ireland) (2.091)
- Fiskeridirektoratets Havforskningsinstitutt (Institute of Marine Research) (Norway) (2.1111)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)

4. Utilisation of thermal effluents

- Instituut voor Zeewetenschappelijk Onderzoek (IZWO) (Institute for Marine Scientific Research) (Belgium) (2.011)
- Resource Branch, Fisheries and Environmental Sciences Division (St. Andrews Biological Station) (Canada) (2.0213)
- Danish Institute for Fishery and Marine Research (Denmark) (2.031)
- Finnish Game and Fisheries Research Institute (Finland)(pl.) (2.041)
- Institut für Küsten- und Binnenfischerei des Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- National Board of Fisheries (Sweden) (2.151)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- University of California (USA) (2.1749)
- University of Maine (USA) (2.17414)
- University of New Hampshire (USA) (2.17415)
- Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (USSR) (2.184)

5. Raft culture

- Fisheries Technology Branch, Industrial Development Division (Canada) (2.0215)
- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports (France) (2.051)
- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Essex (England and Wales) (2.163)

6. Container system, trays

- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastaland Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- Fisheries Experiment Station, Ministry of Agriculture, Fisheries and Food, Conwy (England and Wales) (2.162)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food Essex (England and Wales) (2.163)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)

7. Bottom culture of bivalves

- Netherlands Institute for Fishery Investigations (Min.Agr. Fish) (Netherlands) (2.101)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Essex (England and Wales) (2.163)

8. Closed water system

- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- Forsøksstasjon for Fisk (Fish Breeding Experimental Station) (Norway) (2.1121)
- Kristineberg Marine Biology Station (Sweden) (2.154)
- Fisheries Experiment Station, Ministry of Agriculture, Fisheries and Food, Conwy (England and Wales) (2.162)
- Institute of Marine Biochemistry, Natural Environment Research Council (Scotland) (2.168)
- Northwest Fisheries Center, National Marine Fisheries Service (with other research facilities at Manchester, Washington, and Auke Bay, Alaska) (USA) (2.173)

9. Silo culture

- University of Rhode Island (USA) (2.17417)

10. Raceways

- University of Tromsø, Institute of Biology and Geology (Norway) (2.114)
- Gulf Coastal Fisheries Center, National Marine Fisheries Service (USA) (2.172)

11. Culture of algae

- Instituut voor Zeewetenschappelijk Onderzoek (IZWO) (Institute for Marine Scientific Research) (Belgium) (2.011)
- Resource Branch, Invertebrates and Plants Division (Canada) (2.0211)
- Fisheries Technology Branch, Industrial Development Division (Canada) (2.0215)

- Atlantic Regional Laboratory (Canada) (2.0221)
- Equipe de Recherche Appliquée de l'Unité d'Aquaculture (France) (2.0512)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092)
- Atlantic Fisheries Ltd. (Private) (Ireland) (2.096)
- Instituto Nacional de Investigação das Pescas, Seccão de Aquacultura, Secretaria de Estado das Pescas (Portugal) (2.131)
- Laboratorio Oceanográfico (Santander) (Spain) (2.1411)
- Laboratorio Oceanográfico (La Coruña) (Spain) (2.1412)
- Laboratorio de Castellón (Spain) (2.1421)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- California Institute of Technology (USA) (2.1741)
- University of California (USA) (2.1749)
- University of Delaware (USA) (2.17410)
- University of Rhode Island (USA) (2.17416)

12. Live food specimen

- Instituut voor Zeewetenschappelijk Onderzoek (IZWO) (Institute for Marine Scientific Research) (Belgium) (2.011)
- Pacific Research Institute of Marine Fisheries and Oceanography (TINRO) (USSR) (2.185)
- Baltic Research Institute of Marine Fisheries (BaltNIIRKH) (USSR) (2.186)

13. Polyculture

- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports (France) (2.051)
- Fiskeridirektoratet (Directorate of Fisheries) (Norway) (2.111)
- Northwest Fisheries Center, National Marine Fisheries Service (USA) (2.173)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- Woods Hole Oceanographic Institution (USA) (2.17420)

14. Sea ranching

- Veidimálstofnunin (Institute of Freshwater Fisheries) (Iceland) (2.081)
- Pracownia Rzeczna Instytutu Rybactwa sródladowego w Gdansku Oliwie (River Laboratory of Inland Fisheries Institute) (Poland) (2.123)
- Salmon Research Institute, Laboratory in Älvkarleby (Sweden)(2.152)
- Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (USSR) (2.184)
- Baltic Research Institute of Marine Fisheries (BaltNIIRKH) (USSR) (2.186)

15. Economy of aquaculture

- University of Tromsø, Institute of Biology and Geology (Norway) (2.114)
- University of Alaska (USA) (2.1748)
- University of California (USA) (2.1749)
- University of Hawaii, Hawaii Dept. Land and Natural Resources, and Oceanic Institute (USA) (2.17413)
- University of Wisconsin (USA) (2.17418)

3.22 Breeding and Rearing

1. Physiology of algae
   - Atlantic Regional Laboratory (Canada) (2.0221)
2. Physiology of molting
   - Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
3. Physiology of reproduction
   - Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
   - Danish Institute for Fishery and Marine Research (Denmark) (2.031)
   - All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO) Ministry of Fisheries of the USSR (USSR) (2.181)
   - Azov Research Institute of Marine Fisheries and Oceanography (AzNIIRKH) (USSR) (2.182)
4. Physiology of fry
   - Biologische Anstalt Helgoland (Biological Station of Heligoland) (Germany, Federal Republic of) (2.071)
   - Fisheries Experiment Station, Ministry of Agriculture, Fisheries and Food, Conwy (England and Wales) (2.162)
   - All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
5. Adaptation of salmonids in sea water
   - Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports (France) (2.051)
   - VEB Fischwirtschaft des Bezirkes Rostock (German Democratic Republic) (2.061)
   - Bord Iascaigh Mhara (Semi-State) (Ireland) (2.094)
6. Physiology, hormonal status of salmonids
   - Marine Laboratory, Aberdeen (Scotland) (2.166)
7. Reproduction and breeding
   - Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports (France) (2.071)
   - Base Océanologique pour la Méditerranée - Unité régionale pour le Développement de l'Aquaculture pour la région sud (Urda/sud) (France) (2.0522)

- Centre Océanologique pour le Pacifique (COP) (France) (2.0523)
- Station de Biologie Marine et Lagunaire de Sète (France) (2.0532)
- Fisheries Experiment Station, Ministry of Agriculture, Fisheries and Food, Conwy (England and Wales) (2.162)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- State University System of Florida (USA) (2.1746)
- Texas A&M University (USA) (2.1747)
- University of Hawaii, Hawaii Dept. Land and Natural Resources, and Oceanic Institute (USA) (2.17414)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)
- Pacific Research Institute of Marine Fisheries and Oceanography (TINRO) (USSR) (2.185)

8. Induced spawning

- Gulf Coastal Fisheries Center, National Marine Fisheries Service (USA) (2.172)
- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
- Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)
- Baltic Research Institute of Marine Fisheries (BaltNIIRKH) (USSR) (2.186)

9. Genetics

- Atlantic Regional Laboratory (Canada) (2.0221)
- Finnish Game and Fisheries Research Institute (Finland)(2.041)
- Forsøksstasjon for Laks (Salmon Breeding Experimental Station) (Norway) (2.1122)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Suffolk (England and Wales) (2.164)
- Middle Atlantic Coastal Fisheries Center, National Marine Fisheries Service (with other research facilities at Milford, Connecticut, and Oxford, Maryland) (USA) (2.171)
- University of Georgia (USA) (2.17411)
- University of Washington (USA) (2.17417)
- All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
- Baltic Research Institute of Marine Fisheries (BaltNIIRKH) (USSR) (2.186)

10. Selective breeding

- Fiskeridirektoratet (Directorate of Fisheries) (Norway)(2.111)
- Selskapet for de Norske Fiskeriers Fremme (Society for Promotion of the Norwegian Fisheries) (Norway) (2.117)
- Pracownia Rzeczna Instytutu Rybactwa śródladowego w Gdansku Oliwie (River Laboratory of Inland Fisheries Institute (Poland) (2.123)

- Salmon Research Institute, Laboratory in Älvkarleby (Sweden)(2.152)
- National Board of Fisheries (Sweden) (2.151)
- Middle Atlantic Coastal Fisheries Center, National Marine Fisheries Service (with other research facilities at Milford, Connecticut, and Oxford, Maryland) (USA) (2.171)
- Oregon State University (USA) (2.1744)
- State University System of Florida (USA) (2.1746)
- University of Maine (USA) (2.17414)

11. Hybridization
    - Centre National de Recherches Zootechniques (France)(2.0533)
    - State University System of Florida (USA) (2.1746)

12. Sexual maturation
    - Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Suffolk (England and Wales) (2.164)

13. Castration and sex reversal
    - Marine Laboratory, Aberdeen (Scotland) (2.166)

14. Rearing techniques
    - Resource Branch, Fisheries and Environmental Sciences Division (Nanaimo Biological Station) (Canada) (2.0214)
    - Atlantic Regional Laboratory (Canada) (2.0221)
    - Finnish Game and Fisheries Research Institute (Finland) (2.041)
    - Biologische Anstalt Helgoland (Biological Station of Heligoland) (Germany, Federal Republic of) (2.2071)
    - Hafrannsóknastofnunin (Marine Research Institute) (Iceland)(2.082)
    - Atlantic Fisheries Ltd. (Private) (Ireland) (2.096)
    - National Board of Fisheries (Sweden) (2.151)
    - Salmon Research Institute, Laboratory in Älvkarleby (Sweden) (2.152)
    - White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
    - Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Suffolk (England and Wales) (2.164)
    - All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)

3.23 Feeds and Feeding

1. Development of optimal feeds
    - Biologische Anstalt Helgoland (Biological Station of Heligoland) (Germany, Federal Republic of) (2.071)

- Institut für Ernährungsphysiologie an der Tierärtzlichen Fakultät der Universität München (Institute for Nutritional Physiology in the Veterinarian Faculty of the University at Munich) (Germany, Federal Republic of) (2.072)
- Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (pl.) (2.092)
- Salmon Research Trust of Ireland (Government and Private Industry) (Ireland) (2.095)
- Fiskeridirektoratet (Directorate of Fisheries) (Norway)(2.111)
- National Board of Fisheries (Sweden) (2.151)
- Marine Laboratory, Aberdeen (Scotland) (2.166)
- Scottish Marine Biological Association (Scotland) (2.167)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- Northwest Fisheries Center, National Marine Fisheries Service (with other research facilities at Manchester, Washington, and Auke Bay, Alaska) (USA) (2.173)

2. Nutritional requirements

- Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
- Centre Océanologique de Bretagne (France) (2.0521)
- Institut für Ernährungsphysiologie an der Tierärtzlichen Fakultät der Universität München (Institute for Nutritional Physiology in the Veterinarian Faculty of the University of Munich) (Germany, Federal Republic of) (2.072)
- Institut für Meereskunde, Fischereibiologische Abteilung an der Universität Kiel (Institute for Oceanography, Dept. of Fisheries Biology at the University of Kiel) (Germany, Federal Republic of) (2.074)
- Electricity Supply Board (Semi-State) (Ireland) (2.093)
- Forsøksstasjon for Laks (Salmon Breeding Experimental Station) (Norway) (2.1122)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Isle of Man (England and Wales) (2.161)
- White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)
- Institute of Marine Biochemistry, Natural Environment Research Council (Scotland) (2.168)
- Middle Atlantic Coastal Fisheries Center, National Marine Fisheries Service (with other research facilities at Milford, Connecticut, and Oxford, Maryland) (USA) (2.171)
- Gulf Coastal Fisheries Center, National Marine Fisheries Service (USA) (2.172)
- Oregon State University (USA) (2.1744)

3. Larvae nutrition
   - Station de Biologie Marine et Lagunaire de Sète (France)(2.0532)
   - White Fish Authority, Marine Cultivation Units (Fish and Shellfish) (Scotland) (2.1610)

4. Growth energy-metabolism
   - Fiskeridirektoratet (Directorate of Fisheries) (Norway)(2.111)

5. Feeding behaviour
   - Fiskeridirektoratet (Directorate of Fisheries) (Norway)(2.111)
   - Laboratorio Oceanográfico (Santander) (Spain) (2.1411)
   - Institute of Marine Biochemistry, Natural Environment Research Council (Scotland) (2.168)
   - All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Ministry of Fisheries of the USSR (USSR) (2.181)
   - Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzCherNIRO) (USSR) (2.183)
   - Pacific Research Institute of Marine Fisheries and Oceanography (TINRO) (USSR) (2.185)

6. Recycling of biodegradable wastes
   - Instituut voor Zeewetenschappelijk Onderzoek (IZWO) (Institute for Marine Scientific Research) (Belgium) (2.011)
   - Laboratorium voor Biologisch Onderzoek van Milieuverontreiniging, Rijksuniversiteit Gent (Laboratory for Biological Research in Environmental Pollution, State University of Ghent) (Belgium) (2.012)
   - Woods Hole Oceanographic Institution (USA) (2.17420)

7. Accumulation of pollutants and their effects
   - Laboratoire de Pathologie des Animaux Aquatiques, Ministère de l'Agriculture (France) (2.0531)
   - Institut für Ernährungsphysiologie an der Tierärtzlichen Fakultät der Universität München (Institute for Nutritional Physiology in the Veterinarian Faculty of the University of Munich) (Germany, Federal Republic of) (2.072)
   - Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei (Institute for Coastal and Inland Water Fishery at the Federal Research Institute for Fishery) (Germany, Federal Republic of) (2.073)
   - Salmon Research Institute, Laboratory in Älvkarleby (Sweden) (2.152)
   - Scottish Marine Biological Association (Scotland) (2.167)

8. Physiology, mineral regulation, haemoglobin polymorphisms of salmon
   - Salmon Research Institute, Laboratory in Älvkarleby (Sweden) (2.152)

3.24 Diseases and their Control

- Resource Branch, Fisheries and Environmental Sciences Division (Halifax Laboratory) (Canada) (2.0212)
- Resource Branch, Fisheries and Environmental Sciences Division (Nanaimo Biological Station) (Canada) (2.0214)
- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports (France) (2.051)
- Laboratoire de Pathologie des Animaux Aquatiques, Ministère de l'Agriculture (France) (2.0531)
- Biologische Anstalt Helgoland (Biological Station of Heligoland) (Germany, Federal Republic of) (2.071)
- Department of Agriculture and Fisheries, Fisheries Division (Ireland) (2.091) (pl.)
- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092) (pl.)
- Netherlands Institute for Fishery Investigations (Min.Agr.Fish) (Netherlands) (2.101)
- Fiskeridirektoratet (Directorate of Fisheries) (Norway)(2.111)
- Veterinærinstituttet (National Veterinary Institute)(Norway) (2.115)
- University of Tromsø, Institute of Biology and Geology (Norway) (2.114)
- National Board of Fisheries (Sweden) (2.151)
- Salmon Research Institute, Laboratory in Älvkarleby (Sweden) (2.152)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Essex (England and Wales) (2.163)
- Fish Diseases Laboratory, Ministry of Agriculture, Fisheries and Food (England and Wales) (2.165)
- Marine Laboratory, Aberdeen (Scotland) (2.166)
- Institute of Marine Biochemistry, Natural Environment Research Council (Scotland) (2.168)
- Unit of Aquatic Pathobiology, University of Stirling (Scotland) (2.169)
- Middle Atlantic Coastal Fisheries Center, National Marine Fisheries Service (with other research facilities at Milford, Connecticut, and Oxford, Maryland) (USA) (2.171)
- Northwest Fisheries Center, National Marine Fisheries Service (with other research facilities at Manchester, Washington, and Auke Bay, Alaska) (USA) (2.173)
- Texas A&M University (USA) (2.1747)
- University of Washington (USA) (2.17417)

3.25 Parasites and their Control

- Resource Branch, Fisheries and Environmental Sciences Division (Nanaimo Biological Station) (Canada) (2.0214)
- Institut Scientifique et Technique des Pêches Maritimes (ISTPM), Ministère des Transports (France) (2.051)
- Biologische Anstalt Helgoland (Biological Station of Heligoland) (Germany, Federal Republic of) (2.071)

- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092) (pl.)
- Marine Laboratory, Aberdeen (Scotland)(2.166)

3.26 Predator Control and Ecology of Aquaculture

- Shellfish Research Laboratory (in association with University College Galway) (Ireland) (2.092)
- Netherlands Institute for Fishery Investigations (Min.Agr.Fish) (Netherlands) (2.101)
- Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Essex (England and Wales) (2.163)

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Indication of spine colours

Liaison Committee Reports	Red
Reports of Advisory Committee on Marine Pollution	Yellow
Fish Assessment Reports	Grey
Pollution Studies	Green
Others	Black

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