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FISHERIES IMPROVEMENT COMMITTEE

by

P. Korringa

1975

Belgium

(P.Hovart)

The studies of the effects of dumping industrial waste along the Belgian coast on the fish and shrimp stocks and invertebrates were continued. The monitoring programme was carried out in two dumping areas by means of research vessel catches on a monthly basis.

The two monitoring programmes on heavy metals in fish and shrimps were continued. In addition to this a preliminary study was undertaken on 10 species along the Belgian coast. Finally, sampling was carried out for the purpose of the ICES Pollution Baseline and Monitoring Studies.

Two toxicity tests were carried out in accordance with the Oslo Convention.

Canada

(E.G. Bligh)

Salmon Culture

The inheritability of various traits in salmon is being studied (16 genotypes) (4 separate stocks) after rearing to smolt stage. Sea-ranching techniques, age and size at sexual maturity (on return) is being investigated. Special trait stock for restocking the St. Croix River run is being developed.

A fish culture technician training program has been developed in conjunction with the New Brunswick Community College system.

In the winter of 74/75 both brook and rainbow trout, held and fed in cages beneath the ice, grew 50% (300 to 450 gm) with little mortality. These same fish reached 2-3 kg by the fall of 1975.

Field tests indicated a moist pellet composed mainly of fish products and fish waste, stable for six months (frozen), showed considerable increased growth compared to commercial dry pellets.

Atlantic salmon smolts increased in average weight from 107 to 240 g from May 1 to July 28 in a cage-rearing study in salt water.

Two diseases, previously unidentified in the Maritimes Provinces, were responsible for losses of Atlantic salmon; about 500 adults from furunculosis (*Aeromonas salmonicida*) and a hatchery fingerling mortality from infectious pancreatic necrosis virus.

A survey of adult Atlantic salmon in three rivers indicated that some individuals have significant levels of agglutinating antibodies to specific pathogens endemic in their river or origin.

Testing of two experimental vaccines and an iodide supplemented diet was undertaken at the Margaree Hatchery, Nova Scotia, to attempt control of Coryne bacterial kidney disease. The effect of these treatments in Atlantic salmon is being studied with respect to disease incidence, specific antibody production and fish condition.

Acclimatization of salmon parr to sublethal copper and zinc concentrations is accompanied by increased food ingestion without concomitant weight gain.

The effects of certain nutrients and age, size and nutritional status on marine survival of Atlantic salmon is being studied and the nutritional protein, amino acid and mineral requirements determined.

Efforts are concentrated upon identification and characterization of a Pasteurella-like infection responsible for a die-off at Kejimkujik, Nova Scotia in 1974.

The extracellular protease from *Aeromonas salmonicida* has been purified and partially characterized. The effect of induced furunculosis *(Aeromonas salmonicida)* upon the chemical constitution of brook trout *(Salvelinus fontinalis)* blood has been determined and is being extended to select blood enzymes.

Research into IPN virus survival and destruction was completed and published.

Fish Health Protection Regulations have been designed to control all international and inter-provincial shipments of salmonid products. Prior to their implementation in July, 1976, the required sampling and diagnostic testing procedures were optimized and two stock areas tested. A design for a fish health research program is still in the formative stages.

Short term high level feeding of krill to promote natural flesh toning of raised trout appears economically better than long term -low level feeding. Year-old frozen krill could be used satisfactorily.

A sensitive method, based on cyclic AMP levels, for defining the reproductive status of salmon has been developed.

Sea ranching experiments utilizing chemically-imprinted salmon smolts released for one year in the sea are underway.

The effect of diet, pH, salinity and temperature on salmon and lobster growth, reproduction, and molting are being studied physiologically to optimize aquaculture yield.

Shellfish Culture

The first year of a 2-year study on shellfish resources of the Northumberland Strait centered on collecting information from a wide spectrum of physical and biological parameters related to life history and production of shellfish, especially lobster, crabs and scallop. Heavy metals in bottom sediments were no higher than those in unpolluted sediments.

Survival and growth rates of European Flat Oyster *(Ostrea edulis)* were satisfactory, as was reproduction. A pilot project on the south (Atlantic) coast of Nova Scotia showed excellent growth and survival during the first year. Oyster shell disease, similar to that described in Holland was observed in some Nova Scotia stock. Low mortalities from this disease, often associated with infection, have been observed.

The causative agent in Malpeque Oyster Disease appears to be a *Labyrinthula* species. Work on transmission, growth and identification of this agent is continuing.

The Cape Breton Marine Farming Development Project continued with first marketing of oyster products. Oyster growth rate was markedly stimulated by judicious use of inorganic fertilizers.

The usual collector materials are effective for attachment of the soft shell clam *(Mya arenania)* and commercial possibilities are being investigated.

An electrophoretic study of inshore and offshore lobster population indicated no genetic differences occurred, suggesting the possibility of the offshore fishery having an effect on inshore stocks.

The last year of the five year oyster *(Crassostrea virginica)* spatfall study in Prince Edward Island and New Brunswick showed spat settlement in almost all stations with 50% of the stations at a commercial level. In general this year's collections were well above those of other years. A management scheme for collection preserves was implemented in the high commercial utilization areas.

An expanded depuration operation with soft-shelled clams (*Mya arenaria*) was optimized at the pilot plant level.

Investigations are continuing in St. Margaret's Bay, Nova Scotia on off-bottom oyster rearing. Fouling and predator problem control techniques are also being studied.

Studies in giant scallop culture in Newfoundland were concerned with spat settlement and larval survival and the effects of water depth and population density upon growth. Economic evaluation of the current available technology was carried out.

Oysters *(Crassostrea virginica)* require dietary linolenic fatty acids; not fully satisfied by the linoleic acid series. Failure to synthesize sterols from either acetate or mevalonate suggest a dietary sterol requirement also exists.

Lobsters require methionine and phenylalanine but not cystine or tyrosine. Casein was a better sole source dietary protein than soya bean whereas cod protein was lethal. Cod liver oil was superior to corn oil as a dietary lipid.

Eyestalk ablation accelerates juvenile lobster growth and yields animals more sensitive to dietary deficiencies. An experiment to determine the feasibility of growing market sized lobster (3-3/16" carapace length) from canner lobster (2-1/2" carapace length) utilizing eyestalk ablation and formulated diets is underway.

Different methods for maintaining water quality in closed sea and freshwater systems are being evaluated and an experimental lobster culture facility was constructed.

Pollution

The ability of trout to metabolize organochlorine insecticides under various environmental conditions has been investigated as well as the ability of trout to metabolize dietary chlorinated biphenyls.

The fate of six-year old stranded Bunker C in Chedabucto Bay, compositional changes of the oil within beach sediments, metabolism of oil by contaminated bivalves and effects on respiration in benthic crustacea are being investigated. An estimate of the residual long-term impact of oil on this ecosystem will be attempted.

No metabolic changes of DDT were noted during an uptake and clearance study of ^{14}C-p,p^{1}-DDT by the copepod *Calanus finmarchicus*. Uptake of ^{14}C-p,p^{1}-DDT by the euphausiid *Thyanöessa raschii* has been measured.

The importance of particulate transport of essentially water insoluble organochlorine pesticides has been investigated as well as bacterial effects on this phenomena.

A joint project was completed with the Canadian Environmental Protection Service to evaluate the effectiveness and toxicity of an oil dispersant with Venezuelan crude oil.

Analysis of waters and sediment for hydrocarbon has been investigated both geologically and seasonally. Results were compared with those obtained using fluorescence spectroscopy.

A study of the accumulation of thallium ions by clams and mussels was completed. Limited accumulation potential was found.

Copper, zinc, cadmium and thallium lethality thresholds for lobster (*Homarus americanus*) were determined. Larva were 10-100 times as sensitive as adults; LT50's were generally increased with lower temperature.

The relationship between toxicity (lethal thresholds in moles/ℓ) of certain pesticides and industrial chemicals and/or their metabolites and their octanol/water partition coefficients were determined using juvenile salmon. Such relationships are dependent upon chemical class of the respective compounds.

The effects of previous exposure to 12 toxic substances on the preferred temperature of juvenile salmon at 15°C were investigated. In general those substances that increase the preferred temperature are more toxic at low temperatures and vice-versa.

The toxicity of several pesticides to lobster was studied in detail, usually at 5 and 15°C using both larvae and adults.

A rapid method for monitoring aromatic hydrocarbons in aquatic fauna was developed.

Studies on the semi-chemical sulfite pulp mill effluent effects in the L'Etang inlet showed that herring avoid such effluents when their concentrations exceed 1 ppm. Attempts to identify the chemical species responsible for the avoidance behavior are underway. Measurements of primary productivity showed decreasing production from the most seaward station up the inlet, reaching unmeasurable levels in the highly stained and anoxic waters of the Upper L'Etang. Chlorophyll *a* values decrease from the most seaward station to near the causeway and increased dramatically in the Upper L'Etang.

Studies of phytoplankton dynamics continued in Passamaquoddy Bay with investigations on the size fractionation of primary productivity during the spring and summer. *Thalossiosira nordenskiöldii* dominated. "Red water" due to the marine ciliate *Mesodinium rubrum* was observed in Passamaquoddy Bay in August and is identical in pigment, composition and ultrastructure to that from Equador and British Columbia.

Laboratory studies on the toxic marine dinoflagillate *Gonyaulax escuvata* are centering on the effects of ecological factors (salinity, temperature, etc.) on growth and toxin production. Studies on methods of increasing depuration rates of toxic shellfish should begin soon.

Death of caged fish and chemical monitoring has led to curtailment of an attempted abondoned mine drainage in the Nepésigut River, New Brunswick.

The effects of contaminants on steroid hormone metabolism as a pollution effects monitoring tool has been developed utilizing rapid and sensitive autoradiography.

The effects of cadmium exposure to metabolizing salmon gonads and ripening eggs are being studied. Cadmium concentrations at 200 ppb or greater were lethal to eggs and at 50 ppb early hatch and lowered hatchability were noted.

Muscle and liver from selected year class cod were analyzed for organochlorine pesticides, arsenic, mercury, zinc, copper, lead and cadmium.

Little inorganic arsenic is present normally in fresh fish tissue. All fish tissues rapidly reduce arsenate ion (less toxic) to arsenite (more toxic).

Studies upon the nature of cadmium in shellfish are underway to attempt to explain the lack of removal by depuration using chelation or ion replacement.

Investigations are underway to determine the chemical nature of lead in fisheries products.

The principal organo-arsenical has been isolated and purified from flounder and is presently being characterized.

Denmark

(O. Vagn Olsen & P. Johansen)

The Danish Environment Protection Agency executed a biological and hydrodynamic survey in relation to the discharge of cooling water from a planned nuclear power plant on the east coast of Jutland. A report has been published in Danish: "Fiskeribiologiske Undersøgelser ved Gylling Næs 1975" (in Danish) Danish Fish. and Mar. Res.

The Belt Project under the Danish Environment Protection Agency has continued its collection of data on the exchange of water and pollutants through the Danish belts. Some reports will be published during the summer 1976, most of them in Danish.

Greenland

Metals. Research on the pollution from lead-zinc mine and mill at Marmorilik, West Greenland was continued by investigations carried out in April and September. A rather widespread contamination by dissolved heavy metals, especially zinc and lead, has been found in the water column in the period with ice cover. Seaweed (Fucus vesiculosus and F. distichus)and mussels (Mytilus edulis) appeared to have accumulated metals in a rather wide area. Adverse effects have been noted on the benthic fauna.

Marine environmental research on heavy metals was carried out in South Greenland, where mining of uranium may start within a few years.

Oil. Research on hydrocarbons in sediments, benthic organisms, fish and shellfish has been initiated in the offshore area at West Greenland, where oil exploration licenses were given in 1975. The results suggest very low concentrations of hydrocarbons in the area, and the hydrocarbons are believed to be of recent biological origin. In the same area studies of the benthic fauna composition are carried out.

Finland

(P. Tuunainen & A. Voipio)

Fish culture

Production of rainbow trout, Salmo gairdneri, in net cages in SW archipelago of Finland amounted to some 250 metric tons, the total surface area of the cages covering about 3 hectares in 1975.

The first experiment in Finland on rearing Baltic salmon smlots (Salmo salar) for stocking purposes, and rainbow trout for consumption in cooling water of electric power plants was completed in 1975. It was carried out near Helsinki using brackish water of about 6‰ salinity. The results were

promising and the salmons which had become smolts by the end of the experiment (age 1 year) were tagged and released in the mouth of the River Simojoki flowing to the Gulf of Bothnia. Rainbow trout of the same age grew also well.

Marine Pollution

Interest in exploitation of marine sand and gravel resources is constantly increasing in Finland. Its development has been followed as in 1974.

Study on the effects of effluents from the titanium dioxide industry on marine biota and fishery was completed in 1975 and a concise report was published as ICES report (C.M.1975/E:26). A more detailed report will be published in 1976.

Finland has actively participated in the Pollution Baseline and Monitoring Studies organised by the ICES/SCOR Working Group on the Pollution Study of the Baltic Sea.

FRANCE

(L. Marteil & J. Audouin)

I. Aquaculture

Les travaux entrepris les années passées sur les mollusques et crustacés ont été poursuivis.

Mollusques - L'élevage des vénéridés (V. japonicus, M. mercenaria), des ormeaux (H. tuberculata) nés en écloseries a continué.

Des expériences de captage et d'élevage de pectinidés (P. maximus, Chl. operculatis, Chl. varia) ont été entreprises en baie de St Brieuc et a Brest (Centre Océanologique de Bretagne) à Quiberon, Belle-Ile et Groix (Institut des Pêches). Les fixations de Chlamys ont été particulièrement importantes.

Crustacés

Homards: En 1975, le niveau de production de post-larves de homards (Homarus gammarus) en vue du repeuplement des zones côtières a été maintenu. 140 000 post-larves provenant de l'Ecloserie de l'Ile d'Yeu et 100 000 provenant de l'Ecloserie d'Houat ont été relachées dans le milieu naturel (côtes de l'Atlantique et de la Manche).

L'Institut des Pêches Maritimes (Centre de Recherches de la Trinité s/Mer et laboratoire de Roscoff) a obtenu à l'Ecloserie de l'Ile d'Yeu 2 000 "hybrides" provenant de l'accouplement de homards américains et européens.

Crevettes: L'Institut des Pêches Maritimes (Roscoff) a poursuivi l'étude des procédés de marquage et des conditions d'élevage des larves et post larves de Palaemon serratus.

Le Centre Océanologique de Bretagne a tenté une nouvelle expérience de production en grand volume (20 m^3) portant sur cette même espèce. 800 000 larves ont été conduites pendant 20 jours jusqu'au moment de la métamorphose sans mortalité appréciable avec une nourriture comportant un aliment synthétique sec. Au moment de la métamorphose une très forte mortalité encore inexpliquée est intervenue.

Une expérience de maturation sexuelle contrôlée par le jeu de facteurs écologiques externes a permis d'obtenir des pontes régulières à partir d'une petite population de Penaeus japonicus.

Algues: Les recherches sur l'aquaculture végétale marine faites dans les laboratoires universitaires comprennent des essais de cartographie, des études sur les cycles ontogéniques des algues rouges et des tests visant à déterminer l'influence des facteurs physico-chimiques sur ces cycles (Laminaria digitata et Laminaria hyperborea).

Des travaux sur la culture de l'Hypnea ont été réalisés par les laboratoires marins de Roscoff et de Banyuls: bien que le développement de l'algue au laboratoire ait pu être accéléré de façon relativement importante, aucun essai n'a été tenté à l'échelle semi-industrielle.

Sur ce même plan, des cultures d'Eucheuma spinosum ont pu être effectuées par l'Institut des Pêches maritimes dans le milieu naturel à partir de boutures provenant d'Indonésie, , sur une superficie de 2 500 m^2 au large de Djibouti; étant donné la vitesse de croissance exceptionelle de cette algue (30% par jour) et la possibilité infinie de bouturage, il a pu être envisagé une extension (actuellement en cours) à l'échelle semi-industrielle.

Des travaux sur les causes de la prolifération anormale d'algues (ulvacées) sont menés sur les côtes septentrionales de la Manche.

II. Sables et Graviers (impacts sur la pêche)

L'étude générale portant sur les effets du creusement d'une carrière de plus de 1 million de m^3, au large du Havre, a fourni des résultats importants (importance de la turbidité due au dragage, destruction et début de reconstitution du benthos, gêne à la pêche, caractère permanent de la nuissance). Les demandes pour de nouvelles extractions seront examinées en tenant compte de la protection des fonds de pêche et de l'importance des gisements de sédiments à exploiter. Jusqu'ici, toutes les demandes portant sur des zones où la pêche est active ont été rejetées (à l'exception d'extractions nécessitées par de grands travaux d'équipement).

Les projets d'extraction en Mer du Nord (région du "Dowsing pit") inquiètent les pêcheurs anglais, allemands, hollandais, belges et français. Le groupe de travail, réuni en décembre 1975 à IJmuiden (Hollande) a recommandé de demander aux gouvernements des pays-membres de n'entreprendre aucun dragage sur les frayères de hareng et autres zones de pêche d'importance notoire.

III. Pollutions

Contamination par les micropolluants inorganiques

Les travaux commencés en 1974 sur les niveaux de contamination en métaux lourds (Hg, Cu, Cd, Pb, Zn) ont été poursuivis en 1975 plus particulièrement sur des espèces en bout de chaîne alimentaire, comme les thons rouges et les roussettes de Méditerranée. Une étude des niveaux de contamination par les dérivés du mercure, methylmercure essentiellement, a également été conduite sur les mêmes espèces.

La détermination des teneurs en métaux lourds dans les graisses et viscères de mammifères marins échoués sur nos côtes a été poursuivie.

Contamination par les polluants organiques

Une première étude sur les niveaux de contamination des poissons pêchés en Atlantique et Méditerranée a montré la présence généralisée de résidus de polychlorobiphenyls (PCB) dans les muscles. Les taux les plus élevés ont été rencontrés chez les clupéidés.

Des travaux effectués avec des moules sauvages de la Méditerranée ont montré l'influence des activités portuaires et des chantiers navals sur les niveaux de contamination de la faune sédentaire par les PCB.

De gros efforts ont été faits pour la mise au point de méthodes de prélèvement des hydrocarbures, dans l'eau et de dosage de ceux-ci dans les coquillages. Une étude est en cours pour suivre l'évolution des teneurs en hydrocarbures total chez des moules accidentellement contaminées par l'échouage d'un pétrolier transportant du fuel.

Surveillance des zones sensibles

Un réseau naturel de surveillance, visant à déterminer les variations des paramètres physicochimiques et de certains polluants en quelques points de référence, a fonctionné en 1975. Il sera reconduit et étendu en 1976.

Indépendemment de ce réseau des zones particulières, rades et estuaires ont été soumis à une surveillance intensive. La baie de Seine, notamment fait l'objet d'un inventaire de la faune benthique en relation avec des rejets de phosphogypses.

Effets thermiques

Dans le cadre des projets d'implantation des centrales nucléaires sur le littoral, de nombreuses études sur le terrain ont été engagées en vue de déterminer du point de vue biologique et physicochimique le "point zéro" avant tout rejet, et en laboratoire d'expérimenter sur simulateur les effets biologiques de variations brutales ou cycliques de la température des eaux de surface.

Germany, Federal Republic of

(G. Hempel & V. Dethlefsen)

Pollution

Monitoring - Seawater of the German Bight was analysed for dissolved anorganic P, total P, pH, silicate and chlorophyll. Oxygen content and total P was monitored in the Western Belt Sea. For heavy metals a monitoring system of 24 stations in the German Bight and 18 stations in the Belt Sea was started, where once a year filtered and unfiltered seawater samples for different depths are taken. Analysis was carried out for Cd, Cu, Fe, Ni, Mn, Zn and Pb. Additional samples of Baltic Sea water and particulate matter were studied for heavy metals. (Deutsches Hydrographisches Institut, Institut für Meereskunde, Kiel).

Seawater samples of the German Bight and the Western Baltic are also analysed for PCB, p.p'-DDD, dieldrin γ-HCH, α-HCH, γ-chlordane. (Deutsches Hydrographisches Institut, Institut für Meereskunde, Kiel).

Concentration of fossile hydrocarbons was measured in the Western Baltic Sea. (Institut für Meereskunde, Kiel).

Nutrients and eutrophication were studied both in the German Bight and in the Baltic.(Biologische Anstalt, Helgoland, Institute für Meereskunde, Kiel).

Sediments of the German Bight were analysed for their heavy metal concentration (Hg, Cd, Pb, Cu, Co, Ni, Cr, Mn, Fe, Zn, org. C,N, mineralogic composition). (Deutsches Hydrographisches Institut), PCB, DDT, DDE and DDD.(Institut für Meeresforschung, Bremerhaven). Cd was measured in sediments of fjords in the Belt Sea.

Organisms. In the framework of the ICES Pollution Baseline and Monitoring Studies heavy metals, chlorinated hydrocarbons and fossile hydrocarbons were measured in fish, fish eggs and shellfish samples from different locations of the German Bight and the Western Baltic. In addition to that extensive surveys are under way to measure Hg-residues in fishes from different fishing areas of importance to the German fishery. (Institut für Küsten- und Binnenfischerei, Hamburg; Institut für Meeresforschung, Bremerhaven; Institut für Meereskunde, Kiel, Staatliches Veterinäruntersuchungsamt, Cuxhaven).

Microbiological studies were carried out on pollution and self-purification as well as of the effect of phenol on natural populations of bacteria in the Baltic sea water. (Institut für Meereskunde, Kiel).

Laboratory Investigations

Heavy metals: Investigations were conducted on the toxicity of Pb and Cd to aerobic heterothrophic bacteria, aim of this survey was to find whether there is a correlation between numbers of bacteria and heavy metal contents in sediments of estuaries (Institut für Meeresforschung, Bremerhaven); toxicity of cyclic organic compounds on marine bacteria with the aim of developing bacteriological test methods. (Institut für Meereskunde, Kiel); effects of Hg and Zn on the growth of marine planktonic algae (Biologische Anstalt, Helgoland); accumulation and toxicity of lead by marine annelids; uptake and accumulation of lead and antimony; influence of acids and sulfate in sea water on growth and mortality of mussels (Institut für Meeresforschung, Bremerhaven); effects of Cd on physiology and accumulation of Cd by Crangon crangon adults, embryos and larvae (Biologische Anstalt, Helgoland); toxicity and accumulation of Cd in different salinities to embryos and larvae of flounder (Platichthys flesus), garpike (Belone belone) and herring (Clupea harengus). (Biologisches Anstalt, Helgoland; Institut für Küsten- und Binnenfischerei, Hamburg); Cd uptake by Corophium volutator. (Institut für Hydrobiologie und Fischereiwissenschaft, Hamburg); uptake of Co^{57} by fishes via food or gill; effects of heavy metals on the physiology of Pleuronectes platessa under oxygen deficiency (Bundesforschungsanstalt für Fischerei, Hamburg).

Chlorinated hydrocarbons

Investigations were conducted on the bacterial degradation of PCB and parathion; on the uptake, excretion and metabolisation of ^{14}C-labelled chlorinated hydrocarbons by marine organisms, PCB by Nereis virens and lindane by Lanice conchilega and Mytilus edulis (Institut für Meeresforschung, Bremerhaven); on the acute toxicity of DDT and DDE on embryos and larvae of the marine fishes Gadus morhua, Pleuronectes platessa and Platichthys flesus (Institut für Küsten- und Binnenfischerei, Hamburg).

Transfer of lindane was tested in laboratory scale freshwater and marine food chains Institut für Hydrobiologie und Fischereiwissenschaft, Hamburg).

Fossile hydrocarbons

Effects of sunken oil on a benthic community were investigated as well as the uptake and metabolism of fossile hydrocarbons by Mytilus edulis (Institut für Meereskunde, Kiel).

Aquaculture

Mytilus edulis and Oysters

Experiments on raft culturing of Mytilus edulis and the Pacific oyster in the Flensburg and Kiel fjords were continued in 1975 (Institut für Küsten- und Binnenfischerei, Hamburg and Institut für Meereskunde, Kiel). The technique of growing oysters in containers, applied at different locations of the German coast since 1974, turned out to be successful and could possibly lead to re-establishment of oyster production in Germany.

Salmonids

Investigations on the development of an optimum trout feed were continued in 1975. Net cage experiments with rainbow trout in the fjord of Flensburg had to be interrupted in September due to acute lack of oxygen in the sea water (Institut für Küsten- und Binnenfischerei, Hamburg). Measurements were carried out in order to detect morphometric differences of rainbow trouts kept under different food conditions. In the Kiel Bight net cage experiments in heated power plant effluents are carried out by the Institut für Meereskunde, Kiel.

An experimental station has been set up in the harbour of Emden to investigate suitability of heated powerplant effluents for production of warm water fishes. The station consists of 15 basins with water basins from 1-50m^3. Maximum water temperatures in July-August were 33°C. (Institut für Küsten- und Binnenfischerei, Hamburg).

Recirculating aquaculture systems

Recirculating sea water systems were tested with respect to the effectiveness of elimination of nitrogen by activated sludge, by-pass ozonisation and certain devices for removal of foam. (Institut für Küsten- und Binnenfischerei, Hamburg, Insitut für Meereskunde; Kiel, Biologische Anstalt, Helgoland).

Iceland

(I. Halgrímsson)

Environmental quality

1). A cooperative programme was started in 1975 with the aim of determining the impact of municipal sewage in the inner part of Faxa Bay.

2). Iceland contributed to the "IOC/WMO IGOSS Marine Pollution Monitoring Pilot Project" by visual observations of oil slicks and other floating pollutants.

3). An investigation of the level of mercury in sea water in the vicinity of Iceland was continued. The results obtained have indicated very low and fairly uniform levels, averaging about 8 ng Hg l^{-1}. An exception to this were transient high mercury concentrations in the immediate vicinity of the Heimaey volcanic eruption in 1973.

In the autumn of 1975 samples of cod and herring were collected to be analysed in the ICES Pollution Baseline and Monitoring Studies.

Mariculture

Experimental cultivation of molluscs.

A Mytilus edulis rope culture experiment is still going on in three localities at the west coast.

Experimental rearing of salmon in sea water.

During the last few years experiments on pen-rearing of salmon have been carried out in four places, in 1975, however, in one place only.

Ireland

(F.A. Gibson & M.J. Crowley)

Environmental matters

In January 1975 approximately 450 tons of Bunker C oil escaped from the tanke "Afran Zodiac" at the Gulf Oil Terminal in Bantry Bay. Initially, dispersants were used in the attempts to clear up the oil, but straw was later used successfully to collect the oil from the shore. The catching or collecting of escallops, clams, sea urchins and periwinkles in a defined area of Bantry Bay was banned by the Department of Agriculture and Fisheries until 1 September 1975. Monitoring of the intertidal zone following this spillage (and also that of October 1974 in which approximately 2 500 tons of Kuwait crude escaped from the tanker "Universe Leader") is continuing.

In a separate investigation, preliminary observations by the diving team and the environmental unit of the Department of Agriculture and Fisheries were made on known Lithothamnion beds in a different part of Bantry Bay. This programme will be extended in 1976.

Cultivation

Investigations into the controlled cultivation of escallop (Pecten maximus) were carried on in Lough Hyne, a deep water inlet with a sill entrance on the south coast of Ireland. Polypropylene spat collectors were successfully used in two forms - woven into onion bags, and shredded as artificial sea grass. Adult white-shelled escallops were induced to spawn in flow trays, and the larvae raised in floating plastic pools on the surface of Lough Hyne for four days before being released into the Lough. Observations on adult escallops in under-water pens at a density of 50 per square meter showed them to have a higher growth rate than escallops outside the pen at a density of 2-3 per square meter.

At the Shellfish Research Laboratory, Carna (Zoology Department, University College, Galway), research is continuing on the conditioning, spawning, hatching, rearing and ongrowing of Ostrea edulis and

Crassostrea gigas. Arising from this work two projects with outside agencies are under way.

(i) Survey and redevelopment of two derelict natural oyster beds on the west coast of Ireland. At the end of this three-year project it is hoped to present a re-development plan for the beds which could be used, with suitable modifications, to re-develop other derelict oyster beds in Ireland. This should also lay the basis of a positive oyster bed management policy.

(ii) To investigate the possibilities of developing intensive oyster culture on selected parts of the Irish coast, based on the artificial production of spat and the use of ongrowing techniques and structures suitable to Irish conditions.

Field and laboratory investigations at the Carna laboratory are continuing on the scallop Pecten maximus and the clam Venerupis decussata. Preliminary investigations have commenced on other indigenous bivalves, e.g. Clamys opercularis, C. varia, Glycymeris glycymeris and species of cardiidae, and where promising results are achieved it is hoped to expand the work. Survey work on stocks of the prawn Palaemon serratus on the west coast have resulted in the development of a small but potentially useful fishery.

Netherlands

(P. Korringa & J. Duinker)

Netherlands Institute for Fishery Investigations (IJmuiden)

The sanitary control of the shellfish farmed in the Oosterschelde and in the Waddenzee did not offer any problems in the year 1975. Tests of Feacal Coliforms in the oyster basins at Yerseke, on the cleansing and storage plots for mussels in the vicinity of Yerseke, and on the plots where the shellfish is farmed demonstrated that all these sites were uncontaminated by faecal pollution throughout the year 1975.

Biological tests nor chemical methods of analysis revealed the presence of phytoplankton toxins in the shellfish during 1975, although occasional blooms of suspect dinoflagellates such as Prorocentrum redfieldi did occur.

Parasitological and pathological research was carried out in a wide range of fish species, special attention was being paid to nematodes, parasitic copepods and microbial diseases. Since the Netherlands import oysters for relaying from Brittany, special attention was paid to the occurrence of the microscopic oyster parasite Marteila refrigens in these oysters. On the basis of this work the Dutch oyster importers received advice and guidance for their purchases. A regular system of sampling carried out after relaying of the imported oysters demonstrated that the disease did not spread and did not aggrevate in the course of the summer.

Studies in the field of chemical pollution concentrated on the contamination of fish and fish product by organohalogenic compounds. Despite efforts made in the framework of the EEC to reduce pollution of the aquatic environment by PCB's, the concentrations of these compounds found in fish and shellfish remained invariably rather high in the Southern Bight of the North Sea: from 20 to 70 ppm, with an average of 40, on fat basis.

Research on heavy metals has been directed to mercury levels in perch collected in different fresh water bodies in the Netherlands. The results were compared with perch collected in Conlin Lough in western Ireland. The values found for perch from the Netherlands ranged from 0.1 to 1.5 ppm Hg on wet weight basis. For Conlin Lough perch values from 0.3 to 0.7 ppm were recorded. Therefore, it is still extremely difficult to say something about the amount of contamination of these fishes by mercury, as it is still very doubtful which values can be considered as "normal".

In October and November 1975 two major oil pollution incidents occurred with tankers, some distance from the Dutch coast. 2 000 and 10 000 tons of a light crude oil (Sahara crude) respectively were lost in the Southern Bight of the North Sea. Due to a prevailing southern wind during both oil spills, the Dutch coastal area was not affected. Field research in marine organisms and in sea water revealed that the oil of these spills dispersed rapidly within a week, probably because it was light oil which was involved.

In order to develop a biological monitoring system which might sound a warning of pollution at a stage where the effects are still sub-lethal, but may potentially affect the long-term survival prospects of a species, a programme was set up to detect such effects by incorporating genetic differences in sensitivity to detrimental environmental factors in a monitoring system. To develop such a system, knowledge is required about the biochemical processes specifically affected by certain compounds, and liable to genetic variability either at the structural level or at the activity level. The enzyme systems underlying the formation and functional maintenance of haemoglobin were selected for a first approach to detect effects of certain heavy metals and the breakdown product of aromatic nitro and amino compounds. Preliminary studies of the genetic variability of these systems will be followed by toxicity assays directed at the detection of selective mortality of the more sensitive individuals among a population.

Netherlands Institute for Sea Research (Texel)

Samples collected during several cruises covering the Rhine estuary, the Southern Bight of the North Sea, and the Dutch Waddenzee were analysed for chlorinated hydrocarbons and trace metals, both in water and in suspended matter. PCB's appeared to be a dominant feature within the series PCB, pṕ-DDT, pṕ-DDD, pṕ-DDE, oṕ-DDD, dieldrin, endrin, aldrin, α-HCH, β-HCH, γ-HCH, pentachlorobenzene and hexachlorobenzene.

A model has been developed for the behaviour of particulate trace metals (Cu, Zn, Fe, Mn) in which sedimentation within the Rhine-estuary plays an important role. No evidence was found for their mobilization into the dissolved state.

Dissolved and dispersed hydrocarbons, derived from the tanker "Colocotronis Piraeis" could be traced in concentrations up to 0.6 mgl^{-1} in the water column of a distinct area a few days after the spill from the tanker. Part of the lower fraction had disappeared in the meantime.

Norway

(G. Berge)

Environmental problems

1. Investigations on the pollution of selected Norwegian fjords were carried out in November. The fjords were selected so to represent different types of industrial loads. Measurements were made of salinity, temperature, primary

production indices, nutrients and oxygen distribution, turbidity, particulate matter and polycyclic aromatic hydrocarbons in sediments, PCB and DDT in fish. (Institute of Marine Research).

2. The inter-institutional study of biological and other aspects of planned nuclear power plants in South Eastern Norway continues. A programme covering baseline studies of fish and shellfish productivity in the Oslofjord and adjacent coastal waters, experimental investigations on termal effects on biological processes and possible utilisation of heated effluents for fish cultivation was carried through the Institute of Marine Research Biological Station Flødevigen. Specific biological programmes related to plant production and composition (attached and free-floating algae) were carried out by the Norwegian Institute of Water Research (NIVA) and the physical programmes by the Waterways and Harbours Laboratory. The results so far have been reported and a joint case-study based on these results has been prepared. Additional programmes to be carried out during 1976 are in progress, and include also studies expanded to cover selected areas at the West Coast of Norway.

3. Monitoring programmes : Petroleum hydrocarbons in sea water. Samples of sea water from 1 m depth at several stations in the North Sea (section Fedje-Shetland, Ekofisk field etc) are collected frequently and analysed, using gas chromatography. The programme is part of the ICES monitoring programme. (Institute of Marine Research).

   Heavy metals in fish and shellfish. Stocks of commercial fish are continuously being analysed on mercury, cadmium, zink, copper and lead at the Official Norwegian Quality Control Institute for Canned Fish Products. Involved in this monitoring are also the Vitamin Institute of the Directorate of Fisheries. These results are made available to the Institute of Marine Research and selected adequate observations are included in the Norwegian contribution to the ICES - conjoint monitoring of fish in the North Sea.

   Heavy metals in sea water and mussels in polluted areas. Analysis of samples from selected fjords are being made on Fe, Zn, Cu, Cd, Pb and Hg at the University of Oslo, Institute for Marine Biology and Limnology. The programme is also part of the ICES monitoring programme for 1975.

4. Organic pollutants in coastal sea water. This programme continues for the third season. The organic load of the Baltic Current is being investigated from the Øresund, through Kattegat, Skagerrak and along the western Norwegian coast. Continuous measurements are made on particulate matter, organic components, nutrients and temperature, whereas primary production indices are measured at regular intervals. (Institute of Marine Research).

5. Bioassays. New equipment for continuous dissolved petroleum hydrocarbon dosage have been developed and installed. Bioassays of effects on selected marine organisms are initiated. (Institute of Marine Research).

6. A programme studying the influence of various concentrations of pollutants on the biology of Pleuronectes flesus was initated in the Oslofjord in 1973 (University of Oslo, Institute of Marine Biology and Limnology). The programme is part of a joint Scandinavian effort aiming at development of an early warning system. The programme continues. A report on the food organisms and the feeding of the flounder was completed.

   Studies on toxicity of nitrite (NO_2) to fish and crustaceans were completed and an IBP-report presented. (University of Oslo, Institute of Marine Biology and Limnology).

7. The eutrophication of the Oslofjord caused by domestic sewage is continuously being observed by the University of Oslo, Institute of Marine Biology and Limnology.

8. The Norwegian Institute of Water Research, NIVA, has been assigned by several industries and municipal authorities in discharge problems of different water systems including fjords. NIVA is further conducting baseline studies of heavy metals and studying potential growth in natural and polluted aquatic systems (including fjords).

9. A programme on surface water drifts around the North Sea oil fields have been terminated. Plastic envelopes were every second week released from Ekofisk platforms and surface. A student's thesis based on these observations is in preparation. (Institute of Marine Research, Norwegian Continental Shelf Office and University of Oslo).

10. Polycyclic aromatic hydrocarbons, originating from heavy industries using the Søderberg electrode, were analysed in organisms from fjords in Western Norway. (Institute of Marine Research).

11. Investigations on the use of brown seaweeds as indicator organisms for monitoring of heavy metals in the marine environment. (Institute of Marine Biochemistry, Trondheim).

12. Development of dialysis culture equipment for bioassays of pollutants. (Institute of Marine Biochemistry, Trondheim).

13. Monitoring of fjord waters with respect to heavy metals and hydrocarbons by means of dialysis cultures of phytoplankton. (Institute of Marine Biochemistry, Trondheim).

14. Development of a research programme for investigating possible effects of low concentrations of oil hydro-carbons on selected sublittoral soft-bottom invertebrates. (University of Bergen, Biological Station).

15. Research on genetic parameters in connection with semi-culture of flatfish. (University of Trondheim, Biological Station).

16. The effect of oil, oil products and oil dispersants on larvae from marine fishes. (University of Tromsø, Institute of Biology and Geology).

17. The effect of oil, oil products and oil dispersants on fertilization, cleavage and differentiation are tested using sea urchin larvae as model. (University of Tromsø, Institute of Biology and Geology).

18. Monitoring programme at the coastline Tvedestrand-Grimstad in Skagerak on the possible effects of general pollution in the marine environment. (Institute of Marine Research, Biological Station Flødevigen).

19. Research on vibriosis (Vibris anguillarum) with respect to marine fishes. (Institute of Biology and Geology, University of Tromsø).

20. Project on better utilisation of viscera from fish. (University of Tromsø, Institute of Biology and Geology and Research Institute of Fishery Technology).

21. The microbiological conditions in the viscera of marine fishes during long-term storage in the sea. (University of Tromsø, Institute of Biology and Geology).

22. A project for studying the environment in and around six fish farm localities was carried out in two cruise surveys in 1975. No critical oxygen values were registered in March, although sedimentation of organic material in smaller and larger extents was observed at all farms. In August/September large sample series were taken for analysing nutrient salts in order to assess the pollution from the farms. In addition the wild fish fauna on the farms and on adjacent localities was examined. Ordinary chemical and physical data were collected and the current was measured. Stagnation with H_2S production in the water masses was found at two farms near the sea floor under the floating pens. (Institute of Marine Research).

Fish Diseases in the Marine Environment

Work on diseases of marine fish was started at the Institute of Marine Research in 1972 in connection with the growing involvement in marine Salmonid culture. In 1975 work has been concentrated on two topics: Vibriosis in cultured salmonids and in the natural saithe populations, and the possibility of fighting salmon lice by oral administration of organophosphorous compounds. This compound has been chosen as it does not seem to accumulate; it disintegrates easily and its fate in marine environment is fairly well known.

Lethal doses of Neguvon for different sizes of Atlantic salmon have been established; degree of disintegration and rest concentrations are analysed gas-chromatographically and overdose symptons are studied. The compound has been used in several field tests with satisfactory results.

Aquaculture

The field station "Fisk og Forsøk" in Matre was enlarged in 1975 by addition of an annex comprising offices and auditorium, laboratories, a large hatchery and water cisterns.

1. Experiments with selective breeding of Atlantic salmon, rainbow trout, pink salmon and Arctic char continue at the field station and at the Svanøy foundation 200 km north of Bergen.

2. The experiment to investigate the smoltification process continued. Parr of Atlantic salmon are submitted to three different temperatures and three different photoperiods with increasing day length. Gain in length and weight is recorded and the sea water tolerance of the fish is tested after different experimental periods. Size seems to be the most important factor for the fish's ability to endure a rapid transition from fresh to salt water. Results indicate that the best growth takes place at 15°C in the longest photoperiod.

3. The experiment of feeding Atlantic salmon a diet with supplementary inorganic salts in order to induce salt water tolerance is being continued. Changes in water content in tissue Na^+ and Cl^- levels in blood plasma, sea water tolerance and gain in weight and length are recorded after different periods of feeding the parr control and experimental diets. Salmon parr seems to be able to cope with a daily intake of up to 12% inorganic salts in the diet. Tolerance to sea water was higher in fish fed salt-enriched diets.

4. Methods and techniques for measuring the respiratory metabolism of pelagic fish have been thoroughly tested. Growth, food conversion and the metabolism before and after feeding have all been recorded on Atlantic salmon. The metabolism of saithe under normal and stressed conditions has been compared. An experiment for studying enzymatic and metabolic processes in the nutrition of fish has been initiated in cooperation with the Vitamin Institute, Directorate of Fisheries.

5. An experiment to investigate the growth of Atlantic salmon parr in relation to temperature and food intake was started in November 1975. Four different temperatures were used from 12 to 18°C, with duplicates for each. Three populations of salmon parr were placed in each aquarium. Length and weight of individual fish were recorded as well as the biomass of each aquarium. The development of the same populations will be followed in 1976.

6. Observation of the behaviour of Atlantic salmon parr in aquaria with different stocking densities was started in 1975. The aim of the experiments is to study the relationship between aggressive behaviour, stocking density and growth. The experiment is going to be somewhat extended and will continue in 1976.

7. Two previous experiments to study food preferences of Atlantic salmon fry at feeding initiation have been followed by a third experiment. The fish were given a commercial dry feed, dry feed with an artificial taste addition, brine shrimp and ground cattle liver. The results indicate that dry feed gives the best growth and food conversion. Addition of colour or taste to the dry feed does not seem to increase the food intake. Observation on feeding behaviour showed that the fry learn to take the food while they are lying on the bottom and that they spread out in the aquarium depending on the rate of water inflow and the dispersion of food. In a lighted aquarium the fry will also choose their positions depending on the possibilities of finding hiding places.

8. In June 1974 young rainbow trout and smolt of Atlantic salmon were distributed to 10 fish farmers along the coast from Bergen to Tromsø. The development of the fish has been surveyed by two registrations of length, weight and maturation in 1975. The results have been compared in relation to species and environment in order to evaluate the economical aspects of market fish farming. The growth of the trout as well as the results also indicate profitability at the other farms as well.

9. A project that was run in cooperation with a commercial fish farmer at Hitra (mid-Norway) concerning growth of Atlantic salmon in relation to stocking density in floating pens was terminated in 1975. At the turn of the year 1974/75 a serious outbreak of vibriosis at the farm affected the growth of the large salmon and caused high mortality among small ones.

10. A survey of localities suitable for aquacultural purposes in West Finnmark started in 1975. Data have been collected on three cruises. Continuous registration of surface salinity, temperature and current has been continued in several places. The field work will be terminated in March 1976.

11. An experiment to assess the effectiveness of several anti-fouling impregnants for net pens started in May 1975 in cooperation with a paint manufacturing company (Monopol A/S, Bergen). Test quadrangles of net impregnated with five different anti-fouling agents have been placed on four localities from Bergen to Bodø. All the anti-fouling agents were very effective the first summer. Eventual differences in effectiveness are likely to appear during the second summer.

12. The registration of commercial fish farms began in 1974 and finished in 1975. Data was collected on pen volumes and production and were used to obtain a review of Norwegian fish farming. In 1974 and 1975 312 farms producing fish for consumption were registered. 161 of these produced more than 1 metric ton of fish for consumption in 1975.

Poland

(J. Wiktor)

Mariculture

In 1975 research was continued on the possibility to incubate salmonid eggs in brackish waters of different salinities. The results so far obtained indicate that :

1. The activity of rainbow trout and migrating sea trout sperm cells increases in salinities ranging from 0‰ to 7‰. Those of lavaret (Coregonus lavaretus lavaretus) in salinities from 0‰ to 12‰ after which there is a rapid drop.

2. The process of turgescence of rainbow and sea trout eggs is normal in salinities ranging from 0‰ to 2‰ and of lavaret eggs in salinities from 0‰ to 6/7‰.

3. The incubation of fertilised and turgescent trout and sea trout eggs is normal in salinities up to 10‰, in the case of the lavaret the salinity limit is higher.

Portugal

(M.J. de Figuereido)

The programme on the assessment of water quality in aquaria provided with biological filters, started in 1974, was continued.

In April 1975 a sampling programme was started to determine the contamination of the water, oysters, fishes and sediments in ten selected stations covering the whole area of the estuary of the River Sado. Organochlorine insecticides and biphenyl polychlorines were determined in water, fishes and sediments; organophosphorus insecticides in water and sediments; and mercury in oysters and fishes. This programme will be carried out on a monthly basis until March 1976.

Determination of metal (Cu, Cd, Pb, Zn and Hg), pesticide and PCB contamination levels in pilchard, sole and hake from the Portuguese coast were performed in order to comply with the request of the Working Group on "Pollution Baseline and Monitoring Studies in the Oslo Commission and ICNAF Areas".

A joint Anglo-Portuguese survey in connection with the Working Group "Pollution Baseline and Monitoring Studies in the Oslo Commission and ICNAF Areas" was conducted along the western coast of Portugal, between the parallels of Setúbal and Oporto in order to obtain information on the physico-chemical state of the shelf waters through measurement of temperature and by collecting samples for determination of salinity, trace metals and nutrient salts.

Spain

(M. Torre)

Aquaculture

Molluscs: The programme on rearing of molluscs on the Atlantic coast of Spain was continued. The main species studied were Venerupis decussatus, V. pullastra, Ostrea edulis and Pecten maximus. They were cultured in a laboratory hatchery. As feed phytoplankton, mainly cultures of Isochrysis, Monochrysis and Tetraselmis was used. Other species of phytoplankton cultured for aquacultural purposes are species of Nitschia, Chaetoceros, Dunaliella, Skeletonema, Asterionella, Phaeodactylum and the fresh water species Scenedesmus obliquus.

Tests were made on the growth of the spat obtained in the hatchery after transfer to the natural environment in the sea. Different techniques such as suspension in plastic baskets, suspension on ropes, oyster cages on the bottom, etc. were used. Juvenile clams were transferred to a beach where they were farmed to market size.

Experiments were started to grow hatchery reared Haliotis rufescens under laboratory conditions. Tests were set up to study the growth of Haliotis tuberculata.

The study of the mussel Mytilus edulis in Riá de Arosa as efficient filter feeder in an intensively aquacultured area was continued

Crustaceans: At two places on the Mediterranean coast of Spain - S. Pedro del Pinatar (Murcia) and Castellón de la Plana - research on the shrimp Penaeus kerathurus and the prawn Palaemon serratus was continued. Both species were also studied in Cadiz; the prawn also on the Galician coast (N.W. Spain).

Investigations were carried out to study the suitability of phytoplankton and zooplankton as food for different larval stages. Sometimes the phytoplankton was cultured as a bloom of mixed species. The zooplankton used was Artemia salina, Brachionus plicatilis and Daphnia magna. As food for juvenile and adult crustacea artificial food of different composition was tried out. Crushed clams were also used as food in the experiments.

In Castellón growth at different rates of shrimps per square metre was tested. The rate of consumption of Artemia nauplii by prawns was observed. Juvenile specimens were transferred to old salt pans in an effort to use those as aquaculture ponds.

In Santander Bay on the north coast of Spain experimental feeding of Macropipus puber, Palaemon serratus and Eriphya spinifrons was carried out with Mytilus edulis, Trachurus trachurus, Arenicola marina, Myxicola infundibulum, and a mixture of Mytilus edulis meat with C-vitámin complex plus Carcinus maenas as food.

Fish: The main species studied was Chrysophyris aurata at Castellón de la Plana, at S. Pedro del Pinatar (Murcia) and at Cadiz. Spawning was induced with CGH and Synahorine. Larval mortality was usually very high around the 20th day, but the specimens which reached the postlarval stage and the fry appeared to grow well, without abnormal mortality. The food used for the juveniles was in some cases pelleted feed, in other cases finely crushed Macropipus depurator and Mytilus edulis.

Another species studied was Solea solea. One of the first experiments was inducing it to spawn with the aid of CGH.

Also the bar Dicentrarchus labrax was induced to spawn with Synahorine. There is now a commercial firm trying to culture the bar in NW Spain.

Floating cage rearing of salmonids (Atlantic salmon and rainbow trout) in salt water was started by two commercial companies during 1975 in two estuaries of the Galician coast (Ría de Ortigueira and Ría de Arosa) in northwestern Spain. Their main problem is the fouling of the nets of the floating cages.

Marine Pollution

Heavy metals: A programme on heavy metal pollution in zooplankton, fishes, crustaceans and molluscs was initiated. During the year 1975 periodical measurement of Pb and Cd contents in canned fish and molluscs was carried out. Toxicity essays of Cd were made. Bioaccumulation in different organs and the LD_{50} of some metals at larval stages and in adults of shrimp (P. kerathurus) and prawn (P. serratus) were studied.

The Hg content of cultured mussels, in plankton and in water was determined in the Ría de Arosa.

Hydrocarbons: Periodical sampling for hydrocarbon analysis took place in San Sebastian, Bilbao, Vigo, the Bay of Cadiz and Castellón de la Plana.

Organochlorines: DDT and PCB was measured in sardines (Sardina pilchardus) and in horse-mackerel (Trachurus trachurus) throughout the year. A similar sampling programme was carried out with Mytilus edulis, Patella patella, Nucella lapillus, Nephrops norvegicus, Micromessistius putassou and Merluccius merluccius.

Sewage: A programme on the autopurification processes by bacteria has been started on the Catalonian coast (NE of Spain) off the mouth of the Besós and Llobregat rivers.

On the northwest coast of Spain different species of pathogenic micro-organisms were sampled and determined.

Sweden

(H. Hallbäck)

Baltic Sea

Offshore investigations started earlier were continued (see Administrative Report 1975).

Southern Sweden, including Øresund

Local investigations in polluted areas carried out by "South Coast Investigations" (SKU) involving hydrographical parameters, plankton and benthos are continued.

The organisation "Swedish Geological Surveys" (SGU) carried out investigations on sand and gravel extraction, mainly in the Øresund.

East Coast of Sweden

A baseline study started in 1975 in the area off the town of Luleå in the Bothnian Gulf where a big steelworks is being built. The programme started earlier is continued (see Administrative Report 1975).

West Coast of Sweden

Several local investigations in polluted areas were continued, e.g. in the Idefjord and Brofjord, outside the industrial town of Stenungsund and in the area of Värö (see Administrative Report 1975).

The Värö investigation is related to warm water discharge from a nuclear power plant. During 1975 diving has been used, as a complement to other methods, to study macrobenthos in this area. Diving has also been used to study the effects of dumping mud, sand and gravel outside the town of Lysekil.

United Kingdom

1. England

(A. Preston)

1. Fish Cultivation - Fisheries Laboratory, Lowestoft

Turbot

Larval rearing

Although the early feeding problems with turbot larvae appear to have been solved by the use of rotifers and bivalve mollusc larvae, continuing mortality during the later phases of the larval cycle remains. Studies on feeding rates of turbot and turbot/brill by hybrids show much variation, but a rough correlation between feeding rate and later survival. Biochemical analysis of larvae show marked fluctuations, particularly in protein content, during the transitional period from rotifer feeding to feeding on Artemia nauplii. Despite the ease with which stage 2b larvae can now be produced, it seems possible that the early feeding techniques are still inadequate.

Late larval stages of turbot have been successfully weaned onto prepared diets, thus obviating the need for grown live foods such as Artemia.

Maturation

Early trials on the control of sexual maturation in dab by manipulating the light requirements were successful. Both short and long light periods were effective and three spawning cycles were produced over a 12 month period.

Genetics

Three spawning grounds, Baymans Hole, Gabbard and West Mud Holes, were sampled for plaice eggs. These were hatched at the laboratory and raised to a size at which electrophoretic analysis could be made of genetically determined enzyme variants. Five loci were investigated. At all loci, all the frequencies were remarkably constant between spawning grounds. There was no evidence of genetic isolation with respect to these spawning grounds.

2. Fish Cultivation - Fisheries Laboratory, Port Erin

Turbot

Larval rearing

Experiments in small volume, 80 litre and 90 litre, open flow rearing systems enabled different early feeding and rearing techniques to be tested with larvae of up to 1.5 cm. Significant improvements in both growth rate and survival were obtained when the alga Isochrysis was added to the rearing tanks instead of Dunaliella during the rotifer feeding phase. In one trial using Isochrysis survival from yolk sac larvae was 37% at day 20, 1.38 cm, and 25% at day 87, 4.7 cm.

Juvenile studies

Growth rate analysis and enzyme activity studies suggested pyridoxine requirements of 0.5 to 1 mg and 2.5 to 5 mg per kg of dry diet respectively. An examination of the effect of stocking density on growth showed no difference in growth rate after 9 weeks growth. The density of the 9 cm fish at that time, expressed as the percentage of the tank bottom covered by the fish, ranged from 30% to 150%.

Dover Sole

80% survival was obtained when 0-group fish of 3 cm were weaned gradually from Artemia nauplii, first onto a wet mussel/Artemia mix and finally onto a low moisture content pellet of mussel and fish meal. At 4.5 cm the fish had a growth rate of 4 mm/week on a diet containing 50% mussel meal, 50% fish meal, at a temperature of 19°C.

Up to a mean length of 20 cm growth rates of 5 mm /week were obtained with I-group fish held at 17°C in self-cleaning tanks. Fish which received an entirely mussel meal pellet grew at the same rate as those receiving a 75% fish meal, 25% mussel meal pellets.

Disease studies

The kidney and liver damage occurring in some turbot and Dover sole receiving artificial diets has been related to the presence of high levels of certain cellulose derivative binding agents used in pellet preparation.

3. Marine Pollution - Fisheries Laboratory, Burnham-on-Crouch

Monitoring activities

Fish and shellfish quality

Investigations have continued to assess the residue levels present in fish and shellfish landed at ports in England and Wales. This work has been undertaken to satisfy the UK national programme (in cooperation with DAFS) the OECD herring/pilchard programme, the baseline study of fish in the Oslo and Paris Commissions, ICES and ICNAF areas. The UK national programme has been expanded to represent more fully the pattern of fish consumed in the United Kingdom from distant, middle and coastal waters. The programme also includes particular attention to fish and shellfish taken from industrial regions, such as the Thames, Morecambe Bay, Liverpool Bay, the Bristol Channel and the Humber estuary. Detailed reports related to specific metals have been published, but a more general summary of monitoring activities carried out since 1969 is expected to be ready soon.

Dinoflagellate toxicity

Monitoring of PSP toxin in mussels on the north-east coast of England continued during the spring and summer. As in previous years, toxin was detected in early spring and the safe level of 400 units/100 g was exceeded in samples taken by mid-May. A value of over 600 untis/100 g found in mussels at Berwick was the highest recorded since 1969, and coincided with bird mortalities which were later attributed to Clostridium botulinium type C.

Vibrio parahaemolyticus

In cooperation with other laboratories, a survey has been made of the distribution of this organism in sea water, sediment and shellfish taken in the United Kingdom. In contrast to previous experience, the organism appears to be widely distributed in sediments, but is less frequently isolated from sea water and shellfish. The distribution appears to be more common along the south and south-west coasts of England, but it is influenced to some extent by the laboratory methods adopted. A review of the investigation will be published late in 1976.

Ecological studies

Gravel extraction

In cooperation with the Lowestoft Laboratory investigations on the effects and subsequent recovery following marine gravel extraction have been made off the east of England. Studies have been made of Lithothamnium deposits off south-west England.

Dumping grounds

In order to fulfil national responsibilities, investigations of the major areas of waste disposal have continued. Chemical sediment and benthic investigations have been made off the Humber, the north-east coast (where colliery waste is deposited), the Tyne, the Thames estuary, off Devon and Cornwall, the Bristol Channel and in Liverpool Bay. More detailed examination of the structure of the sediments has allowed a critical evaluation of the benthic populations, and such studies now form an integral part of all benthic investigations. A detailed report of the surveys carried out off the north-east coast will be available later in the year.

During the year a detailed analysis has been made of the benthos/sediment relationships in one major dumping area using advanced computer techniques, but it has not been possible to discern any effects attributable to sludge dumping. As a result of increased effort devoted to sedimentological studies, it has been possible to show that abnormal growth of oysters (C. gigas) in a traditional oyster growing area is attributable to the concentration and particle size composition of solids in suspension.

Toxicological studies

Laboratory tests of industrial wastes

Routine tests have been made to determine the acute toxicity of a wide range of industrial wastes, using Crangon and Agonus. The results have been applied to specific discharge situations, offshore and in coastal areas.

Sublethal studies

The long-term studies using Crepidula have proceeded satisfactorily. Emphasis has been devoted to the development of successful breeding techniques, and initial investigations have been carried out to determine the effects of different rations on condition, growth rate and reproductive state. The

experiments are about to enter the phase where a stress factor will be introduced, and measurements will be made of oxygen consumption and nitrogen excretion.

Oil pollution

Dispersant and oil toxicity

The acute toxicity of a wide range of dispersants has been tested by routine techniques described previously. Developmental work has been carried out to devise tests which are suitable for determining the toxicity of dispersants used at sea, where there is adequate water for dilution of the dispersant/oil mixture, and on beaches, where benthic animals are exposed for a short period to relatively high concentrations of dispersants. The sea test employs Crangon and mixtures of crude oil and dispersant, maintained in suspension by agitation. For the simulated beach test Patella attached to hard surfaces are exposed in air to dispersant, for varying periods, and their survival after immersion in sea water used to determine the time required for 50% mortality to occur. The results of these tests are used as a basis for approval by the controlling authority. A variety of other products such as an oil absorbant, an oil degradation product and 4 drilling mud products have also been tested to determine their toxicity.

Hydrocarbon surveys

In cooperation with a university department, a detailed investigation is being made of an estuary subjected to discharges from a refinery, and by frequent oil spills. The quantity and quality of discharges into the estuary are being measured by TLC and GLC. Ecological surveys have been made and environmental samples (benthos, sediment and water) are being subjected to hydrocarbon analysis. From these studies, it is hoped that sufficient information will be obtained to allow an assessment to be made of the most suitable way of measuring the effects of pollution resulting from exploration and exploitation of oil from platforms.

Microbiology

Field investigations

Experimental work has continued into the effects of sewage pollution on molluscan shellfish in areas of commercial importance. The suitability of shellfish processing plant for removing faecal bacteria by steaming processes has also been determined. The use of faecal coliform organisms as indicators of the distribution of sewage sludge dumped at sea, showed the method to be suitable for further development, and additional work will be undertaken. The effects of sewage sludge on the rate of heterotrophic activity in sediments is being determined by ^{14}C techniques.

Public health aspects

Purification equipment continues to be developed, and to be installed commercially. Six new plants of the high density type, where the molluscs are held in trays, have been put into operation. A further 10 plants are at the design specification stage. A substantial proportion of the oysters and mussels sold in this country are now treated in purification plants. The development of biological filters for use in high density units, in order to avoid loss of condition of sea water, has now commenced. The bacterial load of shellfish passing through purification systems has been determined and the factors causing fluctuations of non-faecal bacteria assessed.

Laboratory studies

Analytical methods for the examination of shellfish have been reviewed and the results published. A review of the methods available for the examination of enterovirus present in sea water and shellfish had indicated that methods

exist which can now be used to determine the distribution and fate of these organisms. Practical investigations will start during late 1976.

4. Marine Pollution - Fisheries Laboratory, Lowestoft

Trace metal and nutrient salt studies

Since 1969 the Fisheries Laboratory at Lowestoft has measured the trace metal content of shelf waters around the British Isles. Initially, the majority of these surveys were in the Irish Sea (Preston et al., Environ. Pollut., 3, 69-82). During later years an increasing amount of effort was directed towards a study of the North Sea (ICES Coop. Res. Rep. 39). The latter investigation was closely related to the activities of the ICES Working Group for the International Study of the Pollution of the North Sea and its Effect on Living Resources and their Exploitation. Progress reports on this exercise tended to be directed through the Hydrography Committee of ICES. During recent years pollution studies have become increasingly allied to the interests of the Fisheries Improvement Committee and therefore the Lowestoft investigations are included in this report for the first time.

In addition to trace metal studies, mention is made of nutrient salt measurements in the southern North Sea related to the study of eutrophication.

Trace metals

During 1975 emphasis was given to a study of trace metals in the water of the north-east Atlantic. The amount of effort directed towards the UK shelf waters was reduced compared with previous years. This change in emphasis was related to the replacement of the ICES North Sea Working Group by a new Working Group on Pollution Baseline and Monitoring Studies in the Oslo Commission and ICNAF Areas.

During the year water samples were taken from several localities in the North Atlantic between Spitzbergen and the Azores and between the Canadian coast and the European continental shelf. Included in this survey were several detailed vertical profiles of metal samples. A joint investigation of the shelf water off the Portuguese coast was made with Portuguese fishery scientists and samples were exchanged for intercalibration. It is hoped to complete the analysis of cadmium, copper, nickel and zinc samples from the above investigation early in 1976. Mercury has already been analysed in some samples from the south-east part of the North Atlantic. Inorganic values ranged between 1 and 11 ng/litre and total mercury between 6 and 17.5 ng/litre. The highest values tended to occur in shelf waters.

Investigations in the North Sea were directed mainly at sampling suspended particulate matter for metal analysis, in order to complement the data on dissolved values. The distribution of dissolved metals in the esturies of the Thames and Humber were also surveyed. The Humber study will be continued in future years and represents the UK contribution to the ICES sponsored investigation into the fate of pollutants across the fresh water/marine boundary.

Finally, the results of an international intercalibration of metals in sea water between teams of analysts in Belgium, the Netherlands and the United Kingdom was presented to the Fisheries Improvement Committee of the 1975 ICES Statutory Meeting (Duinker et al., ICES C.M. 1975/E:27). The greatest discrepancies were reported between basically different analytical techniques. Similar methods of analysis generally gave comparable results although some degree of random variation was evident.

Nutrient salts

Recent investigations in both the Netherlands and the United Kingdom (van Bennekom et al., Proc. R. Soc. Lond. B., 189, 359-74; Folkard & Jones, Mar. Pollut. Bull., 5, 181-85) have shown that the winter level of nutrient salts in parts of the southern North Sea has increased during recent years. This phenomenon is attributed to an increase in the amount of sewage and industrial waste discharged from territorial sources and the possible resultant eutrophication is cause for concern.

During January 1975 the Lowestoft Fisheries Laboratory surveyed the distribution of nutrient salts in the southern North Sea. Phosphate and nitrate levels in coastal waters were approximately twice those recorded on similar surveys during 1961 and 1962, whereas silicate values showed little change compared with the earlier investigation.

2. Scotland

(A.D. McIntyre)

1. Food chain investigations

During the year measurements were made of juvenile plaice production in relation to food supply, predators, and water quality on flatfish nursery grounds. This is part of a continuing programme on the factors controling recruitment to the adult stocks.

The study of experimental ecosystem in large plastic bags suspended in the sea has been extended to include observations on the survival and growth of herring eggs and larvae.

2. Shellfish cultivation

Raft experiments on oyster culture were continued in five west coast sea lochs. In four places Crassostrea gigas grew from 0.1g seed to commercial size (ca. 50g) in 1½ years and to 100 g in 2½ years. The flesh condition was good. Initial mortality was high but larger animals survived well. Trials on the shore over a wide area and under varied conditions gave good growth. Growth and fattening in cages at LWN were almost as good as in cages suspended from rafts. Ostrea edulis nowhere reached commercial size after 2½ years.

A further settlement of Chlamys operularis seed was obtained and growth was good during the first year.

No extension of the known distribution of shellfish pests and diseases in Scottish waters was noted during the year.

3. Fish farming - disease and parasite studies

Surveys of wild fish for infectious pancreatic necrosis (IPN) virus in the vicinity of a fish farm known to have had diseased stock for 5 years have shown it is present in <1% within a 6.5 km radius and not detectable outside this distance from the farm outfall into a freshwater loch. IPN virus was not detected in spawning salmon from each of 10 major Scottish salmon rivers. Examination of farmed rainbow trout surviving IPN disease showed a significant number with pancreatic damage.

UDN and associated fungal infections were common in wild salmon during spawning time.

Studies of immunising regimes in rainbow trout using injections of heat killed cells of Aeromonas salmonicida have shown that secondary stimulation

of agglutinating antibody can be moderately enhanced or greatly diminished depending on the timing of injection.

Plerocercoid larvae of Diphyllobothrium spp. were found in 3 year old rainbow trout in one instance. Encapsulation of the cestode larvae on the peritoneal surface of the flesh led to rejection of a significant number of fish destined for human consumption.

Herring from selected Scottish east and north-west coast grounds showed 96-100% infestation with larval nematodes in common with the findings of previous years. Blue whiting were also found to have significant infestations about one fifth of all larvae occurring in the flesh. Ichthyophonus spp., a systematic fungal pathogen, caused serious spoilage in some catches of wild Scottish east coast plaice and also a disease condition in farmed plaice. Gel diffusion studies of the serum of infected wild fish against whole cells and spores of the fungus produced precipitin bands whereas the serum of fish apparently free of infection did not. Turbot caught as wild juveniles retained some parasites (Myxidium, Bothriocephalus) after 3 years of cultivation while infections with others (Plistophora) apparently disappeared. A Trichodina sp. caused a serious infection in nursery reared juvenile turbot.

4. Pollution

Shellfish and public health

A service was maintained for advice on purification and for analyses of shellfish and water for selected pollution indicators.

Sewage input

Studies of the effects of sewage, both untreated and treated components, were continued. This work involves both field work in intertidal and subtidal regions, and experimental investigations in underwater containers.

Heavy metals

Continuing an extensive project on the effects of heavy metals on marine food chains, lead was used in experimental tanks containing plants, herbivores and fish and the experiment was run for a six month period during which effects at all three trophic levels were assessed.

Baseline monitoring and other pollution investigations

An extensive study of levels of toxic metals in fish flesh was undertaken in 1975, when 24 species of fish and shellfish were sampled from 16 ports round Scotland and also from research vessel catches for analysis of copper, lead, zinc, mercury and cadmium. These data represent an input to both national and international (ICES) programmes.

Surveillance of petroleum hydrocarbons in the North Sea has continued in collaboration with Torry Research Station and in 1975 this work was concentrated on a line of stations from the Firth of Forth to the Forties oil field. More localised investigations were made at Sullom Voe and Scapa Flow where oil terminals are being constructed. Experimental work on oil included an examination of the effects on autumn spawned herring eggs and larvae of water soluble fractions of North Sea oil.

Monitoring of the effects of pulp mill effluent has been continued in collaboration with the Scottish Marine Biological Association laboratory at Oban.

Work at the Pitlochry Laboratory

Further samples of plankton, fish and seal blubber were analysed for organochlorine residues during 1975. The twice yearly sampling programme of commercial species of fish was continued for four species (cod, whiting, plaice and herring) taken in the Moray Firth, and the Clyde, Firth of Forth and Viking or Ling Bank areas. The programme has now continued for seven years, but may be terminated in 1976 to allow more time for other research. Of the areas sampled, only the Clyde shows consistently high contamination by DDT, dieldrin and PCBs.

Samples of herring were again taken from the Clyde for organochlorine analysis as a contribution to the last year of the four-year OECD monitoring programme. The report on this international programme will be produced for OECD during 1976. Herring, cod and plaice sampled for the 1975 ICES baseline study were also analysed for organochlorine residues.

Plankton samples taken by the Institute of Marine Environmental Research in a transect from the Firth of Clyde to Ocean Weather Ship India, and also on a North Atlantic drift cruise from West Scotland to the English Channel and Bristol Channel, have been analysed for organochlorines for comparison with earlier plankton analyses. The abnormally high values in the Firth of Clyde were again confirmed, as well as high PCB levels in the Bristol Channel.

Blubber samples from common and grey seals taken by the Marine Laboratory on the east coast of Scotland in 1973-74 were analysed, no significant change in organochlorine levels being detectable over the period since 1968.

A network of eight sampling stations for precipitation on the east coast of Scotland and England was set up during 1975, for the purpose of estimating organochlorine input to the North Sea from precipitation and dry fallout. A new sampling and analytical technique has been developed for the investigation, and samples are returned to Pitlochry every three months. Analyses were completed for the first two three-monthly periods, and will be continued for at least one year. The concentrations measured for total DDT and PCBs have so far been less than 5 parts per trillion at seven of the eight sites.

U.S.A.

(C.J. Sindermann and D.W. Menzel)

1. Marine Pollution

Expansion of interest in and commitment to studies of effects of coastal pollution on fish and shellfish, and on the ecosystems which support them, continued in 1975. Impetus for expansion derived from: 1) increased public concern about the effects of ocean dumping of sewage sludge and ocean sewage disposal outfalls on the coastal environment, 2) the imminent expansion of petroleum exploration and production on the continental shelves, 3) increasing legal pressures on industries to halt or reduce ocean dumping practices and 4) the need to understand ecological impacts of offshore floating nuclear generating stations, channel dredging, deep water oil terminals and artificial islands. Of these, the obvious need to understand possible effects of petroleum exploration and production on living resources of the continental shelves has resulted in comprehensive environmental studies in areas where petroleum related activities are

planned. Substantial research effort is underway on the Pacific and Gulf of Mexico coasts, and has recently been started off the Middle Atlantic States, with federal financial support (Bureau of Land Management, U.S. Department of Interior). Establishment of an adequate understanding of existing biological conditions is one of the objectives of the programme.

Studies of the effects of ocean dumping of sewage sludge, dredge spoil, and chemicals have intensified, with emphasis on the Middle Atlantic coast, where much ocean dumping occurs, and where resulting environmental problems have been identified. Principal contributors to studies include the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce, with its Marine Ecosystems Analysis (MESA Programme and its National Sea Grant Programme) and the U.S. Environmental Protection Agency, through its internal system of research laboratories as well as its extramural grant programme.

Several environmental contaminant problems have received public attention during 1975. PCB's have been identified at substantial levels in fishes of the Great Lakes and in certain Atlantic coast rivers, resulting in some closures of fisheries. Additionally, the chemical "kepone" (chlorodecone), a chlorinated hydrocarbon insecticide, was released in large quantities in an important oyster-producing river (James) tributary to Chesapeake Bay, and resulted in closure of the entire river to fishing. In addition to the extensive field studies of contaminants and their effects, a number of state, federal and university laboratories are carrying on experimental studies of various chemical pollutants - particularly long-term studies at environmental levels. Important ingredients of the laboratory studies are histopathological and physiological effects.

Reports of red tide outbreaks, possibly associated with increased nutrient loading of estuarine and coastal waters, have increased in the past several years on the New England and Middle Atlantic coasts of the United States. Outbreaks of Gonyaulax (and associated shellfish poisoning) occurred in 1972, 1974 and 1975 on the New England coast, and blooms of a number of other phytoplankton organisms have become annual occurrences in parts of the Middle Atlantic Bight (particularly in the New York Bight area).

Pollution associated public health problems in United States waters have received attention during 1975. An important study relating increased prevalence of gastrointestinal infections in bathers with degrees of pollution of recreational coastline was reported, and concern about survival and infectivity of viruses in marine waters has resulted in inception of several new and major studies of these problems.

2. Marine Aquaculture

Commercial marine aquaculture in the United States is largely limited at present to oysters and pen-reared salmonids. Increasing reluctance on the part of potential investors has resulted from recent failures to reach commercial viability (due in part to inadequate technology) in shrimp and pompano culture.

Attempts to develop an adequate technological base for commercially successful operations are proceeding for salmonids, fresh-water shrimps (Macrobrachium), American lobsters, bay scallops and penaeid shrimps; with lesser efforts on species such as mullets, abalones, mussels, European oysters, striped bass, and others. Most of the support for these research actvities is provided by federal funding from the U.S. Department of Commerce, through its National Oceanic and Atmospheric Administration elements (the National Marine Fisheries Service and the National Sea Grant Programme) and some risk 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 roles and responsibilities of federal and state governments, universities and private industry, and sets priorities on species to receive major attention.

Closed system rearing of bivalve molluscs and salmonids has progressed to the pilot plant stage, even though further research is needed in areas such as low-cost diets, denitrification, disease control, spawning inhibition and brood stock maintenance. Major foci for this work are Sea Grant supported projects at the University of Rhode Island and the University of Delaware. A detailed report on silo culture of salmonids was presented at last year's Committee Meeting, and is available to interested members.

Shellfish hatcheries, often as adjuncts to other types of shellfish industry operation, are expanding in number slowly. About 15 such commercial hatcheries, of varying capacities, now exist, divided roughly evenly between the Atlantic and Pacific coasts of United States. A trade organisation (Shellfish Hatchery Association) has been formed. Most of the production of the hatcheries is concentrated on oysters (of several species) and clams, with limited efforts on abalone and bay scallops.

Despite occasional success stories - such as the recent development of pen-reared salmon culture in the Pacific Northwest - the expansion of marine aquaculture in the United States has been slow. At present many of the small enterprises started in the early 1970's have disappeared, leaving the field to a small number of large diversified companies whose profits are derived from other types of production, and who do not depend on too rapid movement of their aquaculture operations to a break-even point. The principal deterrent to commercial viability for much of marine aquaculture is clearly a deficient technological base.

U.S.S.R.

(A.F. Karpevich)

Five million eggs of pink salmon were delivered to the fish-rearing stations of the Murmans region in 1975.

In 1975 abundant stock of adult pink salmon migrants, mainly from the natural spawning in 1973, returned to the rivers of Northern Europe. About 200 000 fish were registered in the waters of the Murmansk and Arkhangelsk regions.

In 1975 the count of young pink salmon downstream migrants that spawned in native waters was conducted.

In 1973 and 1974 young pink salmons with the length of 38-41 mm and a weight of 280-420 mg were released into Latvian rivers. The young grew well and in June-July 1974 and 1975 adult salmon (III-IV stage of maturation) arrived to spawn, the mean length of males being 50.1 and 49.6 cm, mean weight 1.96 and 1.77 kg, of females - 47.3 and 45.5 cm, weighing 1.47 and 1.35 kg respectively.

Unfortunately no information on the arrival and spawning of pink salmon in the rivers of the neighbouring countries was received by the USSR.

Lack of such information made it difficult to estimate the biological effectiveness of this work.

In 1976 observations on down-stream migration of young pink salmon and run of adult migrants into the rivers will be continued.
