International Council for
the Exploration of the Sea

C.M. 1978/M:9
Anadromous and Catadromous
Fish Committee

THE 23rd MEETING OF THE

BALTIC SALMON WORKING GROUP

Alvkarleby, Sweden, 26 - 28 April, 1978

*) General Secretary
ICES
Charlottenlund Slot
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Denmark

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Members present:- O. Christensen, F. Chrzan, N. Johansson, P.-O. Larsson, H. Lassen, D. Møller, R. Porter, and J. Toivonen.

Also present:- Mr. O. Simola, Mr. K. Storå, and Mr. O. Sumari (Finland); Mr. A. Jungmark, Dr. O. Karlström, Mr. E. Montén, Dr. L. Nyman, and Mrs. Ingrid Åkesson (Sweden), and during part of the meeting Dr. B. Holmberg and Mr. C. Wendt (Sweden).

1. The Chairman, Mag. O. Christensen, opened the meeting and welcomed the members of the Working Group and other participants. A special welcome was forwarded to the three new members, Mr. Lassen, Dr. Møller, and Dr. Porter.

2. The Agenda was approved (Appendix 1).

3. The Protocol of the 22nd Meeting was approved.

4. Member list after revision:-

Canada	Dr. R. Porter
Denmark	Mr. O. Christensen (Chairman) Mr. H. Lassen
Finland	Mr. J. Toivonen
Fed. Rep. of Germany	Prof. F. Thurow
Norway	Dr. D. Møller
Poland	Dr. Z. Chelkowski Prof. F. Chrzan Dr. R. Sych
Sweden	Dr. N. Johansson (Secretary) Mr. P.-O. Larsson
U.S.S.R.	Dr. (Ms) Estugova

5. The Chairman reported on the activities since the last meeting of the Group. The editoral committee (Christensen and Larsson) for "the Baltic Salmon Synopsis" held a meeting in Stockholm 17-21 October last year. Prof. A Lindroth participated as editorial adviser. The manuscript was revised and is circulated to the Working Group members for final comments and adjustments. The wording will be amended by Dr Pyefinch. According to the decision at the 1977 meeting of the Anadromous and Catadromous Fish Committee, the synopsis shall be submitted to the 1978 meeting of the Committee for comments before a recommendation for publication in the Cooperative Research Report series will be considered. As an introduction to the synopsis a short outline will be presented at the Committee meeting above (ICES, C. M. 1978/M:8). According to the resolution of ICES (C.Res. 1977/2:32 (i)d), and (ii)e)), the "International Baltic Sea Fishery Commission" has requested ICES to provide a description of the life history, fishery and distribution of commercial important stocks in the Baltic. Two reports,

"Baltic Salmon" and "Baltic Sea Trout", on the information requested had been prepared by O Christensen, circulated before this meeting for comments and will now be submitted at the meeting of the Consultative Committee 22 May and to the Anadromous and Catadromous Fish Committee as per Appendix 2.

6. According to the resolution of ICES (C.Res. 1977/2:31) the Working Group discussed the research and management requirements for Baltic salmon and sea trout. The subject was covered in accordance with the items specified in the Agenda.

Ad. p. 3.1.1 Various methods for optimal utilization of streams were discussed, i.e. stocking of rivers with fry and parr, fertilization of rivers, feeding of parr in rivers. Dr Karlström reported on restauration of spawning beds in Sweden. Dr Porter presented his paper on upwelling incubation boxes (C.M. 1977/M:22).

Ad. p. 3.1.2 Mr Sumari presented a paper on present and near-future rearing capacity in Finland (Appendix 3). Prof. Chrzan mentioned that the Polish sea trout production is 500 000 smolt anually, and that this number will be increased in the future. Reduction of smolt costs by means of "new" rearing methods, improved quality of smolts (Appendix 5) and production of 1-year old smolt was discussed.

Ad. p. 3.1.3 Mr Larsson gave an introduction and presented figures on the catch of salmon spawning migrators in the main Swedish Baltic salmon rivers (Appendix 4). A decreasing number of females available for stripping in most Swedish rivers is evident. The same situation was reported from Finland (River Simojoki) by Mr Toivonen. The deficit is assumed primarily to be a consequence of increasing fishing intensity. By means of catch-effort figures Mr Christensen informed about the development of the offshore fishery in recent years.

Ad. p. 3.2 Dr Johansson gave an introduction (Appendix 5) and stressed the potential risks for genetic alterations of the Baltic salmon stocks in the long run. Considerations for future management and research was discussed, and the need for adaption of the salmon catch to the necessary demand for spawners in the rivers, as well as further studies on the pattern of genetic diversity in the Baltic salmon stocks, was pointed out.

Ad. p. 3.3 Referring to his paper C.M. 1977/M:42, Mr Larsson informed about research on salmon smolt release in Sweden. Prof. Chrzan reported on experiments with release of sea trout smolts in Poland. Smolt release in the spring resulted in an 8-10 times higher recapture rate than release of smolt in autumn. Mr Toivonen pointed out that climatic factors are of importance for the result, and that optimal climatic conditions in the sea should be investigated.

Ad. p. 3.4 Mr Lassen gave an introduction and pointed out the need for some basic data for estimation of TACs and necessary regulations. A paper on methods for stock assessments will be provided by Mr Lassen to the Anadromous and Catadromous Fish Committee at the 66th Statutory Meeting of ICES.

Ad. p. 3.5 Different techniques for sea trout tagging were discussed, and the members were asked to give detailed information at the next meeting of the Working Group on the methods used in their country.

Ad. p. 3.6 No near-future plans for introduction of non-indigenous species in the Baltic were reported by the members.

7. Excursions and Demonstrations in Connection with the Meeting

i. The Salmon Research Institute, Wednesday 26 April (Dr Johansson)

ii. Nose-tagging technique, Thursday 27 April (Mr N G Steffner)

iii. Biotest lakes at the Forsmark Nuclear Power Station, Friday 28 April (Dr Eric Neuman)

8. Recommendations

8.1 Within the Working Group

In order to consider the possible need of an international tagging experiment, the members should be prepared at the next meeting of the Working Group, to give available information on the different methods and techniques used for tagging of sea trout.

8.2 To be submitted to the Anadromous and Catadromous Fish Committee:-

Observations in 1976 and 1977 on parr density and utilized spawning sites as well as deficient number of breeders for rearing purposes suggest an alarming low number of spawners in several rivers. Potential causes such as changes in the fishery and diseases were pointed out. The Working Group realized the risks for long-term genetic alterations and the necessity of preservation and maintenance of the genetic variability of the Baltic salmon population.

The Working Group therefore recommends that a meeting should be arranged for two or three days in March 1979 in order to:-

a. Provide basic data on changes in efficiency and intensity of off-shore, coastal and river fishery.

b. Establish a population model and specify the required basic data which enable the evaluation of introduced regulations in the fishery

on Baltic salmon. Such measures may be catch quotas, closed seasons and closed areas and the evaluation will be in terms of changes in the stock biomass or part thereof or optimal total yield taken from the stock.

c. Provide a programme for studies on the pattern of genetic diversity of the Baltic salmon river stocks.

d. Provide basic data on diseases and injuries of possible influence on the salmon populations.

e. Provide basic data on factors of influence on survival in the river life and post-smolt period.

Appendix I

AGENDA

1. Approval of the Protocol of the last meeting.

2. Chairman's report on the activities of the Working Group since the last meeting.

3. Research and management requirements for Baltic salmon and sea trout to be treated according to the resolution of ICES (C.Res. 1977/2:31).

   3.1. Possibilities to increase national smolt production

      3.1.1. Optimal utilization of streams suitable for natural reproduction based on studies of the ecology and possibly by improvement of spawning sites, and habitats for river life.

      3.1.2. Increase of artificial reproduction considering financial resources and possibilities of reducing production costs, e.g., rearing in heated effluents of power plants. Present and near-future rearing capacity.

      3.1.3. Problems of providing sufficient numbers of mature fish for stripping.

   3.2 Quality of reared smolts. Genetic selection of stocks aiming at high growth and survival rate, and favourable pattern of migration. Age and size of stocking material. Control of parasites and diseases.

   3.3. Smolt release. Importance of time and place of release, including the advantage and disadvantage of release in higher and lower reaches of rivers, in river mouths and estuaries, inshore and offshore, with special attention to the predator problem.

   3.4. Stock assessment of salmon and sea trout, i.a., in preparation for establishment of TACs.

   3.5. Taggings. Looking for new and improved methods and techniques. Diversities of demands to salmon and sea trout tags. PR-activity for tagging experiments.

   3.6 Non-indigenous species of salmon and trout. Mutual information on transplantation experiments in the Baltic Sea.

Appendix 2

REPORTS ON BALTIC SALMON AND SEA TROUT COMPILED BY THE BALTIC SALMON WORKING GROUP ACCORDING TO C.RES. 1977/2:32

BALTIC SALMON

Geographical Distribution

Baltic salmon is confined to the Baltic drainage area mainly east of longitude 13°E and to a nowadays reduced number of affluents, Figure 1. The occurrence in the western Baltic is sporadic and the number leaving the Baltic through the Danish seas is supposed to be insignificant.

Sweden contributes with about 70% of the total natural production maintained by 13 rivers, the majority falling into the Gulf of Bothnia. In a few other streams spawning occurs more occasionally. Besides the Finnish-Swedish boundary river Torne Älv salmon run in Finland is limited to a 2 medium-sized rivers, both in the Bothnian area. The natural production of Baltic salmon in the USSR is mainly concentrated to two major rivers running to the Gulf of Riga: in addition, spawning occurs in a small number of other affluents to the Gulf of Riga, to the Gulf of Finland and to the Main Basin. In Poland there is only one river left supporting salmon run regularly and to an extremely modest extent.

The Baltic Main Basin is the principal feeding area of adults from most of the Baltic rivers. A certain proportion of the populations from the Gulf of Bothnia remains in the Gulf during their whole marine phase and are joined by feeding migrants originating in other parts of the Baltic area. In relation to salmon feeding in the Main Basin, salmon staying in the Gulf of Bothnia have a considerably lower growth rate.

The stock in the Gulf of Finland almost exclusively originates from the USSR.

The Gulf of Riga is mainly a transition area for local migrants heading for the feeding places in the Main Basin, in the Gulf of Finland and the Gulf of Bothnia and for returning spawners.

Migration Pattern

Migration of young salmon leaving the rivers of the Gulf of Bothnia in late spring seems to follow the mean current, i.e., the anti-clockwise surface circulation in the Gulf of Bothnia and the Main Basin. The majority migrates into the Main Basin more or less directly, joining the post smolts from the southern and eastern rivers.

Spawning migration in the Main Basin is chiefly a rapid northward movement to home rivers starting late March or in April. In Sweden and Finland grilse, i.e. 2 summer old salmon in the sea do not enter their home river until July, the 2 sea winter salmon and still older individuals start the run somewhat earlier. The first salmon homing for rivers of the Gulf of Riga appear in the Gulf in late May or early June and enter the rivers in August, while the peak of grilse run occurs in September.

Apart from the large-scale migration of post smolt and spawning migrants, salmon during the marine phase does not seem to exhibit a distinctly fixed migration pattern. Catch-effort data of the off-shore fishery, however, suggest some sort of seasonal regularity in the movement of the main body of feeding salmon. In the autumn the greatest abundances are found in Sub-divisions 29 and 30 and the northern part of 27 and 28, in the winter usually somewhat more southerly and in spring the greatest concentration occurs in Sub-divisions 25 and 26.

Recruitment to the Sea

The reduction of the recruitment of wild smolts to the sea by establishment of power plants, pollution and various other human activities is estimated to 1/4 of the original capacity of about 8 million at the beginning of this century.

The losses have been partly compensated by release of hatchery-reared smolts, to the greatest extent by Sweden. In Sweden 24 rivers with a drainage area of more than 1000 km^2 contribute to the reproduction, naturally and artificially. At present the total stocking of reared smolt is by number supposed to exceed the natural smolt run to the sea. (See Table 1).

Table 1. Estimated annual smolt recruitment to the Baltic.

Countries	Original natural production (about 1900)	Remaining natural production (about 1970)	Released reared [b] production (1977)
Denmark	-	-	120 000
Finland	2 540 000	350 000 [a]	101 000
Germany, Fed. Rep. of	-	-	17 000
Poland	10 000	1 000	?
Sweden	4 000 000	1 400 000	2 014 000
USSR	700 000	204 000	(575 000) [c]
TOTAL	7 250 000	1 955 000	2 828 000

a) a further decrease occurred in the 1970s.

b) USSR, mainly yearlings and one year old fish, other countries smolts of an age of two years

c) data from 1970.

Distribution of Fishing

Table 2 shows nominal catches of Baltic salmon 1967-1977 distributed on the Main Basin, the Gulf of Bothnia and the Gulf of Finland. A more specified distribution of Sub-divisions and statistical rectangles is possible for catches by Denmark, Finland and the Federal Republic of Germany, but only for the later years.

Commercial river fishery is carried out in Finland, Sweden, and USSR. Angling is of minor importance.

The catches in the Main Basin consist practically without exceptions of feeding salmon fished offshore by drifting gear. About 50% of the Swedish and 25% of the Finnish catches in the Gulf of Bothnia are fished in Sub-division 31, and almost exclusively coastal with fixed gear. The majority of the catches in Sub-division 30 is taken offshore by drifting gear. In the Gulf of Finland (Sub-division 32) the Finnish catches are obtained by drifting gear, mainly long-lines, while the USSR catches are exclusively coastal. The main part of the USSR catches are taken in the Gulf of Riga by fixed gear in the estuaries and river mouths, only 6-10% enter the river fishery proper.

Table 2 Annual nominal catches in metric tons of Baltic salmon.

	Baltic Main Basin							Gulf of Bothnia				Gulf of Finland	
Sub-division	24-29							30-31				32	
Country / Method[x]	Denmark O.	Finland O.	Fed.Rep. of Germany O.	Poland O.	Sweden O.(99%)/C.	O.	USSR C.(94%)/R.	Denmark O.	Finland C.(65%)/O.	Sweden C.(85%)/O.	R.	Finland O.(99%)/C.	Total
1967	1 754	143	187	8	364	-	126	4	168	133	99	114	3 100
1968	1 868	197	213	8	339	-	148	1	151	120	97	118	3 260
1969	1 469	169	134	30	366	-	135	0	197	94	69	140	2 803
1970	1 298	121	130	11	341	-	101	11	193	111	45	136	2 498
1971	993	138	106	11	285	-	95	52	82	109	50	124	2 045
1972	1 034	122	117	13	277	-	107	11	143	135	65	138	2 162
1973	1 107	192	107	17	407	-	122	12	191	179	134	135	2 603
1974	1 224	282	52	20	403	21	155	0	310	195	155	111	2 928
1975	1 112	237	67	10	352	43	194	98	258	305	127	158	2 961
1976	1 372	181	58	7	332	?	?	38	426	251	80	81	2 826

x) O. = Offshore fishery; pelagic gear (drift nets and long lines), yield: feeding salmon
C. = Coastal catches; fixed gear (fyke nets, bag nets, etc.), yield: mainly maturing salmon on spawning migration
R. = River catches, mainly fixed gear, yield: maturing salmon on spawning migration.

History of Fishing

The original salmon fishery based on catch of ascending spawners in the rivers was the prevalent way of salmon exploitation until the end of the 19th century. At present less than 5% of the total yield of Baltic salmon is due to river fishery. Until the late 1940s sea fishery was mainly a coastal fishery of spawning migrants with fixed gear similar to the river fishery. Today the coastal fishery contributes with about 15% of the total catches. Though drift nets were operated at least from the middle of the previous century a proper offshore fishery of feeding salmon was first developed in 1947 as a consequence of introduction of drifting long-lines.

Replacement of the original net material hemp with synthetic fibres in the first half of the 1960s made drift net the primary salmon gear. Nowadays about 80% of the total catches are yielded offshore by drifting gear.

While total catches of Baltic salmon before 1945 did not probably exceed 2 000 tons annually, they subsequently fluctuated between 2 000 tons and 4 000 tons. In recent years the annual yield amounted to about 3 000 tons.

State of Exploitation

According to recent observations the number of spawners in Swedish and Finnish rivers is too scanty to utilize the present spawning sites. In 1976 the density of parr in the River Tornionjoki - the most productive of the remaining Baltic salmon rivers - was very low and in the rapids of the upper tributaries 0-group parr were totally lacking. In 1977 the same phenomenon was observed in River Simojoki and River Kalix Älv. The reason for the insufficient reproduction is supposed to be change of efficiency and intensity of the fishery, but also diseases may be considered.

Danish catch-effort data suggest, however, the total effort of the offshore fishery in the Main Baltic to be significantly lower in the 1970s than in the 1960s.

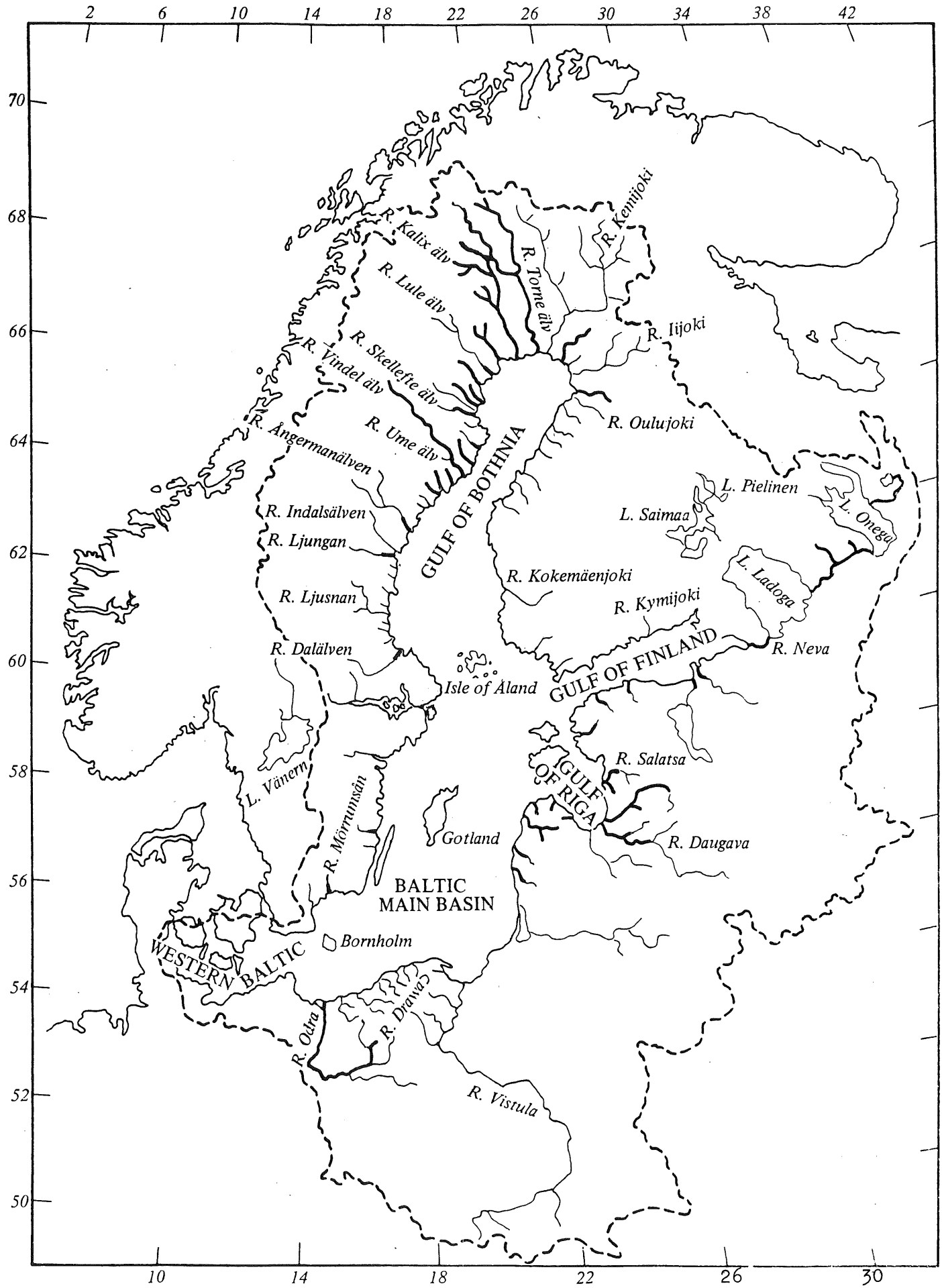

Fig. 1. Baltic drainage area.
Rivers and reaches of rivers supporting salmon run in former time (thin line) and at present (thick line).

BALTIC SEA TROUT

Distribution and Migration

Sea trout is an anadromous form of the species Salmo trutta, which like salmon spawns and spends its juvenile phase in fresh water and its growth phase in the sea. Two varieties of sea trout occur in the Baltic area. Stocks of trout with a migration pattern and growth comparable to salmon are established exclusively in the southern Baltic and mainly in Polish rivers. The ordinary, more stationary form is distributed as well in the northern as in the southern Baltic rivers. Stocks of both forms may occur together in the same river system as well as in rivers occupied by salmon too.

As reproduction areas and habitats for the juveniles, sea trout prefer smaller streams and the tributaries of the larger river systems contrary to salmon, that occupy the main courses of the rivers. Consequently, sea trout streams compared to salmon rivers are more numerous and widespread, especially in the southern Baltic drainage area where suitable natural conditions are met with. Human interference has naturally limited their number recently but not to the same extent as salmon rivers. During the marine phase sea trout are more or less abundant in all coastal areas and archipelagos of the Baltic, but occur more scarcely offshore.

About 80 smaller sea trout streams are draining the Danish mainland and isles into the western Baltic and Main Basin. The stocks are rather stationary, about 80% seem to stay within 15 km from their native river. There are but few evidences of individuals crossing the open sea.

At present 15 affluents to the western Baltic from the Federal Republic of Germany support sea trout run.

At least three of the numerous sea trout stocks of southern Sweden belong to the widely migrating type, the stocks of R. Verkeån, R. Mörrumsån and R. Emån. A relatively large proportion is recorded far from the native rivers offshore and in almost all Sub-divisions of the Baltic.

The sea trout rivers and streams falling into the Gulf of Bothnia are not enumerated, but amount to several hundreds.

Large-scale tagging experiments show that sea trout of Swedish, northern as well as southern Bothnian rivers disperse passively over rather large distances inshore without preference for any particular direction. No recaptures are recorded from the open sea, and those recorded from the Finnish side of the Gulf have obviously migrated along the coast or by means of the central archipelago and the Isles of Åland.

Of the 5 sea trout rivers left in Finland, 3 are running to the Gulf of Bothnia and 2 to the Gulf of Finland. Apart from the still very productive Finnish-Swedish boundary river Tornionjoki, the population in the other rivers are considered to be deficient.

Contrary to the migration pattern of the Swedish Gulf of Bothnian sea trout, the Finnish stocks in the Gulf seem preferably to disperse northwards along

the coast. Recaptures of those recorded from the opposite side of the Gulf suggest that they have used the same routes as Swedish migrators, i.e., avoiding open sea crossing. Apart from staying inshore the migration of the Finnish sea trout of the Gulf of Finland does not show any definite trend as to direction into or out of the Gulf.

In northern Poland populations of sea trout occur in 14 rivers and 10 larger tributaries.

The sea trout of the Pomeranian rivers and the tributaries to the lower River Vistula belong to the widely migrating variety occurring all over the Baltic, but probably most abundant in the southern and eastern part. After smolt descend into the sea, feeding migration is mainly directed east- and northwards to the eastern part of the Main Basin, and further along the coast of Finland and Sweden and even to the western Baltic. The ascent in other rivers than the native one seems to be less frequent compared to other stocks of sea trout. In winter-spring the feeding sea trout stay on the inshore grounds gradually moving offshore with rising water temperature. The spawning run in Pomeranian rivers starts in June-July with a peak in October-November shortly before spawning time. River Vistula is entered by spawning migrants all the year.

Maintenance Stocking

On the line of the comprehensive stocking of Baltic rivers with salmon, smolts, the sea trout populations are maintained by release of hatchery-reared trout. Besides trout smolts also fry and 0-group, one-, two-, and three-summer old parr are applied as stocking material (Table 1), as well as captured breeding fish which are released as kelts after stripping. In Polish rivers and coastal areas the non-indigenious species rainbow trout is used for stocking too.

Table 1 Stocking of reared trout in the Baltic area in 1977

Stocking Material (No.)	Smolt	Parr	Fry
Denmark	37 000	238 000	405 000
Finland	210 000	415 000 x)	-
Germany Fed.Rep. of	-	-	-
Poland	324 000	-	3 745 000
Sweden	596 000	55 000	1 957 000
USSR	?	?	?

x) large 2 and 3 summer old parr of smolt size

Distribution of Fishing

As a consequence of their generally more stationary behaviour and inshore occurrence sea trout compared to salmon is exploited to a far greater extent by the coastal and the river fishery of their home country. Besides the purely commercial catches, quite important quantities of sea trout are landed by anglers and part-time fishermen, implying that the catch statistics are rather incomplete. The catches are significantly higher than refelcted by Table 2.

Besides being exploited by the home water coastal fishery the widely migrating sea trout enter into the offshore pelagic salmon fishing as a valuable by-catch. On an average about 3% of the catch figures of the Danish salmon statistics and on average 7% of the salmon catches referred to the Federal Republic of Germany are in fact sea trout. In Table 2 annual mean catches by the two nations are estimated. Judged by the distribution of the catches in the sea - those of Denmark and the Federal Republic of Germany are mainly obtained in Sub-divisions 25, 26, and 28 - their origin is primarily in Poland. Also the salmon catches of Finland before 1973 and of the USSR contain sea trout at an annual average rate of 9% and 10%, respectively.

The coastal and offshore fishery occupy 2/3 and 1/3 respectively of the total sea catches of Polish trout. Less than 5% of the offshore catches are landed by Polish vessels; the remaining part enters as by-catches into the salmon fishery of other nations mentioned above.

Table 2 Nominal catch of sea trout in the Baltic Sea.

	Denmark	Finland	German Dem. Rep.	Germany, Fed.Rep. of	Poland	Sweden	USSR
	b)	c)	a)	b)	c)	d)	a)
1967	-	-	-	-	54	-	-
1968	.....	-	-	10-12 tons -	133	-	-
1969	.....	-	-		58	-	-
1970	.....	-	-		56	84	-
1971	.....	-	-		41	66	-
1972	about 40 tons	-	-		75	64	-
1973		-	18	4-5 tons -	83	89	141
1974		92	29		101	119	123
1975	.....	96	25		79	101	60
1976	-	103	-	-	97	86	54

a) Bulletin Statistique
b) Estimated proportion of salmon catch
c) Personal communications
d) "Fiskeristatistisk Årsbok"

Appendix 3

Olli Sumari

The Finnish Game and Fishery Research Institute
Tha Laukaa Fish Culture Research Station

Increase of artificial reproduction considering financial resources and possibilities of reducing production costs, e.g., rearing in heated effluents of power plants. Present and near-future rearing capacity. Problems of providing sufficient numbers of mature fish for stripping.

The annual salmon smolt production in Finland on fish farms has varied between 50 000 and 200 000 in the last few years. The smolts have been raised by power station companies and stocked to the Bothnian Bay. In future, more smolts will be stocked yearly. On the basis of the judgements of water courts one million additional smolts must be stocked to the Gulf of Bothnia and 50 000 smolts to the Gulf of Finland. However, it will take several years before the final judgements of the Courts of Appeal will be given.

The following amounts of smolts will be produced and stocked by the State Fish Farms:-

	1978	1979	1980	1981	1982
Smolts	74 000	112 000	180 000	140 000	230 000
Yearlings			300 000	300 000	300 000

One year old salmon parr will be stocked in Torniojoki river. There the smolt production has diminished because of the lack of spawners.

A salmon farm in the Åland Islands is under construction and is expected to produce 100 000 two years old salmon smolts in 1981.

At present the lack of funds, farming capacity and lack of eggs set bounds to salmon smolt production in Finland. The amount of salmon eggs allows a production of some half a million smolts yearly, but the egg production can be increased, if needed, by brood fish culture. The present capacity of salmon farming can roughly be estimated at one million smolts yearly.

Over the last few years the Finnish Game and Fishery Research Institute has been increasingly studying the methods of salmon smolt production. In particular, raising experiments in warm water are being performed to produce one year old smolts. Stocking experiments with one year old smolts have also been carried out. It is evident that the production costs of one year old smolts can be considerably lower than those of two year smolts. More research, however, should be done concerning the stocking characteristics of one year old smolts.

Only few Baltic salmon stocks remain in Finland, and the amount of salmon migrating into the rivers is small. Therefore, the majority of eggs needed for salmon culture is produced by raising mother salmon in the State Fish Farms. The present salmon egg production is a few hundred litres. The eggs produced, however, are small and the mortality of fry is high. Promising results have been achieved in the raising experiments of salmon brood fish in net cages in sea water. The growth rate of salmon has been better than in experiments in lake water, the overwintering has succeeded well, and the egg quality has been better than in control fish at fish farms.

The general opinion is that salmon farms should be supplied eggs from a natural salmon stock. It may be that the effective sea fishing of salmon in the Baltic Sea will lead to a genetically retarded salmon growth. Therefore, it should be discussed whether this development could be avoided by the production of salmon roe from cultivated mother fish originating from high-quality wild salmon selected on the basis of rapid growth and big size.

Appendix 4

CATCH OF SALMON SPAWNING MIGRATORS IN THE MAIN SWEDISH BALTIC SALMON RIVERS.

P.-O. Larsson

The catch of spawning migrating salmon to the hatcheries in some Baltic salmon rivers in Sweden 1973-1977 is shown in Table 1 (page 18). For some rivers the number of females and mortality before stripping are also given. The general trend is a decrease of the total catch 1973-1977, especially in the last two years. The total number of females available for stripping is in several cases lower than necessary for obtaining a sufficient number of eggs and a subsequent number of smolt.

In some rivers even females with possibly inheritable abnormalities, like spine-bendings or shortened spines, had to be used to obtain the number of eggs needed.

Table 1. Catch of salmon spawning migrators for breeding purposes in some Swedish rivers

River		1973	1974	1975	1976	1977
Lule 300[1]	total catch	1 990	1 316	992	842	540
	♀♀	635	392	553	254	301
	♀♀ dead before stripping	20	14	336[2]	87[2]	14
Skellefte 60[1]	total catch	948	718	867	1 024	634
	♀♀	80	147	60	64	80
	♀♀ dead before stripping	5	27	13	5	7
Ume 75[1]	total catch	2 225	3 962	1 242	1 073	1 512
	♀♀ from reared stock			159	86	95
	♀♀ of wild stock			187	309	457
Ångermanälven	total catch	3 154	2 899	2 752	1 556	?
Indal 250[1]	total catch	11 771	11 883	6 586	6 493	1 421
	♀♀	429	250	490	283	211
	♀♀ dead before stripping	232	89	288[2]	85[2]	46
Ljungan 15[1]	No of females in the catch	10	12	9[3]	0[3]	0[3]
Ljusnan 175[1]	total catch			4 962	2 008	711
	♀♀			190	143	35
Dalälven 25[1]	total catch			186	54	67

1) No. of females to obtain sufficient no. of eggs (and smolts)

2) UDN main mortality factor

3) UDN recorded in the river

Appendix 5

CONTRIBUTION TO THE DISCUSSION ON 3.2 IN THE AGENDA:
QUALITY OF REARED SMOLT, by N. Johansson

The recruitment of salmon smolts to the Baltic relies at present by about 60% upon reared smolts, and the proportion of artificially reared salmon will probably increase in the future. Therefore, it is of primary interest, not only for the "smoltproducers" but also for the salmon fishery, that this stocking material is of high quality with reference to post-hatchery survival, growth and homing. Carlin has clearly shown by tagging experiments that smolts which are apparently in good condition when they leave the hatchery are not necessarily those which survive best in the sea. However, we have still very little knowledge of which factors influence the quality of smolts, and practical methods of monitoring the overall quality of stocking material at an early stage are missing. The future of our stocking programme and of the salmon fishing industry of the Baltic will therefore be dependent on international co-operative research and on international agreements that enables smolt producing nations to fulfil their obligations.

1. Genetic Selection

Introduction of a large number of reared salmon smolts into the Baltic salmon population implies risks for genetic alterations within the population. The risks can be summarised as follows:-

1. The small numbers of mature fish at present available in some rivers imply risks for deterioration of the genetic variation and inbreeding depression.

2. Culturing itself implies a relaxation of selection during the freshwater phase.

3. The heavy fishing in the Baltic may lead to an undesirable type of selection among individuals used for stripping.

4. Differences between the artificial environment of the hatchery and the natural habitat may lead to an unfavourable selection.

According to Rasmuson, (Salm. Res. Inst. Rep. 3/1968) it is possible to reduce these risks by international agreements on reduction of the total salmon catch in order to increase the amount and quality of fish for stripping, and by breeding dispositions. If a sufficient number of "spawners" can be guaranteed, it is possible to maintain the present quality of the Baltic salmon. An even more efficient production of artificially reared salmon might be achieved by selective breeding. One method would be to select stocks with high survival and growth rates. Rasmuson suggests that the most promising method would be "a breeding which uses recaptured females and artificially reared males, the breeding value of which is estimated from individual and sib-performance."

Also, "inter-racial" crosses between salmon from different rivers, as a means of obtaining hybrid vigor, seems to be a possible way to a more efficient production.

However, before these methods of possible increase of smolt quality can be used in practice, further studies on the pattern of genetic diversity and the genetic background of characters of economic importance have to be made.

2. Conservation of Genetic Resources

Over-exploitation of the wild salmon stocks as well as selective breeding and "domestication" of reared material may result in reduced genetic variation. For the future management of Baltic salmon it is therefore essential to develop efficient means of preservation and maintenance of natural genetic variability. This could be done through:-

i. protection of natural river habitats for important remaining salmon stocks.

ii. reducing the likelihood that indigenous wild river stocks will mix with introduced stocks.

iii. development of methods for long-term storage of gametes.

iv. establishment of controlled gene pools.

3. Age and Size of Stocking Material

It is shown by several authors (i.e., Carlin, Peterson, Ritter, and Larsson) that the relation between the size and the quality of the smolt (measured by means of tag returns) is a nearly linear regression within the size 12.5 - 13 to 18 - 20 cm of length. This increased quality with increasing size has very little to do with the actual age of the fish within the limits of size. Therefore it could be economically sound to intensify the efforts made to produce 1-year-old smolts.

4. Control of Diseases and Parasites

Although diseases in hatchery-reared salmon have been studied for several years, we have very little knowledge on what influence diseases during the time of rearing may have upon the post-hatchery survival and growth. Most pathological conditions are probably of importance and there are, inter alia, the following biologically plausible events of influence in the present salmon management:-

i. factors predisposing to infection could be created before the smolts are liberated or by handling at release.

ii. chronic ailments and chronic lesions supporting diseases are very likely to decrease the survival after release.

iii. spread of contagious diseases such as furunculosis and ulcerative dermal necrosis to natural waters.

There is an urgent need for studies on these possible relationships in order to reduce environmental stress factors and incidences of disease.

During the last 10 years, the picture of disease incidences in salmon stations has obviously changed. Among eggs and fry, diseases have been recorded which directly originate from the condition of the parents and which were never seen before.

There is also tendency towards increased susceptibility to infections caused by facultative and atypical bacteria among reared fish during the parr-smolt transformation.

In 1975 the first known epizootic in the Baltic salmon stock was recognized - ulcerative dermal necrosis. The agent of this disease is not known, and there is little knowledge on whether it is possible to transmit it to young salmon and sea-trout under rearing conditions, and whether they can be carriers.

5. Summary of Suggestions

5.1 Considerations for future management

5.1.1 Adaptation of the offshore salmon catch to the necessary demand for spawners in the rivers - natural spawning as well as artificial rearing.

5.1.2 Protection of natural river habitats for important remaining salmon stocks and isolation of indigenous wild river stocks from introduced stocks.

5.1.3 Recording of diseases (Health control) in all hatcheries responsible for salmon and sea-trout production.

5.1.4 Reduction of environmental stress factors before and during the smolt release.

5.1.5 By national and international traffic with eggs and living fish, the recommendations given by the FAO/OIE should be followed. (FAO Fisheries Reports, No. 192: "Control of the spread of major communicable fish diseases".)

5.2 Future research works of high priority

5.2.1 Development of methods for estimation of quality of smolts at the time of release.

5.2.2 Further electrophoretic studies on the pattern of genetic diversity in the Baltic salmon stocks.

5.2.3 Development of methods for long-term storage of gametes.

5.2.4 Further studies on methods for determination of the degree of parr-smolt transformation.

5.2.5 Further studies on the survival of 1-year-old smolts after release.

5.2.6 Further studies on the influence of environmental stress on susceptibility to disease.

5.2.7 Survey of the possible relationship between disease and quality of smolts.

5.2.8 Studies on the relationship between the condition of spawners and certain diseases in the offspring.

5.2.9 Diagnostic tests and identification of the causal agent of UDN.

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