The Equity of Distribution of Costs and Benefits in New England Anadromous Fish Programs[1]

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Proc Symposium on Small Hydropower & Fish

An examination is of the costs and benefits of the Atlantic Salmon Restoration Program and their distribution leads to the conclusion that the current arrangement is neither equitable nor efficacious. It is proposed that it would be fairer and more effective for the government to assume responsibility for fish passages at existing dams, subject to PURPA. While this seems fairer, it may not be politically feasible.

INTRODUCTION

The Atlantic Salmon Restoration Program is the best known of a group of programs to preserve and restore anadromous fish in the rivers of New England. It is also the best documented. For this reason, I will use it as a paradigm for the entire effort. The program consists primarily of fish passage construction and the breeding and stocking of large numbers of smolts. Other activities, such as biological research and habitat improvement, are minor by comparison. There is no overall plan for the anadromous fish programs. There are strategic plans available for the Connecticut and Merrimack river basins, but these address only salmon, and treat each river system in isolation. The U.S. Fish and Wildlife Service has no written plans at all for shad or alewives, which are being "restored" to many more streams than are salmon. The Draft Environmental Impact Statement, which the Fish and Wildlife Service issued in August, 1984, is the only document available which discusses all of any single aspect of the program. It covers the entire salmon effort on a region-wide basis. Because it is the only comprehensive document available, I have used it as my program definition. The goal of the program[3] is to "restore reproducing Atlantic salmon runs" to New England's rivers. The implication is that after some years of stocking and the completion of the necessary passages, the salmon will be on their own, coming and going with only minimal human intervention[4], and breeding lots of little salmon in privacy in their own natural homes. Unfortunately, this is far from any probable actuality. To maintain reasonable population levels, stocking must be continued indefinitely throughout New England. This is not necessarily bad. After all, virtually all trout in the Northeast are stocked (and usually caught the same season). It does mean, however, that this program is a permanent establishment, or is of such long duration that the difference is moot.

Many environmentalists and environmentally concerned people evaluate the effects of development activities and environmental programs from a false baseline. They think and talk as if all such activities started from a "state of nature." This is no more realistic for modern environmental analysis than it was for eighteenth century political philosophy. In the environmental case, it leads to confusion between the concepts of mitigation and of enhancement. A new dam on a river with existing populations of migratory fish does affect a resource, the fishery. A fish passage in its design is indeed a mitigative measure, reducing the harm done by interrupting the stream flow. Turbine installation at a century-old dam, however, does not have any impact on the no longer existant migratory fish. A fish passage in such a project is a means of environmental enhancement, a genuine improvement of the situation as it now exists. The entire anadromous fish effort in New England is an enhancement activity, a valiant attempt at terraforming to improve the status quo.

As government programs go, this one is not ex-

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[3]Stolte, 1984, page 1.

[4]The Fish and Wildlife Service operates within or around a philosophical ambivalence. On the one hand, they abhor human intervention to improve fish mobility, eschewing "trap and truck" schemes in favor of relatively high-tech fish ladders and elevators. On the other hand, they perpetrate permanent breeding and stocking programs in order to maintain "natural" recreational fisheries, at least one of which (this one) is of unprovable effectiveness. See also Eicher, 1985, page 86.

pensive. The current plan projects expenditures of $113 million over the next 25 years[5]. Included in this sum is $44 million in private funds for the construction and operation of fish ladders and elevators. These private funds are provided by dam owners and operators, who are required to build and operate fish passages to the Fish and Wildlife Service's specifications. For the first decade of the program's existence, before 1978, this was not a problem. The dam owners involved were major regulated utilities, who simply transmitted the costs to the general public (i.e.: their customers) by including them in their rate bases, and made their normal profit on that investment, also. Since the passage of the Public Utilities Regulatory Policy Act in 1978[6] and the progress of the program into smaller tributary streams, this situation has changed. Fish passage construction is now being required of dam owners who have no ability to pass the costs on to customers, and who may, in fact, be forced out of business by the expenditure.

The benefits claimed for the salmon program are small, diffuse and very difficult to measure. They do not accrue to the people who must pay the costs, and only one of them can be characterized as a direct benefit to anyone or any group. The only benefit discussed in detail in the Draft Environmental Impact Statement is based on the travel cost to fish for salmon on the existing runs of northern Maine. This benefit accrues to a very small group of dedicated fishermen.

Are the costs and benefits of this program directly comparable? Are they fairly divided? That is, do those pay the costs receive appropriate benefits? And do those who do get the benefits pay a fair share of the costs? Does the current arrangement of costs and benefits contribute to the success of the program? In order to discuss these issues, it is necessary to define the categories and criteria I intend to use. This is not a matter of more or fewer dollars to some group, it is an issue of distributive equity and of the nature of the benefits derived from this program. Therefore, this is not a quantitative discussion, but a philosophical one, and numbers will be used only for illustrative purposes.

CONCEPTUAL STRUCTURE

I will examine the nature of costs and benefits, generally, and attempt to achieve a usable definition for equity. I will then discuss the specifics of this program, classifying the costs and benefits, and identifying the source or beneficiary of each. This discussion should lead to a conclusion about the equity and efficacy of the current program arrangements.

First, what are costs and benefits, and how can they be categorized? Costs include any money required to accomplish the goals of the program. In addition, they include any non-monetary resource which is used up or tied up (i.e.: committed) so as to preclude its use for other purposes. It is tempting to ignore such costs, for example, the cost of lost generation due to water diversions for fish passages, but to do so can distort the program analysis seriously.

Benefits include, but cannot be limited to, any direct monetary profit which results from the program. Also, improvements to or increases of resources which cannot be denominated in monetary terms must be considered benefits. Most environmental improvements fall into this last category.

Both costs and benefits come in two flavors, direct and external. Direct costs and benefits are the ones dealt with by classical economics. They can be counted in dollars and directly attributed to a product, project, or person. Direct costs are the costs of all the materials, supplies, labor, machinery and overhead used to create and distribute a product or service. Direct benefits, in classical economic terms, are limited to those who have paid the costs. Thus, the purchaser of a left-handed widget is assumed to have paid the full cost of its manufacture, and to receive the full measure of its benefit, to the exclusion of any others who might desire that benefit. In the economists' construct of perfect competition, the market, also called the "invisible hand", forces an optimal distribution of costs and benefits so that the economic pie is perfectly and completely divided. In this construct, change is a zero-sum game with any increase in someone's profit necessarily creating a decrease in someone else's. On the other hand, costs and benefits which do not clearly accrue to a specific project, product or beneficiary are both possible and actually rather common. One classic example of such a cost is water pollution from a manufacturing operation. Society as a whole must bear the cost of having polluted water or of cleaning it up, while the manufacturer and his customers reap the benefit of cheaper widgets. Similarly, an improvement in the appearance of one home can benefit the entire neighborhood in the form of increased land values. Economics texts call these non-direct costs and benefits externalities, or external economies and diseconomies. I'm going to call them external costs and benefits, so as to clarify later comparisons. Externalities are not controlled by the invisible hand of perfect competition. Indeed, in many cases, they are not controlled at all. Another important feature, for our purposes, of many of the externalities associated with environmental projects, is that they are not consumed. Air or water pollution, if untreated, harms, to a greater or lesser extent, everyone who contacts it. Similarly, enhanced real estate values or beautified scenery benefit all who are exposed to them.

The foregoing characteristics of costs and benefits are inherent to them. In addition to such intrinsic qualities, all costs and benefits accrue to someone or some group. The costs and benefits

5) Stolte, 1984, page 23.

6) Public Utilities Regulatory Policy Act, Public Law 95-617 & 96-294.

of widget making accrue to the manufacturer until a customer pays him the costs in order to gain the benefits. As was said earlier, externalities are not controlled, that is the benefits can accrue to people other than those who pay the costs who, in turn, may receive little or no benefit at all. External costs and benefits can accrue to individuals, to specific groups, or to the public at large. Benefits which do the latter are called "public goods." Similar costs, for reasons known only to economists, are not called "public bads." They are left nameless, perhaps in the hope that they will go away if ignored. Acid rain, for example, is currently residing in this category.

All this is prelude to the real topic under discussion, **equity**. The concept of equity is basic to our society and to economic thought. The concept is strongly affected by the frame of reference within which it is discussed. What discussion is available in the economic literature is usually scaled to equity between nations. The finest level of detail available discriminates between different income levels within a country. Discussion of equity between apparently similar groups are very hard to find.

According to the Oxford English Dictionary, equity means "fairness, impartiality, even-handed dealing." The word derives from the latin 'aequus, aequites', which means, simply, equal. Equity, however, does not mean equality. Equity involves treating all participants in an action with equal fairness, not necessarily just alike. Aristotle, in his Laws, says "Injustice arises when equals are treated unequally, and also when unequals are treated equally." Our problem here is to determine the nature of the groups to whom costs and benefits accrue, whether they are, indeed, equal and whether or not they are being treated equally.

DATA

The costs and benefits we will consider are those listed in the Draft Environmental Impact Statement, with one addition. I will start with the benefits. The only one seriously considered in the Impact Statement is recreational fishing. The value of this benefit is calculated using a "travel-cost" method, at $109 daily[7]. A total is then calculated for salmon fishing in New England, including all such angling. There are some problems concerning details of this computation. There is no question, though, that the consumer surplus associated with sport fisheries is a benefit of the program.

Other benefits listed in the Draft Environmental Impact Statement are improved resource management, increased non-angling tourism, improved instream mobility (of all fish), and augmented ocean fisheries. None of these are quantified, although one, at least, can be. Some researchers claim that as much 80% of the released stock are caught by commercial marine fishing operations from other countries[8]. A simple calculation from the hatchery release numbers and the price of imported salmon ($6-8 per pound fresh, $17-35 per pound smoked) would yield a monetary value for the ocean catch. One other benefit, not claimed by the Fish and Wildlife Service must be included in our inventory. Many environmentally concerned people would see as the greatest benefit of this program the improved strength and resilience of a healthier, more diverse ecosystem.

So, we have five benefits claimed by the Fish and Wildlife Service and one more which must be acknowledged on their behalf. Two of these, the recreational and commercial fisheries, are capable of enumeration and monetary valuation. The other four can not, and perhaps should not, be quantified. They are, however, real and should be considered. If there are other benefits which both the Fish and Wildlife Service and I have overlooked, they are most likely to be unquantifiable and without specific source or beneficiary. They will not change this argument. All six listed benefits of the program are external benefits, that is they are not limited to those who pay for them, nor is their acquisition or consumption regulated by any market mechanism.

To whom do these benefits accrue? Primarily to the public at large. The consumer surplus associated with recreational fishing accrues to a relatively small group of dedicated sportsmen. Potentially, anyone may join this group. If everyone does, then the group becomes congruent with the general public. If no one new joins, we have this group as it now is, very small, very vocal, and rather affluent. Somewhere between these two extremes is a reasonable picture of the beneficiaries of improved fishing, a not large segment of the general public who are devoted to fishing for one special fish. The augmented ocean catches accrue to the commercial fishing fleets of Canada, Ireland and Norway. There is no U.S. based marine salmon fishery. For this reason, it is arguable that the ocean catch improvement is not a benefit at all. It is certainly no benefit to the U.S. economy. Improved instream mobility actually accrues directly to the fish, and indirectly to the public at large as part of the improved ecosystem. Better resource management, increased tourism and improved ecological health accrue only, and directly, to the public at large. Thus, all of the claimed benefits of this program fall into the category of "public goods." The only benefit which accrues to a definable group is "free" to that group, thus it is still an external benefit, in that the costs are paid by someone other than the beneficiaries, and those who do pay have no control over the benefit. Since it is, theoretically, available to the whole society, I feel that it is, in fact, a public good.

[7] Stolte, 1984, page 76.

8) Sununu, John H., 1985, Comments of the State of New Hampshire on Draft Environmental Impact Statement for the Restoration of Atlantic Salmon, unpublished.

The costs of this program are, not surprisingly, much easier to define, count and discuss than the benefits. The two biggest items on the list are the construction and operation of hatcheries and fish passages. Other costs which are, or should be, quantified and justified are fisheries research[9], cleanup of water pollution from the hatcheries, and lost generation due to water use by the fish passages. Non-quantifiable costs include lost fishing due to the expected need to curtail sport fishing while the salmon population is becoming established[10], and the loss or reduction of currently existing fish populations due to ecological competition[11].

Direct costs of the program, which are enumerated but not detailed in the Draft Environmental Impact Statement, are those associated with hatcheries, fish passages and research. Hatchery and research costs accrue to the Fish and Wildlife Service, while fish passage costs are borne by dam operators. In New England, where most hydro development involves existing dams, the cost of fish passage construction is frequently a major expense. Not only does this cost a hydro developer extra money, lowering his return on investment, its operation reduces the available water for generation. Contrary to the claim of the Draft Environmental Impact Statement, the foregone revenues from this lost generation is a real cost of the program, and must be calculated and included any economic analysis of the program.

The cost of lost generation is not only an external cost accruing to the hydroelectric industry, it involves an additional cost accruing to society as a whole, in that every kilowatt not generated with local, renewable resources is replaced by generation using fossil or nuclear fuel, or is imported from Canada. The difference between these costs must be calculated. Other external costs of this program are pollution and its effects, losses of other fish species, and restriction of fishing opportunity.

I have listed seven costs of the salmon program. Two of them, the costs of hatchery activities and of research, accrue to the public by way of the Federal government. These can be viewed as directly purchasing the public goods of fishery resources and knowledge. Three and a fraction accrue to the public, but are economically uncontrolled external costs. These are water pollution, lost or reduced fish populations, lost angling opportunities, and the marginal cost of obtaining replacement energy for the foregone generation. The remaining costs, fish passage expenses and the immediate revenue losses from foregone generation accrue, as externalities, to the hydro industry.

Is the hydroelectric industry a single, unified economic group? No. It is clearly subdivided into three different classes, the public (i.e.: government) utilities, the regulated, investor-owned major utilities, and the small power producers operating under PURPA. Each of these subgroups has a different economic position and outlook. The public power authorities, mostly municipalities in New England, are subject to state regulation of their retail rates, and FERC regulation of their wholesale ones, if like the Power Authority of the State of New York, they sell at wholesale. They are allowed to recover their costs in full, without any profit. The investor-owned major utilities are regulated by the same agencies. They, however, are allowed a specific rate of return (profit) on all costs included in their rate bases, which usually means virtually all costs actually disbursed. Small power producers sell to regulated utilities, at rates set by individually negotiated contract with the purchasing utility. These costs are related to the "avoided" costs of the purchasing utility according to a formula set by each state public utilities agency. There is no provision for any reasonable return on investment or any profit margin. Unlike regulated utilities, small hydro producers have no protected profit, in fact, they may not be able to recover their actual investment. Therefore, the hydroelectric industry should be viewed and considered as three separate groups.

EVALUATION

The benefits of this program are all externalities. They all apply, at least potentially, to all citizens equally, and thereby fall into the category of public goods. (There is one possible exception: ocean fishing, which accrues to no citizen of this country, nor to its society, but exclusively to the societies and industries of other countries.) It has been argued that sport fishermen constitute a small, select, special interest group. Since there are no bars to entry into this group for any interested person, it should really be considered as "public-at-large." So the whole society, rather than any individual or group receives the benefits of this program.

The direct, monetary costs are divided about equally between the government and the private hydropower industry. The external costs, both monetary and unquantifiable, are also divided, between society and the hydro industry, with the hydro industry drawing all the monetary external costs. Thus, hydro developers are bearing half the costs of this program, from which they derive no benefit, with all of those benefits accruing to society as a whole.

With these distinctions in mind, let us consider two questions concerning imposing fish passage costs on the hydroelectric industry. One: is it equitable? and two: is it effective?

The answer to the first question is: No. It is not equitable (fair) to impose identical costs

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[9] Stolte, 1984, page 75, note omission of research from list of project costs included in benefit-cost analysis.

[10] Stolte, 1984, pages 42, 81-82.

[11] Stolte, 1984, pages 42, 80, 85.

which confer no benefits equally on unequal groups. Small hydro producers have no ability to recover these costs, unlike regulated utilities. This is clearly a case of equal treatment of unequal groups.

The imposition of fish passage costs on hydro developers appears to stem from the belief that they enjoy protected profits from their licensed use of the public resource. Before PURPA, this was true. It no longer is. It is also argued that hydro developers get tax credits to defray this sort of investment. This is not the case. Energy tax credits are intended to encourage high risk investment in all types of energy. They exist for all energy investments, and are actually higher for wind power, which has no corresponding environmental requirements.

The second question, concerning efficacy, must also be answered with an unequivocal: No. This is not an economically effective way to achieve salmon restoration. What is currently being done amounts to the imposition of what economists call a "Pigovian tax." Pigou theorized that, in the context of perfect competition, the production of public goods and bads could be optimized by imposing taxes and subsidies such that a business's total costs reflects accurately the social cost or benefit created, as well as his own[12]. This is the principle behind effluent taxes on water polluting industries, for example. There are two objections to applying this theory to fish passages at hydroelectric dams. The first is that the public utility system in this country is not even imperfectly competitive. The profit margin of the major utilities is not affected, so they experience no change in their economic incentives. The second is that, within this theory, the production of a public good should be subsidized, not taxed. This maintains the firm's total profit to compensate for the revenues foregone in producing the public benefit.

It can be easily shown that, under current conditions, no dam owner has any incentive to further this program. Any delay in building, starting or maintaining a fish passage is to the advantage of the power producer. After all, what can the Fish and Wildlife Service do if an elevator malfunctions? Even more vexing is the problem of cancelled projects or bankrupt or uncreditworthy producers. Both situations leave an existing dam without a fish ladder. It is neither ecologically, economically nor politically feasible to simply destroy non-conforming dams. At the same time there may be very serious problems of ownership and liability which make compliance unenforceable. There are no simple answers to the questions raised by this analysis.

[12]Whitcomb, 1975, pages 9-18.

PROPOSALS

Having spent all this time and paper explaining what's wrong with the current cost-benefit arrangement in this program, I will now propose some possible improvements. These are suggestions, meant to stimulate discussion and hopefully legislation. They are intended as openers, not the final word.

One measure discussed whenever hydro people gather is charging user fees of salmon fishermen. The Fish and Wildlife Service's Duck Stamp Program is usually cited as a precedent for this. The fishermen are already paying a Federal excise tax on all their gear. This is the source of the "Dingell-Johnson" funds used for this and other fisheries programs. So, in reality, they already pay a user's fee. Hunters pay a similar levy, as well as an additional user's fee for specific kinds of game, such as the Duck Stamp for waterfowl. So, it would seem that a "salmon stamp" would be a reasonable charge. Such a fee would be equitable vis-a-vis other sportsmen, and would make the only direct beneficiary of this program pay more of its real costs.

Another possible change would be to provide subsidized or low-interest government loans for fish passage construction costs. For marginal small power producers, something like this is needed as an absolute minimum. No banker in his right mind will loan money to a low-profit business for a capital expenditure which will only reduce the firm's available revenues. A PURPA producer who ardently backed the salmon program would still have great difficulty funding the required construction. If no other change was made, this would at least render cooperation by the small power producer a real possibility. It would improve the fairness situation, but is only a partial answer.

The Federal Power Act, in its original wording, made a distinction between new construction, where fish passages could be integrated into the plans, and the addition of such facilities to pre-existing dams. It specified that where fish passage or navigation facilities were not included in the original plans and license, the owner should simply convey to the government title to all necessary real estate and water rights[13]. Responsibility for actual construction and operation of the facility then devolved on Washington. I would propose that the Federal government reassume responsibility for retrofitting fish passages at existing dams and for operation and maintenance of the system. Such a return to the original philosophy of this law has many advantages.

Treating fish navigation in the same manner as boat navigation makes coordination of these functions much easier. The Corps of Engineers is currently evaluating extending navigation much farther

[13]Federal Water Power Act, Section 18(b), United States Statutes at Large, 1920, June 10.

upstream on the Connecticut River. The history of the St. Lawrence Seaway demonstrates that fish utilize navigation locks with ease. The reverse is, of course, ridiculous, but the point is that if the Corps decides to pursue this, pending fish passages will be rendered superfluous.

Federal ownership and operation would mean improved efficiency in many ways. Because of the inequities in the current situation, hydroelectric developers have strong incentive to drag their heels, and no reward for active furtherance of the program. Coordinating fish passage operations with the upstream progress of the run would be very easy if one agency controlled the entire sequence. If fish passage watching actually became a popular pastime, the government is better able to cope with the liabilities involved in public access than is any private developer. Finally, enforcement problems would be eliminated. The program could be scheduled and kept approximately on schedule, since lack of cooperation and ordinary private sector business delays would no longer be a factor.

Economic arguments also favor such an arrangement. The Pigovian tradition is the major body of economic theory agruing for private production of public goods and services[14]. All the permutations of Pigou's theory, however, share the precondition that they only function in a situation of perfect competition. By law, the electric power industry is noncompetitive. In situations lacking perfect competition, it is generally conceded that no economic manipulation can induce optimal production of public externalities[15]. The real world demonstrates the truth of this inability. For instance, it is virtually impossible to tax industry effectively to reduce pollution to desirably low levels. It is usually cheaper for a firm to cheat and pay the fine only if it gets caught. This is just one illustration of why many economists believe that the government is the best supplier of public goods and services. The rationale behind this theory is that it transfers the costs of the public goods to their true beneficiaries, the public.

Government ownership and operation of the fish passage system would, then, be more equitable, simpler, and more economically efficient. It has a great deal to recommend it as an alternative to forced business closures, breached dams, and abandoned facilities which can easily result from attempting to enforce this sort of construction program on businesses with limited resources.

SUMMATION

I have shown that the cost-benefit distribution of the salmon program, as it is currently constituted, is far from fair. This comes from both sides of the equal treatment coin. Equals, that is sport hunters and fishermen, are treated unequally. That is, anglers pay less of the actual cost of maintaining their prefered game populations than do hunters. There is no evidence of any difference in the ability to pay, the desirability of the activity, or the pleasure derived. On the reverse side, all hydroelectric generators are treated equally, although it clear that they are divided, as a matter of law, into different groups, with different resources and responsibilities.

If we attempt to consider the rest of the anadromous fish restoration effort, the inequity is the same or is amplified. Many more fish passages are required, but the resultant fishery is not considered as valuable, so the economic analysis does not improve, and may become less favorable. This matter should be studied and discussed.

I have proposed that the economic inequity of this program would be improved by some combination of user fees for anglers and financial relief for small hydro developers. This, of course, would require Federal legislation. It may not be possible. A paper like this is the best of all possible worlds. I can remake any part to suit. Federal ownership and operation of fish passages, which logic labels as the fairest and simplest solution to many of the salmon program's problems, is almost certainly not politically viable. But the judgement about fairness should be separated from the judgement about feasibility. Only if we seriously consider what constitutes an ideal solution, can we arrive at reasonable and effective trade-offs, and at programs that can succeed.

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[14] Whitcomb, 1972, pages 9-18.
[15] Mansfield, 1975, pages 520-521.

This paper not to be cited without prior reference to the Council[x)]

International Council for the Exploration of the Sea

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Anadromous and Catadromous Fish Committee

REPORT OF THE ICES/ICNAF JOINT WORKING PARTY ON NORTH ATLANTIC SALMON

Dublin, March 21-24, 1972

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Report of the ICES/ICNAF Joint Working Party on North Atlantic Salmon

March 1972

A. INTRODUCTION

1. The Working Party met in the Department of Agriculture and Fisheries, Dublin on 21st - 24th March 1972. The following were present.

A.W. May	Canada
C.P. Ruggles	Canada
O. Christensen	Denmark
Sv. Å. Horsted	Denmark
J. Møller Jensen	Denmark
I.R.H. Allan	England and Wales
A. Swain	England and Wales
P. Davaine[a]	France
R. Vibert	France
F. Thurow	Federal Republic of Germany
T. Gudjonsson	Iceland
Miss E. Twomey	Irish Republic
A.E.J. Went	Irish Republic
K.U. Vickers[a]	Northern Ireland
L. Rosseland	Norway
W.R. Munro	Scotland
B.B. Parrish (Chairman)	Scotland
K.A. Pyefinch (Rapporteur)	Scotland
R. Hennemuth[a]	USA
J. Møller Christensen	ICES

a Present for part of the meeting only

Apologies for absence were received from G.J. Ridgway (USA) and A. Bogdanov (USSR). A representative from Iceland attended for the first time.

2. The Working Party received the latest information available on the West Greenland and Norwegian Sea salmon fisheries, made further assessments of the effects of these fisheries on total and home-waters catches and considered in detail the plans proposed by the Tagging Planning Group for the International tagging programme at West Greenland in 1972.

B. WEST GREENLAND FISHERY

3. At its annual meeting in 1970, ICNAF adopted a resolution setting out a number of regulatory measures for the salmon fishery in its Convention area during 1971. This resolution is set out in Appendix 1. These measures, which came into force on 1 January 1971, included a limitation of the aggregate

tonnage of the fishing vessels employed or the catch taken by each contracting Government to the 1969 level and the prohibition of the use of any monofilament nets not acquired before 1st July 1970. The events in the West Greenland fishery in 1971, dealt with below, are considered in the light of these measures.

1. Statistics and Composition of the Fishery

4. The salmon catches at West Greenland in the years 1960-71 (the data for 1971 are provisional) are shown in Table 1. In 1971, as in the previous year, it was not possible to separate the catch by Greenland vessels into its drift-net and gill-net components.

5. The total catch in 1971, according to present information, was 2615 metric tons, which is a substantial increase over the catch for 1970 (2146 metric tons) and is the highest catch yet recorded at West Greenland. Though this catch cannot be completely separated into drift-net and gill-net components, the former was, almost certainly, the larger. On the basis of the catches made by research vessels, the size and age composition of the salmon stock exploited were very similar to those in previous years. The stock consisted almost entirely of one-sea-winter fish which had migrated to sea as two- or three-years-old smolts. The remainder consisted of fish older than one-sea-winter. The sex ratio (3.1 females: 1 male) was also similar to that in previous years.

6. As in previous years, the total catch shown in Table 1 includes a small catch (less than 10 metric tons) taken at Angmagssalik on the east coast of Greenland. The distribution of the fishery in 1971 is shown in Fig. 1. This indicates that the drift-net fishery extended all along the west coast, from the Disko area in the north to the vicinity of Julianehåb in the south and that gill-netting was carried out at a number of places along this length of coast.

7. The table below shows the number of vessels (excluding Greenland-registered vessels) which have taken part in the West Greenland drift-net fishery from its inception in 1965.

Year	Number of Vessels				
	Denmark	Faroe	Norway	Sweden	Total
1965	0	1	1	0	2
1966	0	1	1	0	2
1967	4	4	3	0	11
1968	10	2	4	1	17
1969	15	6	11	2	34
1970	13	7	10	1	31
1971	11	3	8	0	22

8. This shows that the number of non-Greenlandic vessels participating in the drift-net fishery in 1971 was fewer than in 1970 (assuming that no Swedish vessels fished at West Greenland in 1971), yet the total catch taken by them was approximately 350 metric tons greater. This must mean either that the abundance and/or availability of salmon in the offshore area was substantially greater in 1971, giving rise to higher average catch rates per vessel, and/or that the total effective fishing effort was higher despite the fewer vessels, due to an increase in their fishing power and efficiency. Although insufficient data are available for the changes in fishing power and efficiency to be determined accurately it is known that in recent years improved, more efficient drift-net gear has been adopted progressively by the fishing fleet. Changes in the gear which may have contributed to the greater efficiency are:-

(a) The use of monofilament nets, which comparative fishing experiments have shown to give higher catch rates than the polyfilament nets used previously. Monofilament nets were first used by a few vessels in 1969 and their use increased rapidly thereafter and, in 1971, most of the drift nets used were monofilament.

(b) The introduction, by some vessels, of a floating, unbuoyed drift-net head line instead of the normal buoyed one. Limited comparative fishing experiments have shown that nets rigged in this new way gave higher catch rates.

(c) A progressive adoption of the most efficient drift-net mesh size.

(d) An increase in the number of nets shot per day by some vessels, through the use of monofilament nets during daylight.

9. Although the combined effects of these factors cannot be estimated accurately the available data suggest that between 1968 and 1971 they, together with a general increase in crew 'skill and experience', resulted in at least a doubling of the average fishing power and efficiency combined of the individual fishing operation and that, therefore, in 1971 the total effective fishing effort by the drift-net fleet was not lower than in 1970. Thus it seems likely that the increase in drift-net catch in 1971 was not primarily due to greater stock abundance, as the average catch per vessel would suggest.

10. These data indicate clearly the limitations of the vessel tonnage regulation introduced in 1971 as a method of stabilising effective fishing effort in a fishery in which major technological and other developments affecting fishing power and efficiency were taking place. Nevertheless the measures introduced did prevent the entry of additional tonnage into the fishery.

2. Origin and Destination of Salmon at West Greenland

(a) Recaptures of Fish at West Greenland Tagged in Home Waters

11. Recaptures during 1963-71 of salmon tagged in home waters either as natural (wild) or hatchery-reared smolts and as kelts are shown in Tables 2, 3 and 4. These tables include new data and revisions of data presented in earlier reports of the Working Party.

12. The latest data show that, in 1971 as in previous years, fish tagged in the main salmon-producing countries were recaptured at West Greenland. The Working Party draws attention to the recoveries at West Greenland of salmon tagged as wild smolts in the extreme south-west of France in 1969 and 1970. Additional tags were reported from Norway bringing the total for that country to eleven recaptures from the West Greenland area. Salmon occurring in West Greenland are, therefore, now known to originate on the European side from about latitude 63°N to about 44°N, which is almost the southern limit of the species. Attention

is also drawn to the high number and recapture rate, in 1971, from hatchery-reared smolts tagged in the USA in 1970. Seven of these tagged fish, together with one from Canada, were taken in the small east coast catch mentioned in para. 6, which indicates that salmon from North American rivers had migrated far up the east coast of Greenland.

13. Some fish tagged as kelts in home waters have been recaptured at West Greenland, usually in the autumn following release and, in particular, there was a substantial increase in the number of Canadian tagged kelts recaptured in 1970 and 1971.

14. The Working Party agreed, as at its previous meetings, that it was not possible to obtain reliable estimates of the proportions of the salmon stock at West Greenland originating from individual countries from the tag recapture data. However, the latter continue to indicate that the major part of the West Greenland salmon stock is derived from rivers in Canada, Great Britain and Ireland.

(b) Recaptures of Fish Tagged at West Greenland and in the Labrador Sea

15. In 1970 and 1971, British, Canadian and Danish scientists conducted further tagging experiments at West Greenland. Seven local recaptures were made from 1 to about 30 days after release. Of the fish tagged in 1970, four recaptures were made in home waters (Canada 2, Ireland 1 and Scotland 1). During the 1971 experiment a hatchery-reared fish tagged in the USA in May 1970 was recaptured in Diskofjord and released after re-tagging.

16. Additional tagging was conducted in 1970 and 1971 by Canadian scientists in the Labrador Sea and a total of 86 fish was tagged in the area. Eleven recaptures have been reported; 6 in the northeast of Newfoundland and 5 in Chaleur Bay on the borders of the Canadian provinces of Quebec and New Brunswick.

17. Table 5 gives details of the recaptures of fish tagged at West Greenland and in the Labrador Sea from 1965 to 1971 inclusive. This shows that 38 recaptures have been reported in home waters, 27 of which were of salmon tagged in the West Greenland area. Of the latter, 12 were recaptured in North America

(Canada) and 15 in Europe (Great Britain, Ireland and Spain). Attention is drawn to the recapture in the River Ason in Spain, which is near the southern limit of the species on the eastern side of the Atlantic.

(c) Other Studies

18. Investigations were continued in 1970 and 1971 on biochemical characters and parasite fauna (as biological tags) in relation to the study of the origin and mixing of salmon at West Greenland.

19. Canadian investigations of blood serum protein in association with parasite studies have provided promising results. Blood samples of 204 Atlantic salmon taken in the Labrador Sea and the West Greenland areas in the autumn of 1970 were analysed by Canadian scientists, using methods described in previous reports. Forty-nine per cent of the fish were identified as North American in origin and fifty-one per cent as European, a result similar to the proportionate returns of salmon tagged at West Greenland and recaptured in home waters (para. 17). Further work is in progress to check these results.

20. Research on transferrin polymorphism which was carried out in England, had indicated that a certain proportion of the salmon can be distinguished as to the continent of origin. An analysis of 984 blood samples collected in the West Greenland area in 1970 showed that 18(2%) could be specifically identified as fish from the UK, 159(16%) as fish from North America though the remaining 807(82%) could not be allocated between the two populations. Further research on these latter fish is in progress. With the co-operation of a Danish commercial fishing vessel, 1,830 blood samples were collected in the West Greenland area in 1971 and these are now being analysed. Work on various biochemical aspects of this problem is also currently being undertaken in other countries.

21. Work on parasites as biological tags was continued in 1970 and 1971. The Canadian results indicate that the abundance of the parasite *Anisakis simplex* in North American salmon at West Greenland and in home waters is consistently lower than for European salmon, whereas the parasite *Eubothrium crassum* is more

prevalent in West Greenland and in North American than in European salmon.

22. Other methods for the separation of stocks are being investigated. Of these, the use of scale characteristics, which has proved so successful in the case of Pacific salmon, appears to be promising. Work in this field is in progress in a number of countries but the results are not yet sufficiently advanced for the full value of this method to be assessed.

3. <u>Assessments of the Effects of the West Greenland Salmon Fishery</u>

23. Previous assessments by the Working Party of the effects of the West Greenland fishery on home-waters stocks and catches of two- or more sea-winter salmon have been based on estimates of the changes in total weight (i.e. the resultant of natural mortality and growth) which would have occurred in the salmon comprising the West Greenland catch had they not been caught there and, if surviving, had returned to home-waters in North America or Europe (ICES, Coop. Res. Rep., Nos. 8, 12, 24). The losses to the combined North American and European home-waters stocks for a West Greenland catch of around 2,000 metric tons, as in 1969 and 1970, was estimated in this way to lie in the range 1,100 - 2,700 metric tons, and to the home-waters catches of between 650 - 1,600 metric tons (using upper and lower values of instantaneous natural mortality rate of 0.02 and 0.1 per month respectively). The same general levels of estimated losses were obtained from the simulation of home water catches of two- or more sea-winter salmon in Canada and the UK returning from West Greenland, assuming they had all been present in the fished area there (for details see ICNAF Comm. Doc. 71/14 and ICNAF Res. Doc. 71/72). It is evident from the West Greenland catch data in Table 1 that the losses to the home-waters stocks and catches resulting from the West Greenland fishery in 1971, estimated by the same method as in previous years, was probably somewhat greater than the above estimates for 1969 and 1970.

24. In the absence of accurate measures of the relative contributions of salmon from different countries to the West Greenland stock it is not possible to

estimate reliably the losses on an individual country basis. However, the information available from tag recaptures (paras. 14 and 17) and biochemical studies (para. 19) suggests that, in recent years, the stock at West Greenland was composed of salmon from North America (almost entirely Canada) and Europe (mainly Great Britain and Ireland) in roughly equal proportions, suggesting tentatively that the home-waters losses are also roughly equally divided between them.

25. The results of detailed studies of the recaptures at West Greenland of salmon tagged as smolts in Canadian rivers show that individual rivers make markedly different contributions to the exploited stock at West Greenland. They indicate that only a small proportion of the natural smolt production in rivers running into the Bay of Fundy contributes to the West Greenland stock but, for other Canadian rivers where smolts have been tagged, especially in the Gulf of St. Lawrence, the contribution has been substantial. This means that Canadian home-water losses also differ markedly between river stocks. On the basis of available tag recapture data and taking into account the differences in stock size, these losses may be greatest for the stocks in the rivers running into the Gulf of St. Lawrence, of which the Miramichi is the largest.

26. The above assessments of home-waters losses refer to the direct, immediate effects on the population of salmon which, if not caught and if surviving, will return to home waters in subsequent years. They take no account of the possible effect of a reduction in spawning stock size, resulting from the exploitation at West Greenland, on future smolt production in home waters.

27. Data from the Miramichi River stock in Canada show that there has been a steady decline in the abundance of two- or more sea-winter salmon entering the river since 1960 and of grilse since 1965, resulting in a marked reduction in the egg production potential of the spawning stock to a level in 1969-71 at which smolt production is probably severely reduced. Although this decline began amongst year-classes produced before the West Greenland fishery reached a high level and was therefore mainly due to other causes it is possible that the West Greenland fishery has contributed to the decline in the most recent years.

C. NORWEGIAN SEA FISHERY

28. At its annual meeting in 1970, NEAFC adopted a resolution setting out a number of regulatory measures for the salmon fishery in its Convention area during 1971. This resolution is set out in Appendix 2. These measures, which came into force on 1st January 1971, included a closed season (1st July to 5th May), closed areas ((i) east of Longitude 22°E and, (ii) between Latitudes 63° and 68°N east of the Greenwich meridian), a minimum size for salmon caught (60 cm.) and a minimum hook size (gape not less than 19mm.). These measures have affected the catches in 1971 to such an extent that, in several respects, they are no longer comparable with the catches of previous years.

1. Statistics and Composition of the Fishery

29. Data on the catches taken and the number of vessels operating in the Norwegian Sea fishery in the years 1965-1970 and provisional statistics for 1971 are given in Table 6. These show that the rapid growth of the long-line fishery since 1965 was halted in 1971 as a consequence of the new regulations. In fact, the fishing effort was lower and the catch only amounted to about half that in 1970.

30. Information on the catch-per-unit-effort in the long-line fishery in 1968-1971 is given in Table 7. Judged from information on the fishery in 1969 and 1970 abundance and/or availability of salmon in the exploited area seems to rise gradually from February until April and decline during the remaining part of the season. The Danish catch-per-unit-effort data for May-June was approximately the same in 1969, 1970 and 1971. It should, however, be noticed that observations in 1970 and 1971 show a marked decline of abundance and/or availability of salmon during June. As the fishery in 1971 was extended over a longer period in June, the catch-per-unit-effort data for this month are not strictly comparable with those for previous years.

31. Owing to the establishment of closed areas in 1971, the long-line fishery was restricted to north of Latitude 68°N and west of Longitude 22°E from the

Norwegian fishery limit to a distance of 360 nautical miles from the coast (Fig. 2). The main fishing was concentrated within 100 miles from the coast. No commercial salmon fishing was conducted in the vicinity of the Faroe Islands in 1971.

32. In previous reports, it has been pointed out that about 90% of the exploited stock in the Norwegian long-line fishery in the period February to mid-May had already spent two or more winters in the sea but that, after mid-May one-sea-winter fish formed an increasing proportion of the catch. As the fishing season in 1971 was restricted to May-June it was to be expected that, in comparison with previous years, one-sea-winter fish would form a greater proportion of the total catch. This was supported by Danish catch data which showed that about 15-20% of the catch (15% of the landings) consisted of this sea age group, compared with 10% in 1970. Prohibition of fishing in the closed areas, where the catches of former years were especially dominated by older salmon, probably also contributed to this increase. It would, however, probably have been greater but for the minimum fish and hook size regulations. The former resulted in some discarding of fish below 60 cm. in length.

33. As in previous years, the condition factors of the two-sea-winter salmon caught in the long-line fishery varied widely but were, on average, low compared with salmon of the same sea age caught at various localities in Norwegian coastal waters. However, the difference between the condition factors of the salmon in the two fisheries in 1971 (10-15%) was less than in previous years (20-30%).

2. <u>Origin and Destination of Salmon in the Norwegian Sea</u>

34. Information on recaptures in the Norwegian Sea fishery of salmon tagged as smolts in home waters is given in Tables 2 and 3 and, for tagging experiments in the Norwegian Sea, in Table 8. Data for 1971 indicate that, as in previous years, the great majority of salmon fished in the Norwegian Sea originated from and returned to Norwegian rivers, though some recaptures were recorded from rivers in the USSR.

35. During the spring in 1969, 1970 and 1971, Faroese and Scottish scientists undertook tagging experiments off the Faroes. A total of 666 salmon was tagged and 29 recaptures, shown in Table 9, have been reported, 15 in Scotland, 5 in Norway, 5 in Ireland, 2 at West Greenland and 1 each in England and the USSR. Most of the recaptures were made in the year of tagging. Of those recovered in home waters, 19 were grilse and 7 were two-sea-winter salmon (the sea age of the recapture in the USSR is not known). The two West Greenland recaptures are of particular interest as they suggest that the Faroes may be on one of the routes taken by European salmon on their way to Greenland.

3. Assessment of the Effects of the Norwegian Sea Fishery

36. In 1970, data on the age composition of long-line samples showed that, as in previous years, about 90% of the exploited stock in the Norwegian Sea consisted of fish which had spent two or more years in the sea and that therefore the effects of this fishery on home-waters stocks and catches would be confined mostly to two- or more sea-winter salmon. Comparable data for 1971 showed that with the implementation of the seasonal and area closures, the proportion of these salmon in the long-line catch decreased somewhat, averaging approximately 80%.

37. The assessment of the effects of the Norwegian Sea fishery on total salmon yield (Norwegian Sea plus home waters) was approached, as in previous years, using data on the increase in weight of the fish from the period of peak fishing in the Norwegian Sea to the period of peak fishing in Norwegian coastal waters and on the proportion of fish present in the fished area which, if not caught there, would subsequently be caught in the home-waters fisheries. Although accurate measures of this proportion are not available it is possible to estimate a limiting value for it, above which the presence of the long-line fishery would lead to a decrease in the total catch from the population of two-sea-winter salmon. For 1970, it was estimated to lie in the range 77-83% and for 1971, when the peak of the fishery in the open sea occurred later than in 1970 (due to the closure at the beginning of the season), it was approximately 90%. The

available data suggest that the average exploitation rate of two-sea-winter salmon in the river systems to which these salmon, if surviving, would return, was below these levels (estimates from a simulation model indicated that it lay between 50-80%) and that therefore the Norwegian Sea fishery in both 1970 and 1971 resulted in a larger catch of two-sea-winter salmon than would have been taken in its absence. It should, however, be pointed out that the overall average 'quality' of the catch taken in the offshore fishery in both years was lower than that taken in home waters.

38. In the last published report of the Working Party (ICES Coop. Res. Rep., No. 24, 1971), a provisional assessment was made of the losses to the two-sea-winter salmon stock in home waters resulting from the long-line fishing in the Norwegian Sea. On the basis that the loss due to natural mortality between the time the salmon are exploited in the open sea and their return to home waters is about the same as the increase due to growth, it was estimated that the losses to the home-waters salmon stocks to which two-sea-winter salmon in the Norwegian Sea return would be roughly the same as (but not greater than) the Norwegian Sea catch. It follows, therefore, that in 1969 and 1970, the estimated loss to the home-waters stocks was around 800-1,000 metric tons. The corresponding estimates of losses to the home-water catches in these years were probably within the range 400-500 metric tons.

39. Since, as shown in Table 6, following the implementation of the closed season and area regulations in the Norwegian Sea, the long-line catch in 1971 was substantially smaller than in 1969 and 1970, the estimated losses to the home-waters stocks and catches were correspondingly smaller. The catch of two-sea-winter salmon by the long-line fishing in 1971 was about 400 metric tons so the estimated loss to the home-water stocks of these fish was approximately of this magnitude and the loss to the home-water catch was within the range 200-300 metric tons. As in previous years, most of this loss would occur in the Norwegian home-waters fishery.

40. It must be emphasised that, as for the West Greenland fishery, these assessments losses concern only the immediate direct effects of the long-line fishery; they take no account of any possible longer term effects from possible decreases in smolt production and salmon recruitment, resulting from a fishing-induced reduction in spawning stock. At present, too little is known of the relation between spawning stock size, smolt production and recruitment of grilse and salmon to the Norwegian stock for these effects to be estimated.

D. HOME-WATERS CATCHES

41. Catch statistics for the home-water fisheries are given in Table 10 and catch-per-unit-effort data are given (in greater detail than in previous years) in Table 11. Information on changes in catches in individual countries is summarised below.

42. England and Wales The overall picture presented by the salmon and grilse catches for 1971 is that of a reduction from the 1970 level; due mainly to reduced net catches, the rod catches having remained steady at the low level experienced over the past four seasons compared to the previous six seasons. The total catch for 1971 by all methods was, however, still above the average for the period 1960-70. The major component in the overall catches has again been the catch made by the commercial net fishery in the northeast coastal area. Apart from this, the remainder of the net catch for England and Wales has remained steady over the period 1960 to 1971. Severe reductions in the rod catches of the early-running two-sea-winter fish have continued in many rivers, but not in all. A factor in this decline may be the incidence of salmon disease (UDN). The counts of early-running two-sea-winter salmon in the River Coquet (Northumberland) have shown an overall decline since 1968 (but a slight increase in 1971) and have formed a decreasing proportion of the total years' runs of salmon and grilse in that river. The data from the River Axe (Devon), where a count is also made, show a decline in two-sea-winter fish over the last three years.

43. <u>France</u> Though the catch cannot be given precisely, there are indications that the total catch of salmon and grilse has decreased in recent years, mainly due to a decrease in the salmon, particularly in the River Adour.

44. <u>Iceland</u> The catch of salmon and grilse combined in 1971 (205 metric tons) was the highest yet recorded. Since 1960, annual catches have generally shown an upward trend, coinciding with a great increase in smolt rearing during that period.

45. <u>Ireland</u> The total catch (salmon plus grilse) in 1971 was similar to that of previous years. However, there was a sharp decline in the salmon catch compared with 1970, which was the first year in which a breakdown was available into salmon and grilse. Some long-term statistics are available for a number of the major river systems and from these it is evident that the decline in early-run fish, which was first noted in 1967, was much more marked in 1970 and 1971. There was a slight decrease in the grilse catch in 1971 but it was still well above the average for the decade in the major salmon rivers where a breakdown in statistics is available.

46. <u>Northern Ireland</u> The commercial catch of salmon plus grilse in 1971 (including 50% of the Foyle total) was 191 metric tons. This is a decrease of 36% from the previous year's catch and represents 58% of the average for the period 1967-70.

47. <u>Norway</u> Provisional figures for the salmon plus grilse catch in 1971 (1,185 metric tons) indicate that this was similar to the 1970 catch but that the catches in both years were below those of all previous years since the early nineteen fifties. On a weight basis, the 1971 catch consisted of about 36% grilse and 64% salmon. Compared with 1970, the proportion of grilse had increased slightly.

48. <u>Scotland</u> Provisional figures for the total Scottish catch (salmon plus grilse) for 1971 indicate that this was less than in 1970. The salmon catch was substantially lower than in any year since 1952 and only about 65% of the

1952-70 average. The grilse catch was similar to that in 1970 and, as in recent years it was well above the long-term (1952-70) average.

49. Canada The total home-water (salmon plus grilse) catch decreased by 260 metric tons in 1971 fr m the 1970 level. The Labrador portion of the catch increased by 180 metric tons, but there was a decrease of 440 metric tons in the other areas represented within the Canadian total catch. Landings from certain regions have shown major decreases, namely Quebec (57% of 1970 catch) and the Maritimes (48% of the 1970 catch). It will be noted that, since 1970, it has been possible to obtain more precise data on catch-per-unit-effort for the major Atlantic salmon fisheries in the Maritime provinces of Canada (Table 11). The Working Party noted the serious decline in the Maritime and Quebec commercial and angling catches for 1971. The reduced runs of large salmon in the Miramichi and the resulting loss in potential egg deposition has prompted the Canadian government to impose severe restrictions on the commercial and sport fishery for this river in 1972. Spawning escapement has been below that believed necessary for adequate seeding of the rivers since 1969 and the autumn portion of the Miramichi run, including both salmon and grilse, has virtually disappeared.

50. The total catch (salmon plus grilse) in 1971, was lower than in 1970 in all the main salmon producing countries except Norway, where it was about the same and Iceland where it was slightly higher.

51. Separate statistics for salmon and grilse catches have generally only been available for recent years but the salmon catches for some European countries, for the years 1969-71, shown below, show a substantial decline in these years.

Country	Salmon Catch (metric tons) 1969	1970	1971
England and Wales	264	313	298
Ireland	260	268	175
Norway	801	816	747
Scotland	987	802	664
	2312	2199	1884

Further, in some countries (e.g. Ireland, Scotland) the decrease in the salmon catch has been most marked in the early spring runs. The Canadian salmon catch was also lower in 1970 than in 1969 (Table 10), but data for 1971 are not yet available.

52. It should be noted that the grilse catches for the European countries listed above also decreased overall, in the years 1969-71, as shown below.

Country	Grilse Catch (metric tons)		
	1969	1970	1971
England and Wales	113	214	127
Ireland	1470	1519	1460
Norway	582	355	438
Scotland	954	622	646
	3119	2710	2671

Between 1969 and 1970, however, the Canadian grilse catch increased substantially.

E. FUTURE RESEARCH

1. International Tagging Experiment at West Greenland

53. The Working Party considered the Second Report of the Planning Group for the International Tagging Experiment at West Greenland in 1972 (Appendix 3). It approved the proposed plans and budget for the experiment, and the arrangements proposed for its administration. They also approved the draft of the Guide Book and standard forms for research vessels and observers, participating in the experiment.

54. The Working Party examined and approved a draft publicity pamphlet for the experiment and agreed that suitable allocations of copies of it should be supplied for distribution in Greenland and in those European and North American countries with an interest in the West Greenland fishery. It was also agreed that individual countries could purchase additional copies of the pamphlet, provided that they informed the ICES Secretariat about their requirements before the printing order was despatched. The Working Party also stressed the importance of additional publicity within countries through especially the press,

radio and television.

55. The Working Party endorsed arrangements drawn up by the Planning Group, for handling and preliminary analysis of data from the Tagging Experiment. These were set out in the First Report of the Planning Group which formed an appendix to the report of the Joint Working Party in 1971, and may be summarised as follows:- Canada will be responsible for handling the research vessel catch and effort data, Denmark the tag return and the commercial fishery data and the United Kingdom the examination of all scale collections. It was also agreed that the ICES Hydrographer should be consulted about the analysis of hydrographic data collected during the tagging experiment.

56. It was agreed that if possible a film record of the experiment should be prepared and countries participating in the experiment were asked to examine this possibility.

2. <u>Other Research</u>

57. The Working Party drew attention to the importance of continuing studies on salmon stocks in home waters, in particular, to investigations of the exploitation rate in home waters, of the relationship between grilse and salmon and of the relationship between stock and recruitment and to the analysis of tag recaptures on a river system basis.

F. FUTURE MEETING

58. The Working Party <u>recommended</u> that they should next meet in Copenhagen, for five days, during the week beginning ~~26~~ 19 March 1973.

Table 1. Catches at West Greenland, 1960-71, in metric tons and round fresh weight. (Based on data available at 31 March 1972).

Year	Drift Net				Gill Net and Drift Net	Total
	Norway	Faroes	Sweden	Denmark	Greenland [d]	
1960	0	0	0	0	60	60
1961	0	0	0	0	127	127
1962	0	0	0	0	244	244
1963	0	0	0	0	466	466
1864	0	0	0	0	1539	1539
1965	[a]	36	0	0	825	861
1966	32	87	0	0	1251	1370
1967	78	155	0	85	1283	1601
1968	138	134	4	272	579	1127
1969	250	215	30	355	1360(385)	2210
1970	270	259	8	358	1244	2146[c]
1971[b]	340	255	0	645	1375	2615

a - Figures not available, but catch is known to be less than Faroes

b - Provisional

c - Including 7 metric tons caught on long-line by one of two Greenland vessels in the northern Labrador Sea early in 1970.

d - Up to 1968, gill net only, after 1968 gill net and drift net. The figures in brackets for the 1969 catch are an estimate of the minimum drift net catch.

Table 2. Number of natural (wild) smolts tagged in the years 1963-1971 and recaptured in West Greenland and in other areas, including home-waters, up to March 1972. Figures in brackets are returns per thousand tagged.

Country	Year of Tagging	Number Tagged	Recaptures					Grand Total
			West Greenland	Norwegian Sea and Faroes	All Other Areas			
					Grilse	Salmon	Total	
Canada	1963	5,850	11 (1.9)	0	70	20 (3.4)	90	101
	1964	15,013	9 (0.6)	0	204	72 (4.8)	276	285
	1965	16,485	73 (4.4)	0	175	193 (11.7)	368	441
	1966	9,509	25 (2.6)	0	120	104 (10.9)	224	249
	1967	17,809	17 (1.0)	0	121	166 (9.3)	287	304
	1968	55,784	127 (2.3)	0	1,212	425 (7.6)	1,637	1,764
	1969	42,879	84 (2.0)	0	377	174 (4.1)	551	635
	1970	37,054	106 (2.9)	0	281	-	281	387
	1971	45,558	-	-	-	-	-	-
Scotland	1963	10,998	10 (0.9)	0	172	92 (8.4)	264	274
	1964	9,200	6 (0.7)	0	110	66 (7.2)	176	182
	1965	9,239	10 (1.1)	0	74	49 (5.3)	123	133
	1966	15,406	30 (1.9)	0	281	39 (2.5)	320	350
	1967	21,002	23 (1.1)	1	169	72 (3.4)	241	265
	1968	15,695	15 (1.0)	0	127	32 (2.0)	159	174
	1969	15,958	53 (3.3)	0	219	57 (3.6)	276	329
	1970	32,071	109 (3.4)	0	564	-	564	673
	1971	20,706	-	-	-	-	-	-
England and Wales	1963	9,485	8 (0.8)	0	15	38 (4.0)	53	61
	1964	17,129	10 (0.6)	0	30	97 (5.7)	127	137
	1965	5,873	12 (2.0)	0	35	57 (9.7)	92	104
	1966	3,219	5 (1.6)	0	28	37 (11.5)	65	70
	1967	4,118	10 (2.4)	0	23	56 (13.6)	79	89
	1968	5,790	20 (3.5)	0	43	48 (8.3)	91	111
	1969	8.611	47 (5.4)	0	27	38 (4.4)	65	112
	1970	7,320	16 (2.2)	0	29	-	29	45
	1971	5,619	-	-	-	-	-	-
Norway	1963	97	0	0	0	4 (41.2)	4	4
	1964	1,485	0	0	67	26 (17.5)	93	93
	1965	2,178	0	0	40	18 (8.3)	58	58
	1966	1,362	0	2	27	16 (11.7)	43	45
	1967	3,601	0	4	59	29 (8.0)	88	96*
	1968	3,562	0	3	105	17 (4.8)	124	131*
	1969	4,273	3 (0.7)	3	83	26 (6.1)	109	120*
	1970	7,603	0	2	217	-	217	222
	1971	5,573	-	-	-	-	-	-
Iceland	1963	63	0	0	2	0	2	2
	1964	63	0	0	0	1	1	1
	1965	8	0	0	0	0	0	0
	1966	83	0	-	-	2	2	2
	1967	154	0	-	2	1	3	3
	1968	59	0	-	1	1	2	2
	1969	15	0	-	-	-	-	-
	1970	16	0	-	-	-	-	-
Ireland	1968	606	0	0	21	0	21	21
	1969	0	0	0	0	0	0	0
	1970	1,522	4	-	1	-	1	5
Sweden	1969	885	0	0	-	85	85	85
USSR	1969	500	0	0	0	0	0	0
France	1969	2,089	15 (7.1)	-	0	4 (1.9)	4	19
	1970	3,854	17 (4.4)	-	0	3 (0.7)	-	20
	1971	3,321	-	-	-	-	-	-

* Including some fish from unknown locality

Table 3   Number of hatchery-reared smolts tagged in the years 1963-1971 and recaptured in West Greenland and in other areas, including home-waters, up to March 1972. Figures in brackets are returns per thousand tagged.

Country	Year of Tagging	Number Tagged	Recaptures: West Greenland	Recaptures: Norwegian Sea and Faroes	Recaptures: All Other Areas: Grilse	Recaptures: All Other Areas: Salmon	Recaptures: All Other Areas: Total	Grand Total
Canada	1963	17,332	4 (0.5)	0	133	32 (4.4)	165	169
	1964	46,659	9 (0.2)	0	101	85 (1.8)	186	195
	1965	45,988	67 (1.5)	0	379	224 (4.9)	603	670
	1966	70,875	70 (1.0)	0	238	299 (4.2)	537	607
	1967	112,288	66 (0.6)	0	275	226 (2.0)	501	567
	1968	113,360	167 (1.5)	0	296	267 (2.4)	563	730
	1969	137,832	247 (1.8)	0	365	217 (1.6)	582	829
	1970	184,962	122 (0.7)	0	288	-	288	410
	1971	205,809	-	-	-	-	-	-
Scotland	1963	6,750	0	0	3	3 (0.4)	6	6
	1964	3,000	0	0	7	7 (2.3)	14	14
	1965	3,000	0	0	19	0	19	19
	1966	8,000	1 (0.1)	0	13	5 (0.6)	18	19
	1967	4,451	0	0	1	0	1	1
	1968	5,335	0	0	4	1 (0.2)	5	5
	1969	3,694	0	0	1	0	1	1
	1970	7,836	6 (0.8)	0	33	-	33	39
	1971	5,247	-	-	-	-	-	-
England and Wales	1963	1,970	1 (0.5)	0	0	0	0	1
	1964	0	0	0	0	0	0	0
	1965	0	0	0	0	0	0	0
	1966	9,668	0	0	0	1 (0.1)	1	1
	1967	18,522	0	0	0	1 (0.1)	1	1
	1968	28,266	4 (0.1)	0	4	5 (0.2)	9	13
	1969	7,420	1 (0.1)	0	4	-	4	5
	1970	4,493	2 (0.4)	0	0	-	-	2
	1971	11,521	-	-	-	-	-	-
Norway	1963	10,999	0	1	88	95 (8.6)	183	184
	1964	9,182	0	1	135	87 (9.5)	222	223
	1965	8,071	0	13	71	33 (4.1)	104	117
	1966	13,812	0	29	403	145 (10.5)	548	593*
	1967	18,393	2 (0.1)	56	229	91 (5.0)	320	404*
	1968	12,983	0	43	171	103 (7.9)	274	337*
	1969	16,967	5 (0.3)	34	141	61 (3.6)	702	248*
	1970	18,673	1 (0.5)	1	160	-	160	164*
	1971	16,771	-	-	-	-	-	-
Iceland	1966	8,367	1 (0.1)	1 (0.1)	66	14 (1.7)	80	82
	1967	10,061	0	0	24	6 (0.6)	30	30
	1968	9,985	0	0	45	0	45	45
	1969	7,566	0	0	246	10	256	256
	1970	10,014	0	0	1	-	-	1
	1971	11,087	-	-	-	-	-	-
Ireland	1966	15,000	0	0	0	0	0	0
	1967	5,000	1 (0.2)	0	1	0	1	2
	1968	222	0	0	1	0	1	1
	1969	7,194	2 (0.3)	0	21	1	22	24
	1970	3,787	0	1	11	0	11	12
	1971	2,381	-	-	-	-	-	-
Sweden	1966	11,181	7 (0.6)	1	690	193 (17.2)	883	891
	1967	4,999	1 (0.2)	4	364	62 (12.4)	426	431
	1968	4,798	1 (0.2)	1	586	37	623	625
	1969	7,381	0	0	514	9	523	523
	1970	6,000	0	0	268	-	268	268
	1971	4,997	-	-	-	-	-	-
USA	1966	82,250	39 (0.4)	0	69	168 (2.0)	237	276
	1967	80,717	1	0	12	10 (0.1)	22	23
	1968	73,730	7 (0.1)	0	9	12 (0.2)	21	28
	1969	73,418	64 (0.8)	0	32	77 (1.0)	109	173
	1970	48,190	329 (6.8)	0	57	-	-	386
	1971	29,905	-	-	-	-	-	-

Table 3 (Continued)

Country	Year of Tagging	Number Tagged	Recaptures West Greenland	Norwegian Sea and Faroes	All Other Areas Grilse	All Other Areas Salmon	Total	Grand Total
Denmark	1965	1,880	0	0	1	2 (1.1)	3	3
	1966	4,270	0	3	19	47 (11.0)	66	69
	1967	2,696	0	1	13	10 (3.7)	23	24
	1968	5,173	1 (0.2)	1	36	0	36	38
	1969	3,837	0	0	5	0	5	5
	1970	1,376	0	0	0	-	0	0
USSR	1969	600	-	-	-	-	-	-

* Including some fish from unknown localities.

Table 4 Number of kelts tagged in the winters 1962/63 - 1971/72 and recaptured in Greenland and in other areas, including home-waters, up to the end of 1970.

Country	Winter of Tagging	Number Tagged	Recaptures Greenland	Recaptures Other Areas	Recaptures Total
Canada[a]	1962-63	653	2	65	67
	1963-64	1,518	0	91	91
	1964-65	1,995	1	141	142
	1965-66	7,169	0	653	653
	1966-67	7,510	1	688	689
	1967-68	3,710	2	395	397
	1968-69	3,707	4	163	167
	1969-70	4,539	10	208	218
	1970-71	5,412	16	333	349
	1971-72	5,012	-	-	-
England and Wales (River Axe only)	1962-63	159	1	12	13
	1963-64	185	2	10	12
	1964-65	184	1	11	12
	1965-66	109[b]	1	7	8
	1966-67	178[b]	1	11	12
	1967-68	188	2	6	8
	1968-69	81	0	3	3
	1969-70	113	0	12	12
	1970-71	7	0	0	0
Faroes	1970-71	24	0	0	0
Iceland	1962-63	114	-	14	14
	1963-64	167	-	9	9
	1964-65	154	-	5	5
	1965-66	357	-	15	15
	1966-67	745	-	75	75
	1967-68	441	-	17	17
	1968-69	369	-	19	19
	1969-70	314	0	21	21
	1970-71	785	0	105	105
Ireland	1962-63	2,264	2	31	33
	1963-64	2,351	2	70	72
	1964-65	2,695	2	34	36
	1965-66	2,972	1	40	41
	1966-67	3,175	0	77	77
	1967-68	1,034	0	24	24
	1968-69	498	0	10	10
	1969-70	1,088	0	28	28
	1970-71	477	0	36	36
Scotland	1962-63	413	1	2	3
	1963-64	134	0	2	2
	1964-65	233	0	6	6
	1965-66	1,376	4	19	23
	1966-67	901	3	18	21
	1967-68	117	0	3[c]	3
	1968-69	152	0	1[d]	1
	1969-70	153	0	1	1
USA	1962-63	151	1	13	14
	1963-64	123	1	10	11
	1964-65	160	0	23	23
	1965-66	146	2	16	18
	1966-67	578	5	75	80
	1967-68	340	5	56	61
	1968-69	218	1	16	17
	1969-70	315	0	8	8
	1970-71	400	1	8	9
	1971-72	240	-	-	-
USSR	1968-69	566	0	10	10
	1969-70	1,147	0	0	0

a Ascending adults tagged during any year are included in the totals tagged for the corresponding winter (i.e. those tagged in 1962 are included under 1962-63, those tagged in 1963 under 1963-64 etc.), but recaptures of these adults in the year of tagging have not been included.

Table 4 (Continued)

b In addition, 180 kelts were tagged by the Dee and Clyde River Authority in 1965-66 and 291 kelts in 1966-67. No recaptures were reported from the first experiment and two (from 'Other Areas') from the second.

c Includes 1 recapture at Faroes

d Recaptured at Faroes

Table 5   Recaptures (to March 1972) of fish tagged at West Greenland

Year Tagged	Number Tagged	Local Recaptures Number	Local Recaptures Days Absence	Distant Recaptures Number	Distant Recaptures Location
1965	223	3	1, 3, 26	1	Canada (SW Newfoundland)
1966	729	28	1-8 (24) 10-50 (4)	4	Canada (Miramichi - 1) Scotland (River Tweed - 2) (River Spey - 1)
1967	375	6	1-2 (3) not known (3)	4	Canada (Labrador - 1) Ireland (River Slaney - 1) (River Barrow - 1) Scotland (River Tay - 1)
1968	47	4	1-3 (3) 1 month (1)	1	Canada (Labrador)
1969	444	14 3[b]	4-35 days 340-398 days	13	Canada (Labrador - 1) (NE Newfoundland - 4[a]) (Miramichi - 1) England (Taw & Torridge Estuary-1) (River Wye - 1) Ireland (Waterville - 1) (River Slaney - 1) Scotland (near Montrose - 1) Spain (River Ason -1) Wales (River Teify - 1)
1970	27[c]	0	-	3	Canada (Chaleur Bay - 1) (River St. Jean - 1) (Escuminac - 1)
	224	3	4-22 days	4	Canada (Labrador - 1) (Nova Scotia - 1) Ireland (Dunmore-East - 1) Scotland (Solway Firth - 1)
1971	59[c]	0	-	8	Canada (NE Newfoundland - 6) (Chaleur Bay - 2)
	226	4	1-ca30		-

a One recaptured in year of tagging

b Recaptured at Greenland in 1970

c Labrador Sea in spring

Year	Norwegian Sea Long-Line Fishery												Drift-net Fishery within Norwegian Fishery Limits
	Denmark		Faroes		Germany		Norway		Sweden		Total		
	Number of Vessels	Catch	Number of Vessels	Catch	Number of Vessels	Catch	Number of Vessels[e]	Catch	Number of Vessels	Catch	Number of Vessels	Catch	
1965	1-2	-[a]	0	0	0	0	?	0	0	0	1-2	-[a]	283
1966	10	-[a]	0	0	0	0	"	0	-[a]	-[a]	10+	-[a]	312
1967	22	77	0	0	0	0	"	-[a]	6	-[a]	28+	77+	333
1968	28	177	2	5[b]	0	0	"	100[d]	16	126	46+	408[d]	228
1969	40	413	4	7[c]	5	24	"	450[d]	2	24	51+	918[d]	234
1970	60	481	5	12[b]	4	21	"	420[d]	1	24	70+	958[d]	183
1971	20	162	0	0	2	9	"	300[d]	1	17	23+	488[d,f]	234

a Not known

b Roughly 70% of catch taken in vicinity of Faroes.

c All taken in vicinity of Faroes.

d Estimated catch

e Precise number unknown, but large numbers of small and medium-sized vessels participated.

f Excluding catches discarded because undersized.

Table 6. Catches in the Norwegian Sea long-line fishery and in the drift-net fishery within Norwegian fishery limits, 1965-71. Metric tons, round fresh weight.

Table 7 Estimates of catch-per-unit-effort in the Norwegian Sea Long-line Fishery 1968-71.

Year	Country	No. of Salmon/1000 Hooks caught in						No. of salmon sampled
		February	March	April	May	June	Total season	
1968	Denmark			92	100			5,539
1969	Denmark		43	57	44	29	39	25,891
	Germany			50	46	23	42	5,459
	Faroe			79[a]				
1970	Denmark	42	50	67	35	27	49	72,000
	Germany			66	35	16	46	6,313
	Faroe			40[a]				366
1971	Denmark				42[b]	25[b]		31,105
	Germany		72[c]					
	Faroe		82[a]	39[a]			60[a]	499

a - Research catch, 20-80 nautical miles NE of Faroe Islands.

b - Including catches discarded because undersized.

c - Research catch.

Table 8 Recaptures of salmon tagged in the long-line fishery in the Norwegian Sea (to March 1972).

Year Tagged	Number Tagged	Year Recaptured	Recaptures			
			Norwegian Sea	Home Water: Norway	Home Water: U.S.S.R.	Total
1968	238	1968	0	5	0	5
		1969	0	0	1	1
		Total	0	5	1	6
1969	932	1969	5	49	6	60
		1970	2	13	2	17
		1971	0	2	0	2
		Total	7	64	8	79
1970	1,118	1970	10	117	8	135
		1971	2	10	3	15
		Total	12	127	11	150
1971	1,937	1971	5	138	18	161

Table 9 Recaptures of fish tagged in Faroe waters.

Year Tagged	Number Tagged	Recaptures					
		Norway	England	Scotland	Ireland	Russia	Greenland
1969	74	-	-	2	-	-	-
1970	233	2	1	5	3	1	1
1971	359	3	-	8	2	-	1

Table 10 Catches in home waters, 1960-71 (salmon plus grilse except where shown separately) in metric tons, round fresh weight.

Year	England and Wales			France	Iceland	Ireland[b]			Northern Ireland[b]	Norway			Scotland			Sweden[c]	USSR	Canada			USA
	S	G	T			S	G	T		S	G	T	S	G	T			S	G	T	
1960	-	-	283	50-100	100	-	-	743	139	-	-	1659[f]	960	476	1436	40	1100	-	-	1635	< 2
1961	-	-	232	50-100	127	-	-	707	132	-	-	1533[f]	820	376	1196	27	790	-	-	1580	<2
1962	-	-	318	50-100	125	-	-	1459	356	-	-	1935[f]	1015	725	1740	15	710	-	-	1717	<2
1963	-	-	325	50-100	145	-	-	1458	306	-	-	1786[f]	1286	412	1698	16	480	-	-	1848	<2
1964	-	-	307	50-100	135	-	-	1617	377	-	-	2147[f]	1216	698	1914	16	590	-	-	2066	<2
1965	-	-	320	50-100	133	-	-	1457	281	-	-	2000[f]	1042	560	1602	17	590	-	-	2113	<2
1966	-	-	387	50-100	106	-	-	1238	287	-	-	1791	1069	555	1624	17	570	-	-	2356	<2
1967	-	-	420	50-100	146	-	-	1463	449	-	-	1960	1245	888	2133	23	883	-	-	2859	<2
1968	-	-	282	50-100	162	-	-	1413	312	-	-	1514	1020	543	1563	14	827	-	-	2104	<2
1969	264	113	377	50-100	133	(260)[g]	(1470)[g]	1730	267	801	582	1383	987	954	1941	9	360	1546	411	1957	<2
1970	313	214	527	50-100	195	268	1519	1787	297	816	355	1171	802	622	1424	?	?	1468	629	2097	<2
1971[a]	298	127	425	50-100	204	175	1460	1635	191	747	438	1185	664	646	1310	56	?	-	-	1837	<2
Angling Catch	Included			Inc.	Inc.	Inc.			Inc.	Inc.			Inc.			Not Inc.	Inc.	Not Inc.[d]			Inc.

S - Salmon; G - Grilse; T - Total (Salmon plus Grilse)

a - Provisional
b - Catch in River Foyle allocated on basis of 50% Ireland and 50% Northern Ireland
c - West Coast catch only, from Bulletin Statistique.
d - Angling catches (mainly grilse) about 10% additional (by weight)
e - Mainly salmon
f - Including sea trout and sea char catches; less than 5% of total.
g - Estimated on basis of 1970 catches.

Table 11 Estimates of catches per unit effort for some home-water fisheries.

Year	Canada (Drift Nets and Traps)[a] lbs	Canada Trap Nets[h]	Canada Drift Nets[h]	Ireland (Open Sea Drift Nets)[b] (numbers)	Ireland (Licences)[c] (lbs)	Foyle Area (Estuary Drift Nets)[b] (numbers)	Norway[d] (Bag Nets) (kg)	England and Wales Drift Nets N.E. Areas[g] (numbers) Salmon	England and Wales Drift Nets N.E. Areas[g] (numbers) Grilse	Scotland (Fixed Engines)[e] (numbers) Salmon	Scotland (Fixed Engines)[e] (numbers) Grilse	Scotland (Net and Coble)[f] (numbers) Salmon	Scotland (Net and Coble)[f] (numbers) Grilse
1960	169			325	950	104	172	84.8	79.8	12.8	20.3	84.1	77.4
1961	159			224	1030	-	158	54.3	46.1	12.3	17.2	60.9	61.4
1962	178			563	2210	297	175	92.8	75.5	14.8	29.6	83.6	134.9
1963	193			456	1940	334	177	49.4	42.7	19.9	21.8	109.3	62.3
1964	266			430	1720	392	195	52.6	58.0	23.2	35.6	98.6	113.8
1965	262			520	1700	361	172	83.6	47.9	17.8	26.6	84.0	99.0
1966	249			516	1250	375	154	66.6	58.9	19.4	30.4	95.0	104.0
1967	300			733	1650	524	154	110.5	90.9	21.6	49.9	130.2	170.4
1968	183			552	1650	482	129			17.3	29.8	97.9	92.4
1969	159			491	2077	455	137	134.5	166.5	15.9	49.7	123.4	194.5
1970	153	13.3	85.9	422	1899	443	117	170.3	245.3	12.3	35.2	98.9	137.5
1971	80	8.4	50.2	420	1683	293	123	84.1	83.4				

a - Miramichi area, salmon only. Average of mean monthly catch/unit effort for both types of gear throughout open seasons for each type. Units of effort taken as 1 trap net or 200 fathoms of drift net, as defined in FRB Tech. Rept. No. 29.

b - Salmon and grilse per drift net

c - Pounds salmon and grilse per licence

d - Salmon and grilse per bag net

e - Catch per net per month

f - Catch per crew per month

g - Catch per net licence issued

h - Miramichi area, salmon only, pounds/unit day

H. APPENDICES

1. Resolution adopted at the ICNAF Meeting in 1970 concerning Regulation of Salmon Fishing

Recognizing that the proposal adopted at the 1969 Annual Meeting for the prohibition of the fishery for salmon outside national fishery limits, not having been accepted by all Contracting Governments, has not been fully effective;

Considering that interim measures are desirable in order to avoid the escalation of fishing for salmon throughout the Convention Area pending a more accurate assessment of its effects on coastal and river fisheries and on the stocks; and

Noting that Contracting Governments which have not participated in the fishery have no present intention of so doing;

The Commission also proposes that:

1. That each Contracting Government which has participated in the fishery for Atlantic salmon, *Salmo salar* L., take appropriate action to limit the aggregate tonnage of vessels employed or catch taken by its nationals in the fishery in the Convention Area to a level not exceeding the aggregate tonnage of vessels so employed or catch so taken in 1969;

2. That Contracting Governments which have not accepted the prohibition on fishing for Atlantic salmon outside national fishery limits take appropriate action to prohibit fishing for Atlantic salmon outside national fishery limits in the Convention Area before 31 July and after 30 November.

3. That the use for salmon fishing of any trawl net, any monofilament net or any troll be prohibited throughout the Convention Area provided that Contracting Governments may authorize the continued use of monofilament nets acquired before 1 July 1970.

4. That these measures be in force for the year 1971 subject to review within that period, in the event of substantial changes in the catches of Atlantic salmon in the Convention Area or in home waters or in the fish stocks.

2. Resolution adopted at the NEAFC Meeting in 1970 concerning Regulation of Salmon Fishing

"Fishing for salmon shall be regulated by the following measures as provided for in Article 7(1) of the Convention.

1. Closed Season Art. 7(1)(c)

   In regions 1 and 2 of the Convention Area, outside national fishery limits, fishing for salmon shall be prohibited from July 1st to May 5th, both dates inclusive.

   Where salmon occurs within the national fishery limits of Contracting States, those States shall prescribe annual closed seasons during which fishing for salmon shall be prohibited.

2. Minimum size for salmon Art. 7(1)(b)

   No salmon of a size less than 60 cm, measured from the tip of the snout to the end of the tail fin shall be retained on board, but shall be returned immediately to the sea.

3. Mesh of Nets Art. 7(1)(a)

   Drift nets, anchored nets and seines used for fishing of salmon shall have a minimum mesh size of 160 mm. The mesh size is to be measured in accordance with the mesh regulations already in force under Recommendation (1).

4. Other Measures for the Regulation of Fishing Gear Art. 7(1)(e)

   In the fishery for salmon

   a) any hooks used shall have a gape of not less than 1.9 cm;

   b) the leader attaching the hook to the line shall have a minimum strength comparable to 0.6 monofil nylon;

   c) the use of any trawl net, any monofilament net, or any troll shall be prohibited.

5. Closed Areas Art. 7(1)(d)

Fishing for salmon in the Convention Area, outside national fishery limits, shall be prohibited.

a) between latitudes 63° and 68°N and east of longitude 0°

b) east of longitude 22°.

The regulations under 2, 3 and 4 shall apply within the whole Convention Area, but outside national fishery limits.

This regulation for salmon fisheries shall enter into force on 1st January 1971 and shall be subject to review by the Commission after two years or in any case if substantial changes occur in the catches of salmon on the high seas or in home waters, or in the fish stocks.

In addition to making this Recommendation, the Commission agreed to urge all Contracting States fishing for salmon on the high seas only to participate in the planting of smolts."

3. SECOND REPORT OF THE PLANNING GROUP FOR THE INTERNATIONAL TAGGING EXPERIMENT AT WEST GREENLAND IN 1972

This Group held their second meeting at Copenhagen from 18th to 20th January, 1972. Those present were:

O. Christensen	Denmark
Sv. Aa. Horsted	Denmark
A. W. May (Chairman)	Canada
A. L. Meister	U.S.A.
B. Milton-Hansen	Denmark
J. Møller-Christensen	ICES
J. Møller-Jensen	Denmark
W. R. Munro (Rapporteur)	Scotland
G. J. Ridgway	U.S.A.
L. Rosseland	Norway
A. Swain	England & Wales
H. Tambs-Lyche	ICES
R. Vibert	France

The Group began by reviewing, briefly, the results of the Danish/U.K. and Canadian salmon work at Greenland in 1971, with particular reference to the decisions which they had to take in relation to the plans for the 1972 tagging experiment.

They then went on to reconsider, and to expand, the plans for the 1972 experiment, which were outlined in their first report (Appendix H to C.M. 1971/M:2). They also discussed in detail the drafts of the 'Guide Book for Participants in the ICES/ICNAF Salmon Tagging Programme at Greenland, 1972' prepared by Dr. May and Mr. Horsted.

Many of the Group's decisions have been fully incorporated in the draft of the Guide Book, which will be submitted to the Joint Working Party at their meeting in Dublin in March 1972. The comments which follow, set out under the headings adopted as the agenda for this meeting, are intended only to cover those decisions which were not relevant to the Guide Book and, where considered necessary, to explain the reasons for some of the points incorporated in it. For a full appreciation of the results of this meeting, this report should be read in conjunction with the draft of the Guide Book.

Review of the Objectives of the Experiment

The Group considered that the objectives of this experiment, as set out on Page 1 of their previous report, still held good and that these were adequately, if more briefly described in the Guide Book (Section 1).

Research Vessel and Scientific Staff Participation and Scheduling

Up-dated information on the availability of research vessels for this experiment is given in the Guide Book (Section 2.1), together with an amended programme of research vessel distribution throughout the experiment, based on this latest information. Those organisations sending research vessels are asked to provide copies of their programme to other participants as soon as they are available and well in advance of their vessel's arrival in Greenland.

Apart from the scientific staff allocated by those organisations which are providing research vessels, the U.S.A. offered to provide scientific assistance up to a total of 24 man/weeks (probably as two teams of two scientists). It was also understood that, as recorded in the previous report, Ireland might be able to provide one scientist for six weeks.

It seemed unlikely that outside scientific assistance would be required on the Danish or U.K. research vessels, but help from one or two U.S. scientists would be appreciated on the 'A.T. Cameron'. The French vessel could provide accommodation for two foreign scientists but, if these places were not required, they would be filled from their own staff. It seemed probable that some accommodation would be available on the U.K. vessels, which could be utilised by scientists with specialist interests, if required. It was agreed that details of these arrangements should be finalised at the March meeting of the Joint Working Party in Dublin and that any organisation wishing to avail themselves of the U.S. offer should contact Dr. Ridgeway directly.

The Group received, through Dr. May, a request from the University of Moncton for facilities to continue their PIROP seabird scheme by placing observers on research vessels taking part in the tagging programme. This programme is concerned with studying the biology of seabirds while they are at sea and, particularly, with the effects of drift-netting on Brunnich's guillemot. In recent years PIROP observers have been placed on Canadian and French vessels operating in this area. Observers would not necessarily be Canadian, but might be recruited from appropriate organisations in the research vessel's own country.

With the exception of the Danish vessel, on which accommodation was very limited, it was agreed, in principle, that accommodation could be made available for a PIROP observer on each research vessel and that this organisation should contact participating organisations directly regarding the placing of their observers.

Selection of Fixed Fishing Stations

At their first meeting the Group proposed that a set of fixed stations should be fished periodically throughout the experiment to provide information on the distribution of salmon throughout the fishing season. At this meeting the Group accepted the pattern of fixed stations suggested by Mr. Horsted (see Guide Book, Section 4.1.3). In their first report the Group had proposed that these stations should be fished overnight but, after considerable discussion, it was decided that these should be fished during daylight, in exactly the same way as during the rest of the experiment (Guide Book, Section 4.4). It was felt that such an arrangement would provide catch data which would be directly comparable with the more extensive records which would be available from the ordinary fishing programme and would also provide the best opportunity of maintaining progress towards the tagging target.

The programme for fishing these standard stations is set out in Section 4.1.2 of the Guide Book.

It was appreciated that scientists in charge of research vessels might have to modify their programmes depending on circumstances at the time, particularly if the numbers of fish which they had been able to tag proved disappointing.

Gear and Fishing Technique

The Group considered available information on the efficiency of various mesh sizes of net, including that obtained by the 'Adolf Jensen' and 'A. T. Cameron' in 1971, using 120 mm mesh nets. They concluded that there was no particular advantage in fishing the latter and that, overall, 130 mm nets seemed to give the best results. However, after considering evidence that there were differences in the size distribution of salmon in various areas off Greenland, and through the fishing season, it was decided that two meshes should be used and that these should be 130 mm and 150 mm stretched mesh.

In view of the increasing evidence from both commercial and research vessels that monofilament nets were more effective, particularly in daylight, it was decided that only monofilament nets should be used during the experiment. It was also felt that this decision would simplify the provision of spare nets to replace any which were lost or damaged.

Details of the standard design for these nets and the composition of the fleet of nets to be used are set out in the Guide Book in Sections 4.3 and 4.4, respectively. It was noted that the 'Adolf Jensen', because of the limited space on board, would be unable to fish more than 80 nets.

Scheduling and Programme for Observers

From information provided at the meeting, it seemed likely that the requirement for placing observers on six commercial vessels could be met, as two Norwegian vessels were willing to carry observers and it seemed probable that three Faroese and two Danish vessels would also accept observers.

The situation with regard to the provision of observers was not finalised but Norway could probably provide two trained observers and Denmark two or three. In addition, three Faroese observers, who would not be members of the Faroese research staff, would be available for duty on Faroese vessels. It was hoped that further details would be available in Dublin in March.

It was agreed that the primary function of observers on commercial vessels would be to ensure the recovery of all tags and to tag suitable fish from the catch. Since it was considered that this would leave them little or no time for other duties it was decided that they should not be asked to carry out any other, more specialised tasks.

If it should prove impossible to implement the full programme of observer participation, it was suggested that the available effort should be concentrated towards the later part of the season, when it was hoped that substantial numbers of tagged fish would have been liberated.

Tags, Tagging Technique, Data from Tagged Fish

The tags to be used will be, basically, as described in the Group's first report (see also Guide Book, Section 4.5.1), but Dr. May undertook to investigate the possibility of using a heavier gauge wire for attachment.

A total of 10,000 tags would be ordered and those would be issued to appropriate organisations by the end of June (1000 each to research vessels and 5,000 divided among observers). Tagging equipment, as specified in Section 4.5.1 of the Guide Book, would be supplied to both observers and research vessels, on request to the Biological Station at St. John's, Newfoundland.

Full instructions on tagging are given in the Guide Book (Sections 4.5.2 and 4.5.3).

Other Biological Data and Specimens, Disposition of Fish

Research vessels would be prepared to collect on request, biological data and material other than that set out in Section 4.5.4.1. of the Guide Book. Individuals or organisations requiring such facilities should make their own arrangements with the relevant organisation and should provide any necessary equipment.

The Group confirmed their previous decision that no fish caught by research vessels should be sold.

Communication during Experiment

The Group reiterated their view that good communications were vital to the success of the experiment. Full details of their proposals for communication during the experiment are set out in Section 2.3 of the Guide Book. All participating organisations were asked to provido, as soon as possible, details of tho radio facilities available on their vessels, for inclusion in Section 2.3.2.

It was realised that regular contact with observers might be difficult to achieve and that commercial vessels might be reluctant to reveal details of their position and catch over the radio, but it was recommended that observers should attempt to contact the 'Adolf Jensen' daily and report the general area in which they were operating; the number of fish tagged; the number of recaptures recorded (1972 experiment tags and others, separately) and the probable time of their next contact. It was suggested that 1500 hours (local time) might be a suitable time for observers to report.

Recording, Reporting and Exchanging Data

Details of the standard records to be maintained by research vessels and observers are provided in Section 4.5.4.1 of the Guide Book and arrangements for subsequent handling of the data are given in the following section.

ICES undertook to produce the three standard forms required for data recording and to investigate, and report in March, on the possibility of producing appropriate scale envelopes for the experiment, as illustrated in the Guide Book.

Data Analysis

This item was not discussed in detail but it was agreed that those arrangements set out on Page 27 of the Group's first report should be accepted.

Publicity

The draft text of a publicity pamphlet (see Appendix), submitted by Dr. May, was considered and accepted and ICES undertook to investigate the provision of a pamphlet in four languages, for which Dr. May also submitted a preliminary design.

It was agreed that a Norwegian text would not be needed if a Danish one was provided and that the pamphlet should, therefore carry the text in Danish, Greenlandic, French and English. A first estimate of the likely requirement for this pamphlet was 20,000 copies, but this figure should be reviewed in March.

The possibility of producing a film record of the experiment was discussed briefly and it was suggested that this topic should be raised again in March, with a view to standardizing technique on the various research vessels.

Budget and Financing

Although no formal promises of contributions to the Special Fund for this experiment had yet been received by ICES, it was understood that the following countries had provisionally indicated their willingness to subscribe, as follows:

United Kingdom	£ 8,000
Ireland	£ 3,000
Canada	$ 15,000
U.S.A.	$ 10,000
approximately	£ 21,000

Since considerable expenditure would arise prior to the beginning of the experiment, it was recommended that contributors should be asked to pay their contributions to ICES before 1st July. Because of administrative difficulties, U.S.A. would not be able to make a contribution in advance but other arrangements would be made by them with ICES.

It was agreed that it would be simplest if ICES did not open a separate bank account for the "ICES/ICNAF Salmon Tagging Experiment Fund", but that they would, of course, keep separate accounts for the Fund. Office expenses incurred by ICES would not be charged to the Fund but these might be offset by any bank interest accruing from the Fund.

It was also agreed that savings on some of the items specified in the budget could be spent on other items, with the agreement of the Chairman of the Joint Working Party and, similarly, that expenditures from the contingency item in the budget, other than those mentioned specifically, should be made only on the same authority.

The Group reconsidered the estimates of expenditure given in their first report and amended these in the light of such more recent information as was available. Details of these amended estimates are given below and are followed by comments on the changes made in some items.

		£
1) Tags, tag preparation, tagging equipment and scale packets.		650
2) Travel for observers including subsistence on shore at Greenland (12 round trips at £250).[a]	£3000	
Subsistence on board commercial vessels (90 days for 6 observers at 25 D.kr/day + 6 x £50).[b]	£1100	4100
3) Clothing allowance for specially-recruited observers (6 x 400 D.kr).[c]		150
4) Salaries of specially-recruited observers (5 observers for 4 months at £250/month).[d]		5000
5) Payment for fish tagged on commercial vessels (1800 fish at an average of £5/fish).[e]		9000
6) Equipment for observers on commercial vessels (Tanks, measuring boards etc).		400
7) Publicity (printed pamphlet)[f]		350
8) Contingencies, including:		
a) Expenses incurred in the attendance of an ICES representative at the Joint Working Party meeting in Dublin in March, 1972.		
b) The shipment of materials and specimens.[g]		1350
		£21000

Notes

a. The cost of travel per observer was increased from £200, as given in the last report, to £250. The present estimate for this item was thought to be a realistic over-estimate since some of the Faroese observers seem likely to travel at least one way on commercial vessels.

b. The revised estimate for this item was based on a figure of 25 D.kr/day, together with a 'good will' payment of £50 to each vessel.

c. It was agreed that this provision should be applicable to specially-recruited observers only and that it should be at the rate of 400 D.kr/observer. Employing organisations should reclaim expenditure under this item from ICES.

d. The exact number of such observers could not be established at the meeting but the estimate given is based on the assumption that funds would probably be required for three Faroese and two Danish observers only, for a period of four months (including travel to and from Greenland).

The problems which could arise in relation to accident insurance, health benefits etc, if observers were employed directly by ICES, were discussed. The Group agreed that such an arrangement should be avoided and suggested that observers might be recruited as temporary employees of the appropriate Government organisation or that they might be employed and paid by the captain of the commercial vessel, who would be reimbursed by ICES.

e. It was agreed that the price paid for tagged fish would have to vary according to the size of the fish, in order to avoid selection of only the smaller fish for tagging. It was suggested that this should be on the basis of a price/length curve, since accurate weights would not be available for tagged fish. If captains of commercial vessels agreed to this arrangement, payment would be made to them by ICES on presentation of a bill countersigned by the appropriate observer.

Danish and Norwegian representatives provided details of 1971 salmon prices in relation to weight and the estimate of the cost of this item was calculated on the basis that the payment for an average Greenland-caught salmon would be £5 (3.5 kg at 20 D.kr/kg + 20 D.kr).

Members were asked to bring to the Dublin meeting of the Joint Working Party, any relevant data which they had on the total length/gutted weight relationship for salmon caught at Greenland.

f. ICES obtained a very preliminary estimate of 5,200 D.kr (£289) as the cost of producing 20,000 two-colour pamphlets.

g. This item, which was shown separately in the estimates in the first report, was transferred to 'contingencies'.

In addition to the items mentioned above, the question of training observers was discussed. It was decided that it was not practicable to make special arrangements for training observers and that arrangements for a simple form of training should be left to employing organisations (a demonstration of tagging techniques for representatives of organisations employing observers, would be arranged at the Dublin meeting). This item was, therefore, deleted from the estimates.

ICES Administrative Functions

Most of these have already been dealt with elsewhere in this report. However, arrangements for dealing with tag recaptures through ICES, as suggested in the Group's first report, were also reviewed. The possibility that tag rewards should be paid from the Fund was discussed and it was agreed that such an arrangement would raise serious problems because of the differing levels of reward paid in the various countries. It was, therefore, agreed that organisations should pay for the rewards for recaptures made in their own territories, in accordance with the arrangements set out in the previous report.

Other Items

a) Index maps of Danish charts for Greenland waters, English translations of 'Harbour Regulations for Greenland' and copies of relevant parts of the first draft of the 'Guide Book' were issued for onward transmission to research vessel captains.

b) The problem of co-ordinating research vessel programmes and controlling the activities of observers was discussed. With the agreement of Mr. Horsted, it was decided that the senior scientist on board the 'Adolf Jensen', as the person who would have the most comprehensive knowledge of day-to-day events, should have overall responsibility for the co-ordination of the programme. He would, therefore, have responsibility for, (a) co-ordinating and advising on research vessel movements and, (b) controlling the work of observers, with particular reference to the avoidance of excessive expenditure or unwise expenditure on fish bought for tagging.

c) The Group considered that it was essential that a representative from ICES should be present at the meeting of the Joint Working Party in Dublin and recommended that the expenses of such a representative should be borne by the Fund (see 'contingencies').

d) The future of the Group was not discussed but it was recommended that the Joint Working Party should consider this question at their Dublin meeting.

APPENDIX

Research vessels from Canada, Denmark, England, France and Scotland will take part in salmon tagging at Greenland in 1972. Scientists will also be present from other countries. Some of these will be working on fishing vessels. Fishermen at Greenland and in other countries are being asked to co-operate in this experiment by returning tags and capture information quickly.

Salmon from many countries on both sides of the Atlantic spend part of their lives in the sea near Greenland. Many thousands of salmon have been tagged when leaving the rivers as young fish and many hundreds of these tags have been returned from the Greenland fisheries. Smaller numbers of salmon have been tagged at Greenland, and some of these tags have been returned from coastal areas and rivers of Europe and North America.

All the countries which produce and fish for Atlantic salmon have agreed that a large tagging experiment at Greenland is needed to determine the facts necessary to manage the Atlantic salmon resource for the best interests of all concerned. Very little is known about the life of salmon in the sea, and information is needed on distribution, abundance, origins of fish, survival in the sea, and the numbers of salmon that can safely be harvested without causing a decrease in abundance. Tagging at Greenland, combined with other studies of salmon at sea and in fresh water, and cooperation of fishermen all over the North Atlantic, will provide the information needed.

Tags are of yellow plastic, are printed with the letter X followed by a number, and are attached below the large fin on the back. Most of the salmon bearing these tags should be taken in 1972 at Greenland and in 1973 in other countries, but some may also be expected in 1973 at Greenland and 1974 in other countries. In addition to this special experiment, salmon tagging will also be done in other areas. It is of course just as important to return all these tags as well.

Tags may be returned to any biologist or fisheries official in the countries where they are taken, or mailed directly to the address on the tag (International Council for the Exploration of the Sea, Charlottenlund, Denmark). Reward payments will be made by the various countries taking part in the experiment. Every fisherman who returns a tag will also be sent information on the time and place of tagging of the individual salmon.

4. List of Working Papers

Note In this list, reference numbers are only quoted for three papers to be circulated to the International Commission for the Northwest Atlantic Fisheries.

1. A report on the 1971 salmon long-lining cruise off the Faroes, by G. Struthers.
2. Scottish salmon tagging data 1963-1971, by D.A.F.S. Pitlochry.
3. Greenland salmon research programme, 1971 - 'Adolf Jensen', by W. R. Munro. (ICES/ICNAF Salmon Doc.)
4. Scottish salmon catch statistics, by W. R. Munro. (ICES/ICNAF Salmon Doc.)
5. Sex ratios of North Esk salmon in relation to age, by W. M. Shearer. (ICES/ICNAF Salmon Doc.)
6. The length, weight and age composition of commercial catches taken on the Rivers Tweed, Tay and Spey in 1971, by W. R. Munro and I. J. R. Hynd.
7. The length, weight and age composition of the salmon catch of the North Esk (Scotland) in 1971, by W. M. Shearer.
8. Summary of salmon parasite investigations 1970-71, by J. H. C. Pippy. (ICES/ICNAF Salmon Doc.)
9. First estimates of "salmon" versus grilse quantities in Canadian commercial catches, 1969 and 1970, by A. W. May and W. H. Lear. (ICES/ICNAF Salmon Doc.)
10. Gutted weight versus total length of Atlantic salmon at West Greenland, by A. W. May and W. H. Lear.
11. Preliminary observations on differences in fishery contributions of hatchery-reared Atlantic salmon (<u>Salmo salar</u>) smolts related to stock selection and release location, by J. A. Ritter and D. B. Lister (ICES/ICNAF Salmon Doc.)
12. Exploitation of Miramichi Atlantic salmon based on smolts tagged in 1968, 1969 and 1970, by G. E. Turner. (ICES/ICNAF Salmon Doc.)

13. A series of graphs prepared for discussion purposes for the March 1972 Joint ICES/ICNAF Working Party on North Atlantic salmon.

14. German long-line fishery off Norway 1971.

15. Research vessel fishing on salmon off Norway (catch, gear behaviour, age, tagging), by F. Thurow.

16. Data from counting installations on the Rivers Coquet and Axe, by M.A.F.F. London.

17. Salmon and grilse catches, by M.A.F.F. London.

18. Percentage of female salmon in the upstream migrations on the River Axe, Devon, by M.A.F.F. London (ICES/ICNAF Salmon Doc.)

19. Salmon tagging data for England and Wales, by A. Swain.

20. Salmon catches for England and Wales, by A. Swain. (ICES/ICNAF Salmon Doc.)

21. The derivation by analysis of covariance of indices of total migrant population size from angling catch returns from the River Wye, by A. S. Champion. (ICES/ICNAF Salmon Doc.)

22. The Danish salmon fishery in the Norwegian Sea in 1971, by O. Christensen.

23. Geographical and seasonal distribution of the Danish offshore salmon fishery at West Greenland in 1971, by O. Christensen. (ICES/ICNAF Salmon Doc.)

24. The Faroese offshore fishery for salmon at West Greenland 1971, by A. Reinert. (ICES/ICNAF Salmon Doc.)

25. The size composition and growth rate of salmon landed in West Greenland during the autumn, 1970, by J. Møller Jensen. (ICES/ICNAF Salmon Doc.)

26. Grilse salmon relationship in two Irish rivers, by Eileen Twomey. (ICES/ICNAF Salmon Doc.)

27. Catches in 1971 and their seasonal break-down, by Eileen Twomey. (ICES/ICNAF Salmon Doc.)

28. Rates of exploitation in Irish waters, by Eileen Twomey. (ICES/ICNAF Salmon Doc.)

29. Use of scales to determine mainland origin of Atlantic salmon caught in offshore waters, by K. H. Mosher. (ICES/ICNAF Salmon Doc.)

30. Second report of the Planning Group for the International Tagging Experiment at West Greenland in 1972.

31. A Guide Book for participants in the ICES/ICNAF salmon tagging programme at Greenland, 1972.

32. Canadian tagging data.

33. Preliminary report of salmon tags of Maine (USA) origin recovered from fisheries in the ICNAF Convention area during 1971, by A. L. Meister.

34. Norway, salmon catches.

35. Salmon tagging in the Norwegian Sea 1969-1971, by L. Rosseland.

36. Norwegian salmon tagging data.

37. Distant and local exploitation of a Labrador Atlantic salmon population by commercial fisheries, by R. F. Peet and J. D. Pratt. (ICES/ICNAF Salmon Doc.)

38. Norwegian salmon tagging data.

39. Canadian catches of Atlantic salmon 1960-1970 (graph only).

40. Overfishing and depleted stocks of Northwest Miramichi salmon, by P. F. Elson. (ICES/ICNAF Salmon Doc.)

41. Sex ratios of salmon and grilse, by P. F. Elson.

International Council for the Exploration of the Sea

C.M. 1971/M:14
Anadromous and Catadromous Fish Committee

GENETIC DIVERSITY IN SALMON

By

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INTRODUCTION

Studies on the genetics of radiation of Atlantic salmon (Salmo salar) were started at the Biological Station, St. Andrews, in 1968. Both blood typing and electrophoretic studies were carried out. Three main patterns of transferrins, Tf AA, Tf AC, and Tf CC, made up of two molecular types, were found in plasma of hatchery and wild salmon (Møller 1970a). Several papers dealing with gene frequencies have been published (Møller 1970a, b, and c). This report gives a survey of the material sampled and analysed up to now.

MATERIAL AND METHODS

Over 5500 blood specimens distributed on 56 samples from 38 localities in Eastern Canada and United States have been collected in 1969 and 1970 (Table 1, Figure 1). Blood specimens from both parr, smolt, grilse, and adult salmon are represented . The methods of sampling, handling, the electrophoretic technique used, and the interpretation of electrophoretic patterns have been described elsewhere (Sick 1965, Møller 1966, 1970a).

RESULTS

Table 2 shows the observed distributions of the transferrin patterns compared to the expected distributions of the types according to the Hardy-Weinberg law of genotype distributions in large random mating populations. Only six of the 56 samples show significant differences between the two distributions (marked x in the table).

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The frequency of the $\underline{Tf}^A$ allele varies greatly (Figure 2). The lowest value, .071, was found in Aides Str., Nfld., while the highest value, .650, was present in the sample from MacDonald R., Anticosti. Low values were found else in Labrador and Newfoundland, while high values were found south in New Brunswick and in Maine.

Great differences in frequencies over short distance (less than 200 km)(Figure 2) were observed between Mingan (.241) and MacDonald (.650); Middle R. (.536) and East R. (.292); and Big Salmon R. (.300-.360)/ St. John R. (.229-.425) and Dennis Str. (.500). In the first case the distance between the mouths of the rivers is about 80 km.

Figure 3, 4, and 5 illustrates the confidence intervals of the observed gene frequency of $\underline{Tf}^A$ (q^A) in the samples. The vertical lines give the observed frequencies, and the horizontal ranges of the bars indicate the 95 % confidence limits. All figures show significant differences of the gene frequencies between neighbouring rivers or between samples collected at different localities in the same river. Another noticeable feature is the similarity between samples collected at the same locality (sample 41-42, 45-46, 52-53, 54-55). Exceptions are some of the samples from Miramichi R. (Figure 4, sample 15 to 38) and St. John R. (Figure 5, sample 47 to 51).

Miramichi R. is probably the worlds biggest salmon river. The river has a heavy ramification, and the two main branches, NW Miramichi R. (sample 15 to 32) and SW Miramichi R. (sample 33 to 35) join just before the estuary (sample 36 to 38). Sample 21 to 27 were collected during the smolt run in 1970 at the river fench at Curventon in NW Miramichi R. The specimens were sampled once a week, some times twice a week. The differences between the samples 21, 22, 23, and 24 are insignificant (Figure 4). However, in the course of three days the frequency of smolts changed from .317 to .479 (sample 24 and 25). The cause of this jump could be that sample 25 represented smolts from the group of individuals up in Little River which were identified by the catch of parr (sample 16) during the same summer.

The significant differences of q^A between sample 34 and some of the other samples representing adult salmon in the same river system were also very interesting. Especially since the sample from the estuary representing fish coming back from the sea (sample 38) shows an intermediate value.

DISCUSSION

The existence of significant differences in the value of the gene frequency q^A between samples, together with the fact that the distribution of transferrin types, with the exception of six samples, are in accordance with Hardy-Weinberg law, are consistent with the general view that nearly all species are made up of genetically distinct populations.

The significant differences between observed and expected distributions in six samples could partly be caused by chance and partly collecting blood specimens from more than one population. Sample 17, 28, 29, 34, and 36 are collected in one river system with a complex structure. Together with the different values of q^A in the same river system, it is obvious to assume that the significant differences between observed and expected distributions in each sample are caused by the presence of several populations of salmon in the river system (Saunders 1967).

One question concerns the influence of artificial stocking on the genetic diversity. Over the years there has been a considerable degree of interchange of stocks within West Atlantic salmon which could have contributed greatly to the present heterogeneity. The difference between samples from St. John R. (sample 47 to 51) is difficult to interprete. The detected heterogeneity could pertly be caused by the heavy stocking in this river over the last few years.

Stocking, however, can not explain all the differences detected. Stocking is not reported between rivers in Labrador (sample 1), Newfoundland (sample 2 to 4), or Anticosti (sample 7 and 8). It is not possible to detect any real difference between areas without stocking or areas where stocking has occurred. One would believe that an exchange of individuals between rivers would break down the isolation mechanisms and lead to panmixia. This does not seem to have occurred. The reason for this could be the common occurrence of the efficient homing instinct or some other possible premating mechanisms. Investigations indicate that populations have their own migration routes at sea. The difference between Mingan (sample 5) and MacDonald (sample 7) can hardly be explained without the existence of an isolating mechanism (see Figure 2).

By any means the complex genetic diversity in salmon together with the lack of difference between areas with and without stocking, should be a warning for the policy of stocking in the future.

Lately, another report has been published concerning transferrin variation in the Atlantic salmon (Payne, Child, and Forrest 1971). The authors explain partly the presence of different populations of Atlantic salmon as the progeny of interstadial populations. The importance of environmental changes of the past for raciation should not be underestimated. However, more importance should be attached to the balance between the evolutionary forces of today and the reaction to these forces from salmon as one species. The complex picture of genetic diversity in salmon in the present report seems to emphasize this balance in the nature comparable to many of the results obtained lately in different animal groups (see for instance Berry and Southern 1970 and Koehn 1969).

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TABLE :

Locality, date, gear, type of animal and number of specimens of collected samples.

Sample no.	Locality	Date of sample	Gear	Type of animal	Number of specimens
1	Sand Hill R., Labrador	23.-29. 7/69	Counting fence	Grilse	130
2	Indian R., Nfld.	15. 6/70	Counting fence	Smolt	120
3	Terra Nova R., Nfld.	12.-17. 8/70	Fishway trap	Grilse	54
4	Adies Stream, Nfld.	1. 8/69	Counting fence	Grilse	112
5	Mingan R., P.Q.	28.-29. 7/70	Electro seining	Parr	27
6	Saquenay R., Tadoussac	3. 11/70	Trapnet	Grilse/adults	120
7	MacDonald R., Anticosti Is.	23.-24. 7/70	Electro seining	Parr	143
8	Juniper R., Anticosti Is.	20.-22. 7/70	Electro seining	Parr	154
9	Matane, P.Q.	2.-10. 7/70	Fishway trap	Grilse/Adults	122
10	Dartmouth R., P.Q.	11.-13. 7/70	Counting fence	Grilse	164
11	St. Jean R., P.Q.	22.-23. 7/70	Electro seining	Parr	115
12	Grand Cascapedia R., P.Q.	1. 7/70	Electro seining	Parr	146
13	Carleton R., P.Q.	1. -25. 6/69	Trapnet	Grilse/adults	120
14	Restigouche R., N.B.	2. 9/69	Seine	Grilse/adults	120
15	Crawford Pool, NW Mira-michi, N.B.	11. 8/70	Electro seining	Parr	73
16	Little R., NWM, N.B.	14. 8/70	Electro seining	Parr	26
17	Stoney Bk + Little Bald NWM, N.B.	20.-26. 8/70	Electro seining	Smolt	80
18	NW Miramichi, N.B.	25.-26.-28. 8/70	Electro seining	Smolt	80
19	NW Miramichi, N.B.	27.-28. 8/70	Electro seining	Smolt	59

Locality, date, gear, type of animal and number of specimens of collected samples.

Sample no.	Locality	Date of sample	Gear	Type of animal	Number of specimens
20	Curventon, NWM, N.B.	5/69	Counting fence	Smolt	93
21	Curventon, NWM, N.B.	20. 5/70	Counting fence	Smolt	120
22	Curventon, NWM, N.B.	26. 5/70	Counting fence	Smolt	120
23	Curventon, NWM, N.B.	29. 5/70	Counting fence	Smolt	120
24	Curventon, NWM, N.B.	2. 6/70	Counting fence	Smolt	120
25	Curventon, NWM, N.B.	5. 6/70	Counting fence	Smolt	70
26	Curventon, NWM, N.B.	9. 6/70	Counting fence	Smolt	120
27	Curventon, NWM, N.B.	12. 6/70	Counting fence	Smolt	120
28	Curventon, NWM, N.B.	3.-6. 7/69	Counting fence	Grilse	117
29	Curventon, NWM, N.B.	17.-29. 7/69	Counting fence	Grilse	146
30	Curventon, NWM, N.B.	3.-30. 6/70	Counting fence	Adults	97
31	Curventon, NWM, N.B.	7.-22. 7/70	Counting fence	Adults	116
32	Sevolge R., NWM, N.B.	3.-25. 6/70	Electro seining	Parr/smolt	44
33	Bartholomew R., NWM, N.B.	31. 5/70	Seine	Smolt	90
34	SW Miramichi R., N.B.	1., 9.-31. 10/69	Trapnet	Grilse	117
35	SW Miramichi R., N.B.	28. 10/70	Trapnet	Adults	62
36	Millbank, N.B.	26.-28. 5/69	Trapnet	Smolt	120
37	Millbank, N.B.	3. 6/70	Trapnet	Smolt	120
38	Millbank, N.B.	24.-29. 7/69	Trapnet	Grilse/adults	59
39	R. Philip, N.S.	1. 7.-30. 9/69	Fishway trap	Grilse/adults	120
40	Wallace R., N.S.	9. 7/70	Electro seining	Parr	70

Sample no.	Locality	Date of sample	Gear	Type of animal	Number of specimens
41	MargareeR., N.S.	1. 7.-30. 9/69	Seine	Grilse/adults	95
42	Margaree R., N.S.	20. 8/70	Electro seining	Parr	115
43	Middle R., Cape Breton	16. 9/70	Electro seining	Parr	110
44	East R., N.S.	9. 6/70	Counting fence	Smolt	120
45	Big Salmon R.,, N.B.	4. 6/70	Counting fence	Smolt	120
46	Big Salmon R., N.B.	5.-9. 9/70	Fishway trap	Adults	114
47	Saint John R., N.B.	1. 5.-30. 6/69	Fishway trap	Grilse/adults	105
48	Saint John R., N.B.	1. 7.-15. 10/69	Fishway trap	Grilse/adults	142
49	Saint John R., N.B.	16.-31. 10/69	Fishway trap	Grilse/adults	91
50	Saint John R., South Esk	9.-10. 11/70	Fishway trap	Grilse/adults	60
51	Saint John R., South Esk	9.-10. 11/70	Fishway trap	Grilse/adults	60
52	Dennis Stream, N.B.	5.-7. 8/70	Electro seining	Parr	40
53	Dennis R., Maine	8. 10/70	Electro seining	Parr	76
54	Machias R., Maine	1. 6.-30. 9/69	Counting fence	Grilse/adults	32
55	Machias R., Maine	11.-13. 8/70	Fishway trap	Parr	124
56	Narraguagus R., Maine	1. 6.-30. 9/69	Counting fence	Grilse/adults	24

TABLE I

TRANSFERRIN POLYMORPHISM IN SALMON

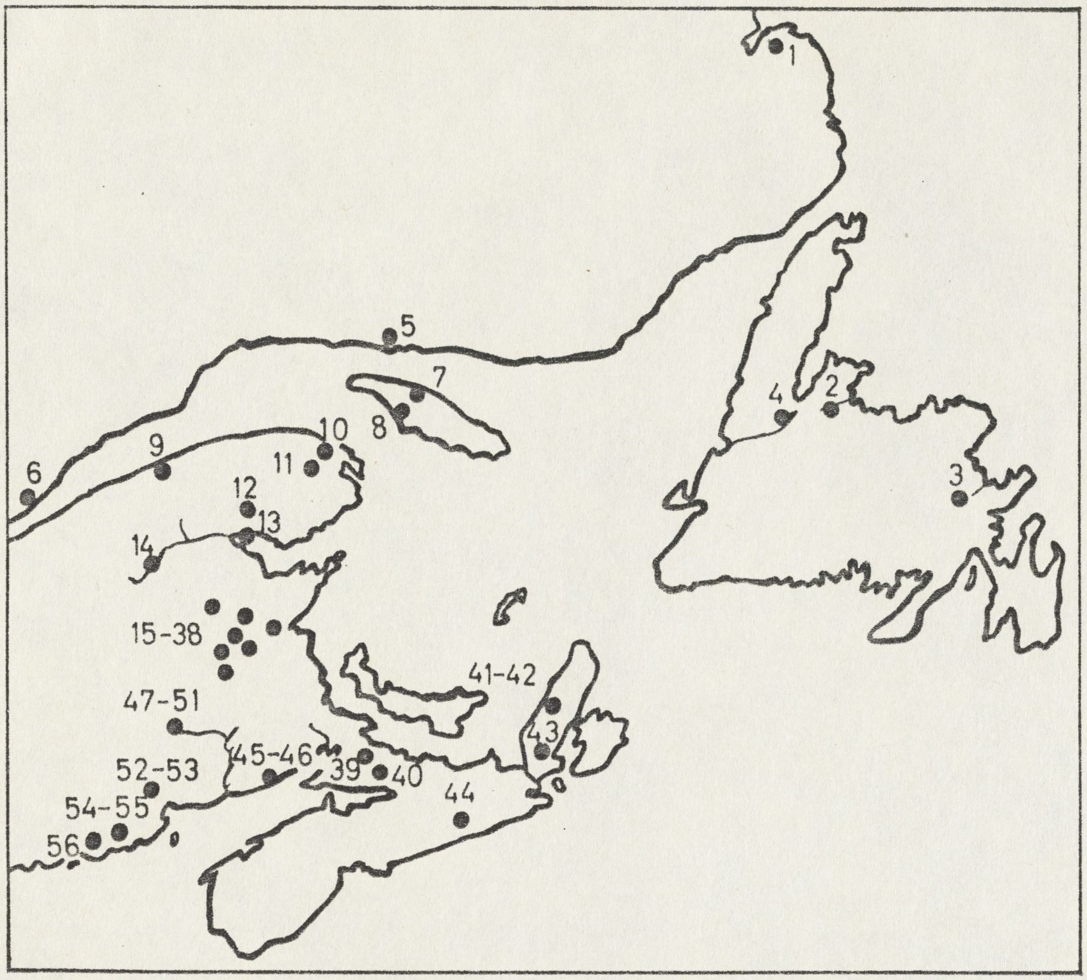
	TfAA		TfAC		TfCC	
SAMPLE	OBS.	EXP.	OBS.	EXP.	OBS.	EXP.
1	2	0.93	18	20.14	110	108.94
2	3	2.4	28	29.19	89	88.4
3	1	0.59	6	6.81	20	19.60
4	1	0.57	14	14.85	97	96.57
5	2	1.56	9	9.87	16	15.57
6	10	8.27	43	46.46	67	65.27
7	56	60.47	74	65.04	13	17.49
8	39	42.61	84	79.79	31	34.60
9	17	13.45	47	54.11	58	54.43
10	30	27.27	52	57.46	33	30.26
11	38	39.63	59	55.76	18	19.62
12	30	25.35	60	60.29	52	47.36
13	22	20.42	55	58.16	43	41.42
14	21	20.01	56	57.98	43	42.01

TRANSFERRIN POLYMORPHISM IN SALMON

SAMPLE	TfAA OBS.	TfAA EXP.	TfAC OBS.	TfAC EXP.	TfCC OBS.	TfCC EXP.	
15	7	8.56	36	22.88	30	31.56	
16	5	5.29	13	12.42	7	7.29	
17	15	8.78	23	35.46	42	35.78	x
18	5	6.91	37	33.20	38	39.91	
19	6	5.80	25	25.41	28	27.79	
20	11	11.36	43	42.29	39	39.35	
21	13	13.67	55	53.66	52	52.67	
22	13	12.04	52	51.94	56	56.03	
23	10	11.60	54	50.80	54	55.60	
24	10	12.04	56	51.94	54	56.03	
25	19	16.03	29	34.94	22	19.03	
26	17	16.14	54	55.74	49	48.13	
27	15	15.05	55	54.90	50	50.05	
28	22	15.08	40	53.84	55	48.07	x
29	28	22.25	58	69.50	60	54.25	x
30	9	9.59	43	41.83	45	45.59	
31	17	18.64	59	55.73	40	41,63	
32	5	6.57	24	20.86	15	16.57	
33	12	11.38	40	41.25	38	37.37	
34	10	5.78	32	40.44	75	70.78	x
35	11	9.68	27	29.64	24	22.68	
36	21	16.50	47	55.99	52	47.51	x
37	15	15.77	57	55.46	48	48.77	
38	7	4.90	20	24.20	32	29.90	

TRANSFERRIN POLYMORPHISM IN SALMON

	TfAA		TfAC		TfCC	
SAMPLE	OBS.	EXP.	OBS.	EXP.	OBS.	EXP.
39	12	12.68	54	52.65	54	54.67
40	7	6.09	27	28.82	35	34.09
41	19	18.57	46	46.86	30	29.57
42	20	23.52	64	56.97	31	34.51
43	28	31.65	62	54.71	20	23.64
44	10	10.12	50	49.57	60	60.20
45	11	10.08	50	50.4	59	58.8
46	15	14.82	52	52.44	47	46.74
47	8	5.49	32	37.03	65	62.48
48	14	10.71	50	56.57	78	74.72
49	10	7.72	33	37.57	48	45.72
50	8	10.84	35	29.33	17	19.84
51	7	8.07	30	27.86	23	24.07
52	8	10.00	24	20.00	8	10.00
53	27	25.47	34	37.06	15	13.47
54	10	11.28	18	15.44	4	5.28
55	5	5.29	13	12.42	7	7.29
56	9	8.76	11	11.48	4	3.76


1
2
3
4
5
6
7
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9
10
11
12
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15-38
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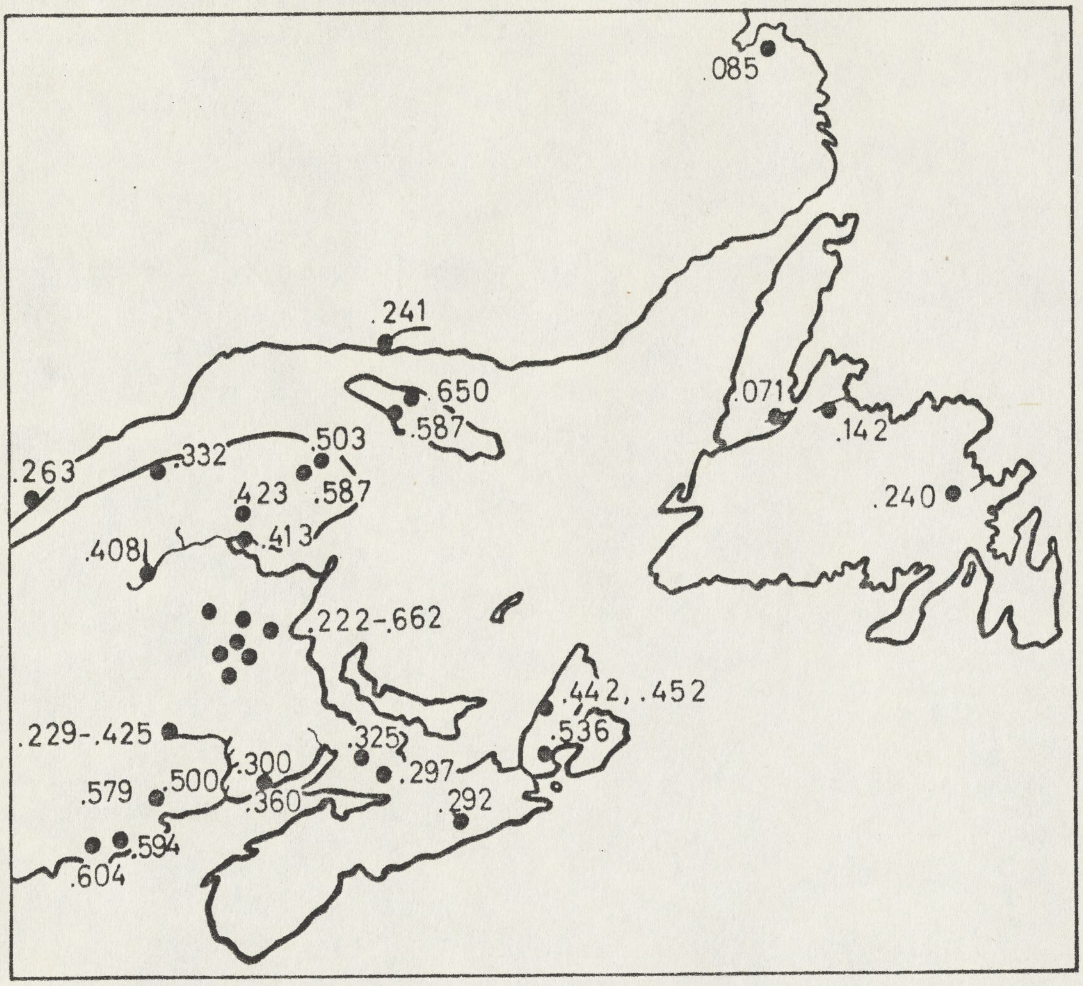
41-42
43
44
45-46
47-51
52-53
54-55
56

FIGURE 1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.241
.650
.587
.071
.142
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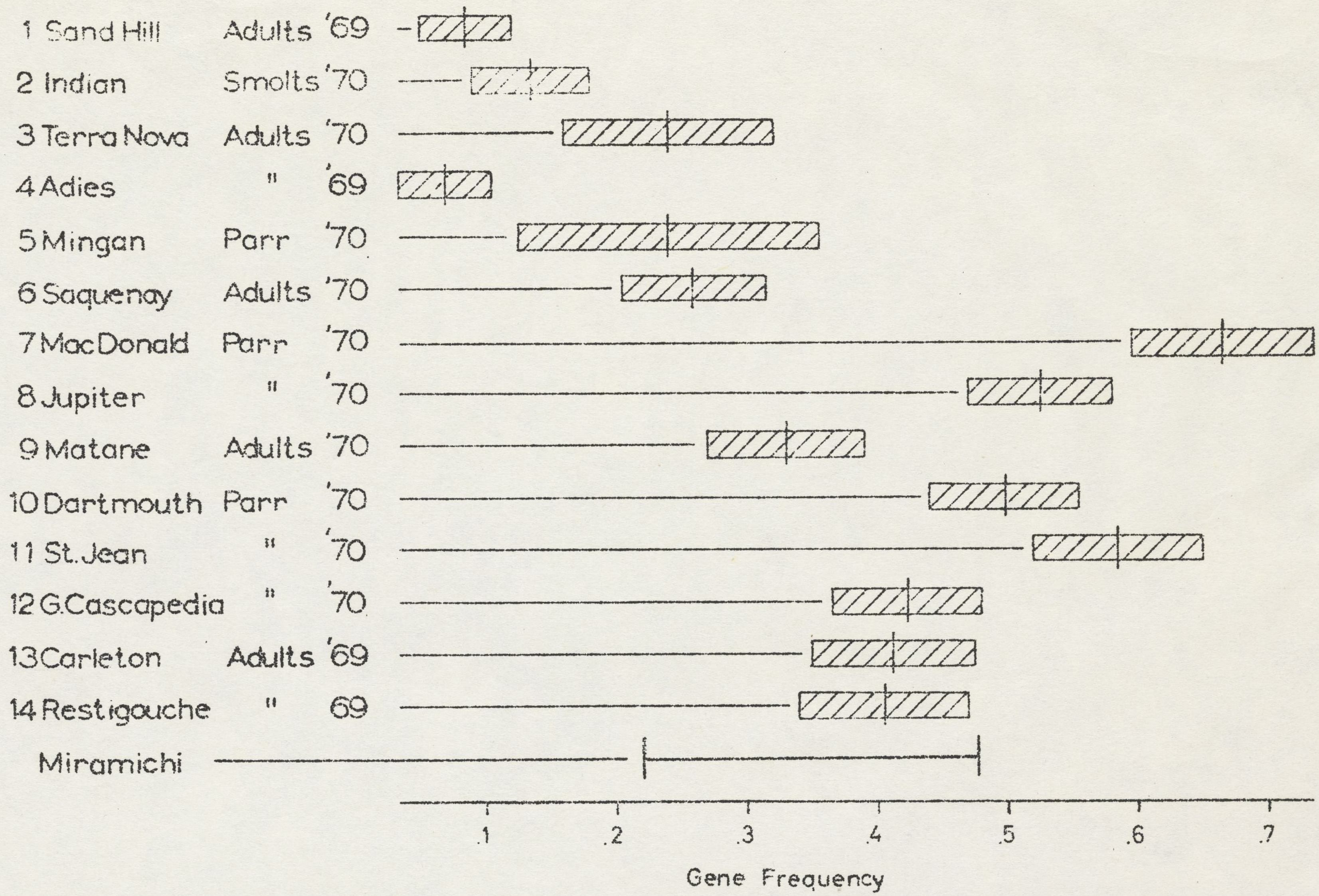
.423
.587
.240
.408
.413
.222-.662
.442, .452
.229-.425
.536
.325
.300
.297
.579
.500
.360
.292
.594
.604

FIGURE 2



1 Sand Hill Adults '69
2 Indian Smolts '70
3 Terra Nova Adults '70
4 Adies " '69
5 Mingan Parr '70
6 Saquenay Adults '70
7 MacDonald Parr '70
8 Jupiter " '70
9 Matane Adults '70
10 Dartmouth Parr '70
11 St. Jean " '70
12 G.Cascapedia " '70
13 Carleton Adults '69
14 Restigouche " 69
Miramichi
.1
.2
.3
.4
.5
.6
.7
Gene Frequency

FIGURE 3

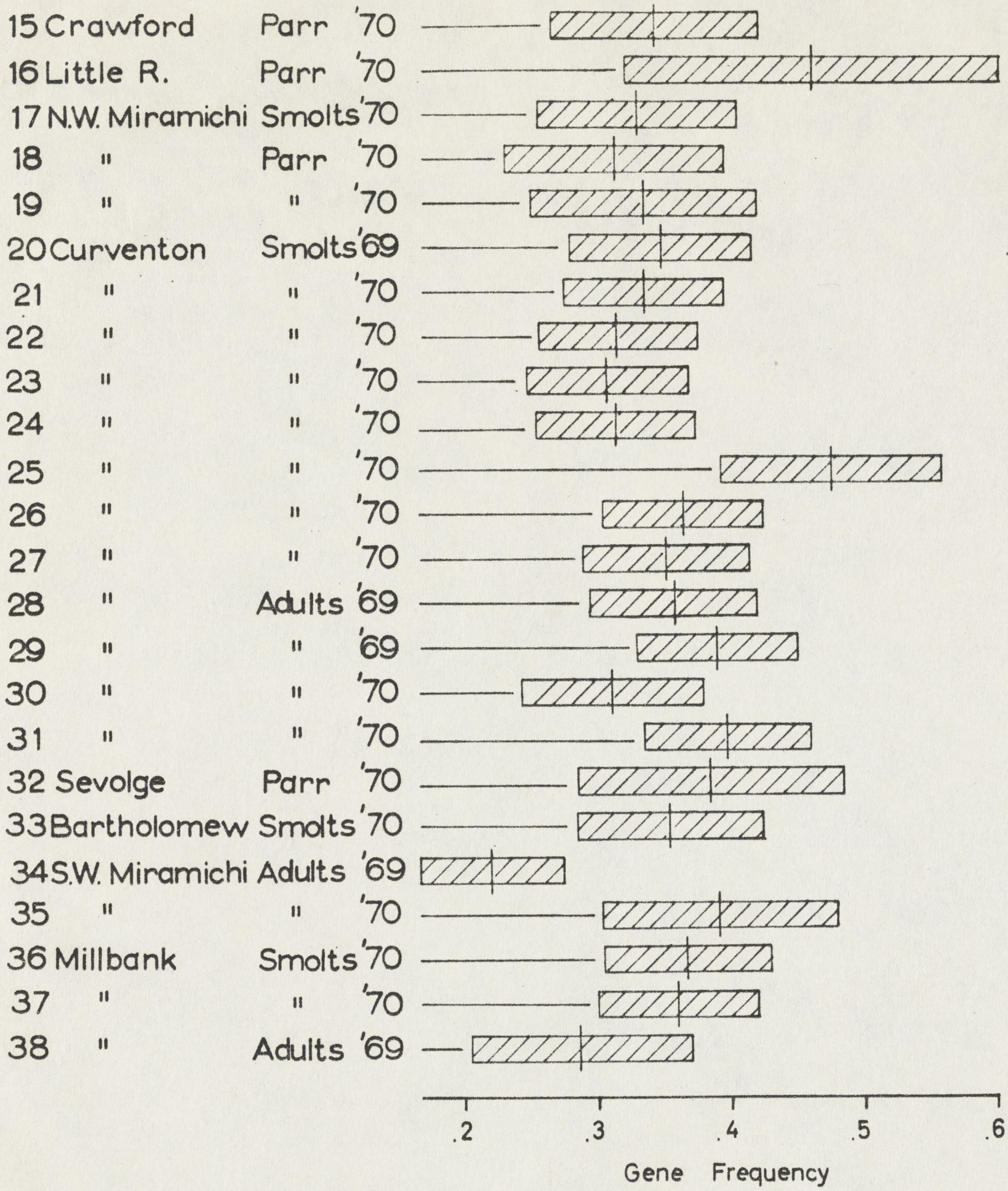
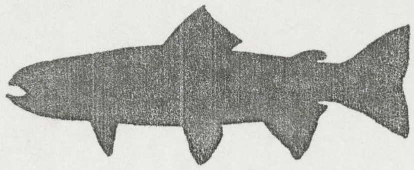

15 Crawford Parr '70
16 Little R. Parr '70
17 N.W. Miramichi Smolts '70
18 " Parr '70
19 " " '70
20 Curventon Smolts '69
21 " " '70
22 " " '70
23 " " '70
24 " " '70
25 " " '70
26 " " '70
27 " " '70
28 " Adults '69
29 " " '69
30 " " '70
31 " " '70
32 Sevolge Parr '70
33 Bartholomew Smolts '70
34 S.W. Miramichi Adults '69
35 " " '70
36 Millbank Smolts '70
37 " " '70
38 " Adults '69
.2
.3
.4
.5
.6
Gene Frequency

FIGURE 4

WDC- draft strategic plan.

ANADROMOUS STREAMS PROGRAM



Anadromous trout classified as game fish include native searun cutthroat, Dolly Varden, and steelhead or searun rainbow trout. Because steelhead are more abundant than cutthroat or Dolly Varden and provide more sport angling opportunity in streams, they are the primary focus of this program. Steelhead populations can be divided into two major groups, winter runs, which return to streams from November through April to spawn, and summer runs, which return to streams from May through October. With some diversity within these major strains, steelhead angling in streams is available almost year around.

Washington streams supporting steelhead and other anadromous fish are distributed throughout the Puget Sound region, the Columbia River drainage, and coastal areas draining directly to the Pacific Ocean.

Management of steelhead in streams is very complex due to a number of major factors including the 1979 U.S. Supreme Court decision which provided for allocation of up to 50% of harvestable numbers of steelhead and salmon to Treaty Indian Tribes; physical and biological competition with commercial salmon species; and continuous reduction of adequate stream-flows and natural spawning and rearing habitat.

SUPPLY AND DEMAND

Steelhead punch card data back to 1970 show that sport angling for steelhead fluctuated from year to year within a narrow but fairly high range until 1976, when the full impact of the Federal Court (Boldt) decision on salmon and steelhead allocation was realized. In 1976 steelhead tag sales dropped off about 35%. Sales increased again by 26% in 1977 and have continued to grow slowly but steadily at a rate of 1-5 percent through calendar year 1980. This slow but steady growth in sport steelhead demand is expected to continue into the foreseeable future.

GOAL

The statewide goal for anadromous streams is to maintain, or increase where feasible, sustainable wild populations of anadromous trout while increasing angling opportunities through selective stocking of hatchery-origin fish. Although management emphasis is on perpetuation of wild stocks, the goal does not preclude hatchery-origin enhancement of streams to meet recreational demand for steelhead and searun cutthroat. The goal is not dependent on federal decommercialization of steelhead trout.

PROBLEMS AND STRATEGIES

1. Problem

   Spawning and rearing habitat for wild and hatchery stocks is being depleted by streambed disturbance and development activities affecting stream habitat.

   Strategies

   a. acquire and analyze back-up information needed to adequately protect and restore aquatic habitat or mitigate fish losses. This will include inventorying aquatic habitat, measuring losses, determining economic values, and developing and evaluating new methods for improving and restoring habitat to replace losses.
   b. represent fish in negotiating protection, restoration and mitigation.
   c. establish statewide programs for such activities as gold dredging, instream flows, and small hydro developments to deal efficiently and effectively with projects that cumulatively have significant effects on aquatic habitat.
   d. effective investigation, coordination, and disposition of Hydraulic Project Approval (HPA) applications.
   e. strong enforcement of HPA regulations.
   f. organized involvement in local, state and federal agency planning which affects anadromous streams.
   g. effective input into other agencies' permit decisions affecting anadromous streams (i.e., Forest Practice, Shoreline Management, Corps of Engineers).

h. review and timely response to EIS's and other environmental documents pertaining to potential impacts on the stream environment.

i. education and information program to raise public awareness about the value of spawning and rearing habitat to steelhead and cutthroat.

j. rehabilitation of spawning beds by gravel cleaning, gabion placement, addition of new gravel, and other techniques.

k. maintain active role in securing regulations and legislation providing habitat protection and opposing legislation and activities detrimental to habitat.

2. Problem

Upstream and downstream migration of anadromous fish is blocked by dams and other instream structures.

Strategies

a. require adequate passage facilities for adult fish and smolts on new and existing dams.

b. continue to seek adequate mitigation for fish and wildlife losses from construction, or during relicensing of hydroelectric dams and federally-funded projects.

c. seek state legislation to require mitigation for state or locally funded dams and diversion structures that impact anadromous fish migration.

d. emphasize selection in hatchery stocks for increased migration survival in streams with artificial passage facilities.

e. increase hatchery production to offset migration losses.

3. Problem

There is severe competition for water between out-of-stream water development interests and fisheries resources.

Strategies

a. insist that adequate instream flows are established and maintained in anadromous trout streams by Department of Ecology and other appropriate agencies. Develop a program to determine amounts of water needed for adequate flows.

b. take other legal measures, including formal adjudication of water rights in some cases, to require adequate flows for fish.

4. Problem

There is a shortage of available harvest, escapement, and recruitment data for predicting runs or for basing and evaluating management objectives for anadromous trout. There is also a lack of basic life history information for anadromous Dolly Varden.

Strategies

a. designate index streams in Puget Sound, Columbia/Snake system, and coastal drainages; collect baseline harvest, escapement, and recruitment data for steelhead, searun cutthroat, Dolly Varden; collect basic life history information for Dolly Varden.
b. inventory waters containing anadromous Dolly Varden.
c. develop a punch card system for all anadromous game fish to yield information on harvest trends.

5. Problem

Uniform stream harvest regulations and the inability of anglers to distinguish between wild and hatchery fish results in excessive harvest of wild stocks in some mixed wild and hatchery stock streams.

Strategies

a. categorize streams according to their potential for wild-only trout management; develop, implement, and enforce specific management programs and harvest regulations for wild-only, hatchery-only, and mixed-stock streams.

what done along these lines?

b. mark hatchery-stock fish to enable the public to distinguish them from wild fish.
c. discontinue planting legal-sized trout in anadromous streams.
d. institute limited entry fisheries in streams managed for wild stocks.

Problem - stocking hatchery neg. impact wild ?

6. Problem

There is a shortage of public streambank access due to increased recreational pressure and private streambank development.

Strategies

a. acquire or promote more public access and easements on selected streams where demand justifies more access.

b. ensure that already-acquired access areas and easements are open and available for public use.

7. Problem

There is a shortage of angler use and preference information for program planning and management.

Strategies

- institute a periodic statewide angler use and preference survey.

8. Problem

Salmon and game fish compete for spawning and rearing habitat in anadromous streams.

Strategies

a. maintain close management coordination with Department of Fisheries and other commercial fish management agencies and Indian tribes.

b. conduct studies to determine the degree of competition in various streams.

9. Problem

There is a lack of proper stream-specific broodstock of searun cutthroat trout.

Strategies

a. develop truly anadromous stocks of hatchery-reared cutthroat trout that will return in reasonable numbers to the streams where they are stocked.

b. develop hatchery and saltwater rearing facilities to produce proper stream-specific stocks of searun cutthroat.

10. Problem

Inadequate coordination takes place among agencies and colleges and universities doing research on steelhead and other anadromous species.

Strategies

a. expand and improve research exchange services through University of Washington and other appropriate fisheries management/research entities.
b. encourage and participate in symposia with other anadromous fish research entities.

11. Problem

Complex regulations to ensure adequate resource protection and maximum recreational opportunity confuse anglers creating compliance problems.

Strategies

a. improve angler understanding of and participation in the regulation development process.
b. make fishing season pamphlets easier to understand.
c. increase angler comprehension of regulations through media and by posting regulation information.

12. Problem

Emergency conservation or allocation closures are often misunderstood. There is a lack of compliance with these actions.

Strategies

a. better anticipation of emergency actions.
b. increase media information regarding emergency actions.
c. increase patrol capability to ensure compliance.

13. Problem

Steelhead harvest information is not consistently documented and reported in an accurate and timely manner.

Strategies

a. develop Wildlife Agent's capability to inspect fish and document commercial enterprises dealing in steelhead.

b. increase patrol.

14. Problem

Commercial fishing for steelhead has the potential for over harvesting runs, reduces sport angling opportunity and catch, and places an expensive, complicated management burden on the agency.

Strategies

- work for decommercialization of steelhead.

Are eggs taken from Kalama ? each year somewhat
- nat. selection - smolt - ocean - return phase of life

Kalama - cutthroat smolts - upstream limit ?

What about selection for 3 salt fish - 30 lb. superstealhead
- reduced return - inbreeding - or poor return ?

Spawning hatchery, wild, summer, winter
Gobar Crk - spatial & temporal separation
A see fig. 6 timing hatchery winter most like summer wild.
A - hatch. - would favor bridging gap in reproduction of native - -
A fitness - testing - WxW HxH HxW will be evaluated.
- but this should have been starting point -
influence Hat. return - release some as fry
- table 23 gene freq
adults - AGP wild .958 - if persisted so many years
1979 Hatch .474
A Need freq. change 0 I II returning adult
if AGP - - - - - selection against hatchery at stage occurring

table 24 ? -
survival
- selection - WxW 1.00 HxH .69 - ca 50% more effective

A table 27 -
1979 parr migrants same gene freq. as adult wild despite 80% spawning by hatchery fish.
A - Need 1979 1980 - 81
follow year class 0 - I - II - returning adults
74% - 97%
AGPA
- 0 I ? - 80% spawning by hatchery B (1979) offspring not present in (1980)
✓ I.) This correct 74% → 97%
A likely lessened impact of 'weeding' out age 0 - due to limit of carrying capacity of yearlings - p. 59-60.

1978 Rep. table 5.2 - AGP AA in Gobar y.o.y. fry
June 2 - 67.8
28 - 91.4 - rapid decrease
July 6 - 94.5 in hatchery gene.
14 - 94.6

fig 2 1980's rept - amazing wild summer - winter runs still there
hatchery winter superimposes summer wild.
hatchery summer - bridges gap.