

Fisheries
Research
Services

SCOTTISH FISH FARMS Annual Production Survey 1997

This report was conducted for The Scottish Office
by the Marine Laboratory Aberdeen.

The Marine Laboratory Aberdeen is a division of
Fisheries Research Services, an executive agency of
The Scottish Office

FOREWORD

The annual production survey of fish farms in Scotland for 1997 was carried out on behalf of The Scottish Office by the Marine Laboratory Aberdeen. The Marine Laboratory Aberdeen is the official reference source for data in this report. In April 1997 Fisheries Research Services (FRS) was established as an Executive Agency within The Scottish Office, and the Marine Laboratory Aberdeen designated an operational unit within the agency.

Responses from Scottish rainbow trout (*Oncorhynchus mykiss*) and Atlantic salmon (*Salmo salar*) farming companies to Marine Laboratory Aberdeen questionnaires covering the period January-December 1997 are summarised in this report. Copies of the questionnaires are included in Appendix I(a-c). The report is structured to allow readers to follow trends within the trout and salmon industries in addition to providing information on the latest production year. Where available statistics are given for the 10-year period 1988-1997. Data from previous years have been reassessed and updated where necessary. Production information by region is given as production by The Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) area to avoid confusion in terminology between different official bodies eg. local government, SEPA etc. The areas used conform to those used in previous SOAEFD reports.

Under the Registration of Fish Farming and Shellfish Farming Business Order 1985, all companies engaged in fish farming in Scotland are required to register with SOAEFD. The registers are maintained by the Fish Health Inspectorate based at the Marine Laboratory Aberdeen. The contents of the registers cannot be made public (Diseases of Fish Act 1937 as amended), however company and farm information can be published in summary form and these are shown in the appropriate tables.

In 1992 Great Britain (GB) was granted Approved Health Zone Status with respect to viral haemorrhagic septicaemia (VHS) and infectious haematopoietic necrosis (IHN) viruses in accordance with EC Directive 91/67/EEC and EC Decision 92/538/EC. In July 1996 further health protection measures were achieved in relation to the ectoparasite *Gyrodactylus salaris* in EC Decision 96/490/EC. These Decisions allow GB to maintain the current high health status in stocks of wild and farmed fish by banning imports of fish from zones of lesser health status and are the basis for implementation for the control of imports of live fish into Scotland.

Other fish species cultured in Scotland include brown trout (*Salmo trutta*), halibut (*Hippoglossus hippoglossus*), turbot (*Scophthalmus maximus*), eel (*Anguilla anguilla*) and arctic charr (*Salvelinus alpinus*). Brown trout were included in the 1996 survey but were omitted in 1997 due to the small quantity produced. The quantity of turbot placed on the market was relatively small, but is likely to increase. The first sales of cultured halibut were recorded in 1997. Detailed information on production of these species cannot be given due to the small number of producing companies involved and the need to maintain business confidentiality.

The Deregulation (Salmon Fisheries [Scotland] Act, 1868) Order 1996 permitted the sale of farmed salmon ova for human consumption (salmon caviar). There were no records of salmon ova having been sold in 1997.

The cooperation of the fish farming industry in completing the questionnaires is gratefully acknowledged.

CONTENTS

SUMMARY	1
I. RAINBOW TROUT	
TABLE 1a Total production (tonnes) of rainbow trout in 1988-1997	3
TABLE 1b Production (tonnes) for the table trade in 1993-1997	3
TABLE 1c Production (tonnes) for the restocking trade in 1993-1997	3
TABLE 2a Numbers of farms grouped by tonnage produced between 1992-1997	4
TABLE 2b Grouping of rainbow trout farms by production tonnages, main method of production in 1997, and comparison with production in 1996	4
TABLE 3 Number of companies and farms in production during 1990-1997	5
TABLE 4 Number of staff employed and productivity per man during 1990-1997	5
Figure 1 Manpower and productivity in rainbow trout production during 1988-1997	5
TABLE 5 Production and staffing by area in 1997 (production farms only)	6
Figure 2 The distribution of active rainbow trout farms and production tonnage by area in 1997	6
TABLE 7 Number (000s) and sources of ova laid down to hatch during 1993-1997	7
TABLE 8a Number (000s) and sources of ova imported into Scotland during 1994-1997	8
TABLE 8b Seasonal variation in number (000s) and sources of ova imported during 1997	8
TABLE 9 Trade in numbers (000s) of fry and fingerlings bought and sold during 1992-1997	9
TABLE 10 Number of farms rearing fish vaccinated against enteric redmouth disease (ERM) during 1988-1997	9
CONCLUSIONS RAINBOW TROUT	10
II. ATLANTIC SALMON OVA and SMOLTS	
TABLE 11 Number (000s) of smolts produced, staff employed and smolt productivity during 1988-1997	11
Figure 3 Manpower and productivity in smolt production during 1988-1997	11
TABLE 14a Number and capacity of smolt production systems during 1994-1997	13
TABLE 14b Number (000s) of smolts produced and stocking densities by production system during 1994-1997	13
TABLE 15 Number (000s) of salmon ova produced during 1991/92 -1996/97 spawning periods	14
TABLE 16 Ova sources and number of ova (000s) laid down to hatch during 1991/2-1996/1997	14
TABLE 17a Sources and numbers (000s) of salmon imported during 1993-1997	15
TABLE 17b Destinations and numbers (000s) of salmon ova exported during 1994-1998 from fish broodstock spawned in the previous year	15

TABLE 18	Records of ova laid down to hatch and actual and forecasted smolt production during 1988-1999	16
TABLE 19	Smolt producing farms and smolt production (number 000s) of smolts produced during 1988-1997	16
TABLE 20	Staffing, ova laid down to hatch and smolt production by region in 1996 and 1997 and projected in 1998 and 1999	17
Figure 4	The distribution of active smolt farms and the numbers (000s) of smolts produced by area in 1997	17
TABLE 21	Number of farms using vaccines and number of fish vaccinated during 1987-1997	18

Production fish

TABLE 22a	Annual production of Atlantic salmon given as the combined tonnage in each calendar year 1985-1997 and estimated tonnage in 1998.....	19
TABLE 22b	Number (000s) and weight (tonnes) of salmon harvested and mean fish weight (kg) per smolt year class in 1993-1997	19
TABLE 22c	Weight (tonnes) and number (000s) of grilse and pre-salmon harvested in 1993-1997	20
TABLE 22d	Proportion of annual production (% weight) by growth stage in 1993-1997	20
TABLE 23	Survival and production (harvest) in smolt year classes put to sea in 1985-1997	21
TABLE 24	Number (000s) and origin of smolts put to sea in 1992-1997	21
TABLE 25	Number (000s) of smolts put to sea, year class survival and total production (tonnes) by Production Area in 1991-1997	22
Figure 6	Distribution of Active salmon farms and production tonnage by area in 1997.....	23
TABLE 26	Number of staff employed in salmon production in 1988-1997.....	23
TABLE 27	Production methods, capacity, tonnage and ratio of production (kgs) to capacity (m ³) in 1995-1997	24
TABLE 28	Productivity (tonnes/man) by companies grouped by scale of production in 1996 and 1997.....	24
TABLE 29	Manpower and production by production area in 1992-1997 and estimated production in 1998.....	25
TABLE 31	Number of sea cage farms employing a fallow period in 1993-1997	26
TABLE 32	Grouping of salmon production farms in relation to tonnage produced in 1992-1997	27
TABLE 33	Number of farms holding broodstock in 1988-1997	27
CONCLUSIONS ATLANTIC SALMON		28

Appendices

Appendix 1	Fish farm production survey questionnaires for 1997	31
Appendix 2	Glossary and Abbreviations	35

SUMMARY

The contents of this report are summarised below. For detail and additional information on production, including time series data, the reader is referred to the specific sections and tables in the report.

RAINBOW TROUT

		1996	1997
Total production	(tonnes)	4,630	4,653
Production for the table	(tonnes)	3,884	3,848
Production for restocking	(tonnes)	746	805
Number of staff employed		189	182
Mean productivity	(tonnes/man)	24.5	25.6
No. ova laid down to hatch	(million)	22.7	23.1
Number of ova imported	(million)	21.3	21.4

In 1997 production in rainbow trout increased by 33 tonnes. Nine fewer staff were employed but productivity per man increased to 25.9 tonnes per year. There was a modest increase of 0.4 million in the number of ova laid down to hatch. Overall production in rainbow trout in 1997 was similar to that in 1996. Imported ova again comprised the bulk of the ova laid down to hatch, the number imported remaining at approximately the 1996 level.

ATLANTIC SALMON

SMOLTS

		1996	1997
No. ova produced	(million)	122.7	186.5
No. ova laid down to hatch	(million)	78.4	85.8
No. ova exported	(million)	42.3	41.5
No. ova imported	(million)	8.0	3.5
No. smolts produced	(million)	33.6	38.2*
No. smolts put to sea	(million)	32.9	42.8
* excludes smolts imported			
Number of staff employed		441	510
Mean productivity (000s smolts/man)		76.2	74.9

PRODUCTION FISH

Total production	(tonnes)	83,121	99,199
Production of 0-year fish	(tonnes)	638	585
Production of grilse	(tonnes)	25,776	34,227
Production of pre-salmon	(tonnes)	32,222	37,122
Production of salmon	(tonnes)	24,485	27,263
Mean fish weight 0-year	(kg)	2.0	2.1
Mean fish weight grilse	(kg)	3.0	3.3
Mean fish weight pre-salmon	(kg)	3.8	3.8
Mean fish weight salmon	(kg)	4.5	4.4
Number of staff employed		1,391	1,295
Mean productivity	(tonnes/man)	60	77

SMOLT SURVIVAL (% harvested)

	years 0+1	Survival year 2	Total survival(%)
1994 input year class	66.9	24.6	91.5
1995 input year class	64.7	23.1	87.8

There were significant increases in production in Atlantic salmon across all growth stages. Ova production and ova laid down to hatch in 1997 increased by 63.8 and 7.4 million respectively and should result in increased smolt production in 1998. Exports of salmon ova dropped by 0.8 million and imports by 5.9 million. Some 10 million additional smolts were put to sea in 1997 and these should contribute to higher production tonnages in 1998 and 1999.

I. RAINBOW TROUT

(*Oncorhynchus mykiss*)

Annual production survey questionnaires were sent to all 51 companies registered with the Marine Laboratory Aberdeen as being actively engaged in the production of rainbow trout in Scotland in 1997. Returns were received from all 51 companies, covering all 69 currently stocked farms.

Production

TABLE 1a
Total production (tonnes) of rainbow trout in 1988-1997

Year	Tonnes	Year	Tonnes
1988	3,556	1993	4,023
1989	3,512	1994	4,263
1990	3,183	1995	4,683
1991	3,334	1996	4,630
1992	3,953	1997	4,653

TABLE 1b
Production (tonnes) for the table trade in 1993-1997

Year	<450 <1 lb	450-900g 1-2 lbs	> 900g >2 lbs	Total tonnes
1993	2,481	272	764	3,517
1994	2,376	288	1,038	3,702
1995	2,736	199	1,149	4,084
1996	2,701	181	1,002	3,884
1997	2,646	104	1,098	3,848

TABLE 1c
Production (tonnes) for the restocking trade in 1993-1997

Year	<450 <1 lb	450-900g 1-2 lbs	>900g >2lbs	Total tonnes
1993	124	346	36	506
1994	125	337	99	561
1995	107	411	81	599
1996	188	484	74	746
1997	97	589	119	805

Annual production of rainbow trout was directed solely at the table and restocking markets. Since 1995 total production has stabilised around 4,600 tonnes, which may indicate that current market demands are being met. Future increases in production are likely only if additional market demand or outlet can be established, and assuming that freedom from disease is maintained.

Production for the table trade was 3,848 tonnes, a decrease of 36 tonnes (1%) on the 1996 figure, and accounted for 83% of total production. Supply was principally for portion size fish weighing <450g/<1lb, and for larger fish weighing <900g/2lbs, for smoking. These two categories comprised 57% and 24% of total production respectively.

Production for the restocking of fishing ponds, lochs and reservoirs has increased annually since 1992 and accounted for 17% of total rainbow trout production. In 1997 production totalled 805 tonnes, an increase of 59 tonnes (9%) on the 1996 figure. Recreational fisheries are not classed as fish farms and the figures given in this report refer to stocking tonnages and not to catches taken by anglers.

Production by Farm

TABLE 2a
Numbers of farms grouped by tonnage produced between 1992-1997

Year	Number of farms per production tonnage				Total number of farms
	<1-25	26-100	100-200	>200	
1992	30	12	10	6	58
1993	28	13	11	5	57
1994	25	15	12	4	56
1995	26	15	13	5	59
1996	24	14	12	6	56
1997	19	22	12	4	57

Production tonnages were reported from 57 rainbow trout producing farms. Since 1992 the number of small producer farms (1-25 tonnes) has decreased steadily from 30 to 19 whilst the number of larger producer farms (>26 tonnes) has increased from 28 to 38.

Production by Method

TABLE 2b
Grouping of rainbow trout farms by production tonnages, main method of production in 1997, and comparison with production in 1996

Production method	Production grouping (tonnes) in 1997					Total tonnage & (%) by method		No.* of farms	
	<10	10-25	26-50	51-100	>100	1996	1997	1996	1997
FW cages	0	3	1	2	5	1,766 (38)	1,729 (39)	10	11
FW ponds and raceways	2	4	3	3	7	1,560 (34)	1,683 (34)	19	20
FW tanks and hatcheries	7	7	2	3	2	657 (14)	657 (14)	21	19
SW cages	0	1	1	1	3	647 (14)	584 (13)	6	7
Total	9	15	7	9	17	4,630	4,653	56	57

* Excludes farms which specialised in the production of ova, fry and/or fingerlings for ongrowing

Fresh water production accounted for 4,069 tonnes (87%) and sea water production the remaining 584 tonnes (13%). The main rearing methods were cages, tanks, ponds and raceways. There was a small decrease in production in fresh water cages whilst production in fresh water ponds, raceways and sea water cages increased slightly.

A number of types of rearing facilities, ranging from hatchery units to tanks, ponds, raceways and cages, may be present on a site. The numbers of farms having the following rearing facilities in 1997 were —

Hatchery units	25 farms
Ponds and Raceways	36
Tanks	39
Fresh water cages	13
Sea water cages/raceways	7

Not all of the these facilities were in use.

Company and Farm Data

TABLE 3
Number of companies and farms in production during 1990-1997

Year	No. of companies	No. of farms
1990	59	71
1991	56	69
1992	53	72
1993	52	74
1994	56	72
1995	54	69
1996	52	69
1997	51	69

The number of companies registered with the Marine Laboratory Aberdeen as actively engaged in rainbow trout production was 51, one less than in 1996. The number of farms registered as holding rainbow trout was 103; of these 80 were classed as Active and 23 as Inactive. Of the Active farms 69 were in production (producing fry/fingerlings or trout), the remaining 11 farms were fallow.

Staffing and Productivity

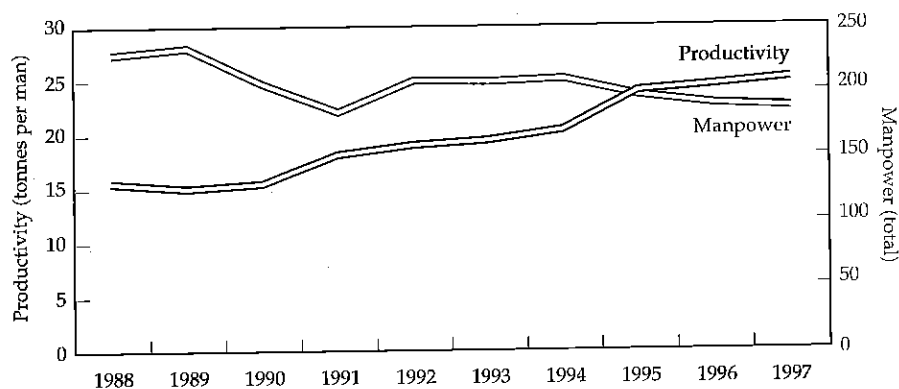
TABLE 4
Number of staff employed and productivity per man during 1990-1997

Year	Full-time	Part-time	Total	Productivity (tonnes/man)
1990	138	68	206	15.45
1991	133	51	184	18.12
1992	135	73	208	19.00
1993	134	73	207	19.43
1994	139	70	209	20.40
1995	132	64	196	23.89
1996	129	60	189	24.50
1997	130	52	182	25.56

The overall number of staff employed in 1997 decreased from 189 in 1996 to 182, continuing the downward trend which has been evident since 1994. The number of part-time staff decreased by eight whilst the number of staff in full-time employment increased by one.

Productivity, measured as tonnes produced per man, increased by 1.06 (4%) to 25.56 in 1997. No distinction was made between full and part-time staff in calculating productivity.

Figure 1. Manpower and productivity in rainbow trout production during 1988-1997



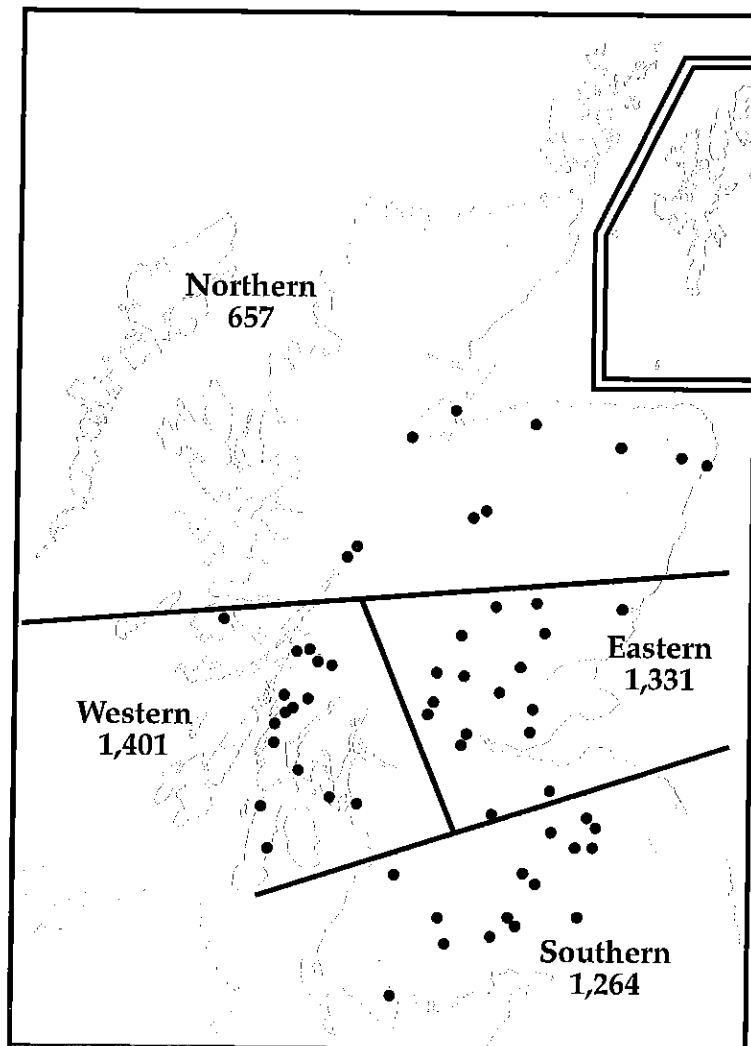
Production by Area

TABLE 5
Production and staffing by area in 1997 (production farms only)

Area	No. farms	Production (tonnes)			Mean tonnes/site	Staffing			Productivity tonnes/man
		Table	Restocking			F/T	P/T	Total	
North	9	548	109	73.0	27	12	39	16.8	
East	17	1015	316	78.3	30	14	44	30.3	
West	16	1273	128	87.6	28	9	37	37.9	
South	15	1012	252	84.3	32	10	42	30.1	
All	57	3848	805	81.6	117	45	162	28.7	

Historically rainbow trout production was concentrated in the south of Scotland, and relatively few rainbow trout farms have been established in the north. The majority of producing farms are now located in the east, west and southern areas. Mean productivity per farm ranged from 73.0 to 87.6 tonnes, and per man from 16.8 to 37.9 tonnes/man between production areas, productivity being greatest in the western and least in the northern areas.

Figure 2. The distribution of active rainbow trout farms and production tonnage by area in 1997



Type of Ova Laid Down

TABLE 6
Number (000s) and proportions (%) of ova types laid down to hatch during 1992-1997

Year	Total ova	All female diploid Nos (%)	Triploid Nos (%)	Mixed sex diploid Nos (%)
1992	21,408	18,099 (85)	796 (4)	2,513 (12)
1993	19,744	17,261 (87)	1,396 (7)	1,087 (6)
1994	19,604	18,105 (92)	1,134 (6)	365 (2)
1995	20,835	19,546 (94)	1,170 (6)	119 (+)
1996	22,678	21,308 (94)	935 (4)	435 (2)
1997	23,503	21,117 (90)	1,386 (6)	1,000 (4)

All female diploid stock accounted for 90% of the ova laid down to hatch in 1997. A small number of triploid fish were produced and targeted mainly at the restocking trade where a proportion of larger fish are required.

Source of Ova Laid Down

TABLE 7
Number (000s) and sources of ova laid down to hatch during 1993-1997

Year	GB ova			Imported ova			Total
	Own stock	Other GB stock	Total GB	Northern hemisphere	Southern hemisphere	Total foreign	
1993	1,830	405	2,235	12,815	4,694	17,509	19,744
1994	479	625	1,104	13,055	5,445	18,500	19,604
1995	165	360	525	12,485	7,825	20,310	20,835
1996	420	988	1,408	13,247	8,023	21,270	22,678
1997	1,232	837	2,069	11,594	9,840	21,434	23,053

In 1997 the total number of eyed ova laid down to hatch (23.1million) was 0.4 million (2%) greater than in 1996, and continued the upward trend evident since 1994. The proportion of ova produced from GB broodstock increased to 7% of the total, but industry was again heavily dependent on imports from sources outwith the GB approved health zone.

Imports of Ova

TABLE 8a
Number (000s) and sources of ova imported into Scotland during 1994-1997

Source	1994	1995	1996	1997
Northern Ireland	6,255	6,285	4,095	2,425
Isle of Man	2,950	3,550	4,182	4,205
Denmark	3,850	2,650	5,075	5,354
South Africa	5,445	7,825	8,023	9,450
Others (EU)	-	-	220	-
Totals	18,500	20,310	21,595	21,434

TABLE 8b
Seasonal variation in number (000s) and sources of ova imported during 1997

Month	Northern Ireland	Isle of Man	Denmark	South Africa
January	370 (3)	500 (2)	550 (3)	-
February	310 (2)	535 (2)	50 (1)	-
March	575 (4)	230 (2)	500 (1)	-
April	420 (3)	-	3,454 (6)	-
May	50 (1)	-	500 (1)	-
June	-	-	-	1,780 (5)
July	50 (1)	-	-	5,800 (11)
August	150 (2)	-	-	1,790 (5)
September	450 (3)	-	-	80 (2)
October	-	100 (3)	-	-
November	50 (1)	980 (3)	-	-
December	-	1,860 (2)	300 (1)	-
Totals	2,425(20)	4,205 (14)	5,354 (13)	9,450 (23)

The rainbow trout ova imports included a quantity of milt, as well as 100,000 fingerlings from Northern Ireland.

Denmark, the Isle of Man and Northern Ireland accounted for 56% of ova imported into Scotland in 1997 (62% in 1996), the remaining 44% coming from the southern hemisphere, namely South Africa. By using ova from both the northern and southern hemispheres, farmers were able to regulate production throughout the year and produce a constant supply of fish to meet market requirements. The quantity of 'out of season' ova imported from South Africa has increased annually since 1994 when imports were first established. In contrast, imports from Denmark, the Isle of Man and Northern Ireland decreased from 13 to 12 million (10%) in 1997, mainly due to a reduction in supply from Northern Ireland.

Since 1993 movements of live fish, ova and gametes within and into the EU have been controlled by Council Directive 91/67/EEC. Northern Ireland, Isle of Man, the Republic of Ireland and parts of Denmark have achieved approved health zone status similar to GB in respect of IHN and VHS viruses. A limited number of farms on mainland Europe have also been granted approved health status. Additional health protection was granted to GB in 1996 under Decision 96/490/CE whereby imports of live salmonids is prohibited from areas in which the parasite *Gyrodactylus salaris* is present.

Companies wishing to import ova or live fish from approved EU Member States, or approved farms MUST GIVE PRIOR NOTICE of any shipment into Scotland to the MARINE LABORATORY ABERDEEN. No imports of a commercial nature are permitted from EU Member States or farms not having approved health status. Imports from Third Countries such as South Africa are only permitted under licence, and following rigorous testing by the official authorities in the originating country.

Trade in Fry and Fingerlings

TABLE 9
Trade in numbers (000s) of fry and fingerlings* bought and sold during 1992-1997

Year	Fry and fingerlings bought (000s)			Total number bought	Total number sold
	All female diploids Nos. (%)	Triploid Nos. (%)	Mixed sex diploids Nos. (%)		
1992	8,993 (84)	617 (6)	1,101 (9)	10,711	10,447
1993	8,395 (73)	917 (8)	2,239 (19)	11,551	9,823
1994	9,854 (90)	1,017 (9)	47 (+)	10,918	10,379
1995	12,449 (95)	683 (5)	0 (0)	13,132	10,912
1996	12,174 (93)	572 (4)	283 (2)	13,029	11,578
1997	15,028 (93)	889 (5)	98 (1)	16,215	10,330

*Includes trade in small fish up to about 80g.

The established trade in fry and fingerlings between hatchery and growers' farms continued in 1997. There was an increase of 25% in the numbers bought, and a decrease of 11% in the numbers sold. Of fry and fingerlings bought 93% were female diploid stock. As in 1996 the demand for fry and fingerlings could not be met from within Scotland and additional supplies were obtained from sources in England, Wales and Northern Ireland.

Use of Vaccines

TABLE 10
Number of farms rearing fish vaccinated against enteric redmouth disease (ERM) during 1988-1997

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
No. of farms	21	21	27	30	33	28	35	31	33	35

Vaccines continued to be widely used as a preventative treatment against ERM – a potentially serious disease – caused by the bacterium *Yersinia ruckeri*. A total of 16.6 million fish were vaccinated — of these two million were vaccinated onsite, the remaining 14.6 million were bought pre-vaccinated. Vaccination was generally by bath treatment at the early fingerling stage, but a number of injection treatments were also used.

CONCLUSIONS RAINBOW TROUT

Production in rainbow trout in 1997 was similar to that in 1995 and 1996. Portion size fish for the table trade continued to dominate production, but an increasingly significant proportion was used by the restocking trade. Production was predominantly in fresh water, in cages, tanks and ponds. Overall there was a decrease in the number of staff employed, but productivity per man has continued to increase year on year.

Increases were recorded in both the number of ova imported and the number of ova laid down to hatch. Approximately one third of the ova imported came from within the United Kingdom – but outwith the GB approved health zone i.e. the Isle of Man, Ireland – and one third from other EU countries. The remaining third came from 'out of season' ova from southern hemisphere.

Industry continued to show a distinct preference for all female diploid stock at the expense of mixed diploid and triploid stocks. There was a thriving trade in fry and fingerlings, shortages of supply within GB again being met from other sources in the British Isles.

Rainbow trout producers' awareness of the hazards of infectious diseases was demonstrated in the continued use of vaccines where appropriate.

II. ATLANTIC SALMON (*Salmo salar*)

This report on Atlantic salmon (*Salmo salar*) is divided into two sections — ova and smolt production in fresh water, and salmon production in sea water.

I. Ova and Smolts

Annual survey questionnaires were sent to 65 companies covering 171 farms. Returns were received from all 65 companies

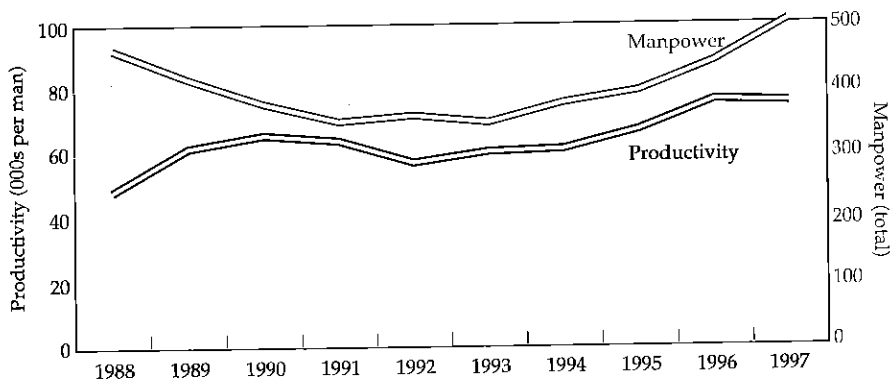
Production and Staffing

TABLE 11
Number (000s) of smolts produced, staff employed and smolt productivity during 1988-1997

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Number (000s) of smolts produced	22,499	25,825	24,875	22,404	20,827	21,043	23,117	26,540	33,619	38,187
Staffing:										
full-time	344	330	285	271	266	233	245	279	308	344
part-time	119	87	93	79	93	115	133	117	133	166
Total staff	463	417	378	350	359	348	378	396	441	510
Mean number (000s) of smolts produced per man	48.6	61.9	65.8	64.0	57.2	60.5	61.2	67.0	76.2	74.9

Smolt production in 1997 increased by 4.6 million (14%) to 38.2 million, compared with 33.6 million produced in 1996. The number of staff employed increased by 69 from 441 to 510 and included an additional 36 full-time and 33 part-time employees. Included in the part-time staff total were staff engaged solely to vaccinate smolts against furunculosis prior to their transfer to sea. Overall productivity, measured as the mean number of smolts produced per man, dropped from 76,200 to 74,900, a decrease of 2%. It can be anticipated that the 1997 smolt year class will give a further increase in the number of salmon harvested in 1998 and 1999.

Figure 3. Manpower and productivity in smolt production during 1988-1997



Smolts by Age Group

TABLE 12
Number of smolts (000s) produced by category during 1992-1997

Year	S ^{1/2}	S1	S1 ^{1/2}	S2	Total
1992	-	20,586	-	707	20,828
1993	686	19,698	202	457	21,043
1994	1,672	20,712	511	222	23,117
1995	2,663	22,705	365	806	26,540
1996	6,298	26,334	523	464	33,619
1997	9,333	27,679	692	483	38,187

Production continued to be directed predominantly at S1 smolts, and this age group accounted for 72% of all smolts produced (78% in 1996). The trend towards increased production of S^{1/2} (photoperiod manipulated) smolts, evident since 1993, continued in 1997 when this age group accounted for 24% of smolts produced (19% in 1996).

The timing of smolt transfer to sea is not exact, and fish may be put to sea as early as October with cohorts possibly transferring any month thereafter. The advantage of using photoperiod adapted smolts (S^{1/2}) in conjunction with normal smolts (S1) is that harvest schedules are made more flexible by allowing better continuous match of fish size to market demand at harvest. Early 'out of season' smolts may also be produced by selectively grading off the top sizes from normal growing populations and transferring them to sea water.

Company and Farm Data

TABLE 13
Number of production companies and farms during 1992-1997

Year	No. of companies	No. of farms
1992	74	137
1993	73	138
1994	68	147
1995	69	162
1996	67	166
1997	65	171

In 1997 the number of companies registered with the Marine Laboratory Aberdeen as being actively engaged in smolt production decreased by two to 65 continuing the decline apparent since 1992.

A total of 224 smolt farms were registered with the Marine Laboratory Aberdeen in 1997. Of these, 49 farms were Inactive and 175 Active. Four Active farms were fallow and 171 were in production. A number of different rearing facilities may be present on a farm, depending on the company's rearing strategy. The numbers of farms and types of facilities available in 1997 were —

Hatchery	83
Tanks	113
Ponds and raceways	2
Cages	108

Not all of these facilities were in use.

Production Systems

TABLE 14a
Number and capacity of smolt production systems during 1994-1997

System	No. of farms with systems				Total capacity (000s) cubic metres			
	1994	1995	1996	1997	1994	1995	1996	1997
Hatcheries, tanks, ponds and raceways	85	95	93	101	54	49	48	45
Cages	62	67	73	70	276	266	308	326
Total	147	162	166	171	330	329	356	371

Two principal methods are used to produce smolts — cages sited in fresh water lochs, and tanks and raceways sited onshore. In 1997 the number of cage farms in production decreased by three whilst the number of tank farms in production increased by eight. From 1996-1997, production capacity in cages (cubic metres water) increased from 308 to 326, and in tanks decreased from 48 to 45.

TABLE 14b
Number (000s) of smolts produced and stocking densities by production system during 1994-1997

Year	Number of smolts produced (000s)				Stocking densities (smolts/m ³)			
	1994	1995	1996	1997	1994	1995	1996	1997
Cages	12,244	15,060	18,335	19,942	44	54	59	61
Tanks	10,873	11,480	15,284	18,245	200	234	318	405
Total	23,117	26,540	33,619	38,187	-	-	-	-

The numbers of smolts produced in cages and tanks increased by 1.6 and 3.0 million respectively. Increases in stocking densities (number of fish per cubic metre water) were also recorded, rising from 59 to 61 in cages, and from 318 to 406 in tanks. The number of smolts produced in cages is governed by fish biomass in relation to permitted levels of phosphate discharge. Increases in numbers produced has tended to be accompanied by a reduction in smolt size, usually given as body weight. The increases in tank production and associated higher stocking densities were a function of the efficiency of the intensive, high density recirculation methods and polytunnel units introduced in recent years. Cages however, continue to have the advantage in that they are relatively simple and less expensive to operate.

The Marine Laboratory Aberdeen advises that husbandry practices in intensive smolt units should be of the highest standard due to the difficulties in treating any disease, should an outbreak occur and reminds growers that increased stocking densities are likely to lead to increased susceptibility of stocks to disease agents unless management of both water quality and husbandry are tightly controlled.

Ova Production

TABLE 15
Number (000s) of salmon ova produced during 1991/92 -1996/97 spawning periods

Year	1991/1992	1992/1993	1993/1994	1994/1995	1995/1996	1996/97
No. of ova	118,432	93,517	98,900	89,556	122,665	186,470

As spawning extends from October to January, the data given here relate to spawning periods rather than to the calendar year. The total number of ova produced in 1996/97 was 186.5 million, an increase of 63.8 million (52%) on the 1995/96 figure.

TABLE 16
Ova sources and number of ova (000s) laid down to hatch during 1991/2-1996/1997

Year	Own stock	Other GB farm stock	GB wild	Foreign	Total	Previous year's estimate
1991/92	32,824	23,722	310	-	56,857	-
1992/93	44,524	19,281	514	4,381	68,699	54,415
1993/94	25,883	14,991	450	5,347	46,672	49,064
1994/95	37,176	25,063	475	2,160	64,873	46,538
1995/96	46,545	23,784	65	8,045	78,439	71,635
1996/97	60,421	23,308	323	1,750	85,802	76,629
1997/98	-	-	-	-	-	69,632

The total number of ova laid down to hatch was 85.8 million, an increase of 7.4 million (9%) on 1995/96 and an increase of 9.2 million on producers' forward estimate for 1996/7. The majority of ova laid down to hatch (70%) was derived from growers own broodstock. Supplies from other GB sources were constant at 23 million, whilst foreign supplies dropped to 1.8 million, the latter mainly being out of season ova from southern hemisphere sources. As in previous years, the total number of ova laid down to hatch included a small number (<1%) derived from wild (non-farmed) fish. Producers' forward estimate for ova to be laid down in 1997/98 was 69.6 million.

International Trade in Ova

Since the introduction of the EU Single Market on 1 January 1993 and the associated Fish Health Regulations common to all Member States, a trade in live salmon and ova has been established. Trade with Third Countries has also been established, but imports are permitted only under licence, and from sources of equal or higher health status to those of GB. Exports to Third Countries are at the discretion of the Third Country. The Marine Laboratory Aberdeen advises potential exporters to ascertain with the importing country well in advance of the spawning season if any specific fish health testing regimes may be a condition of export.

IMPORTS

TABLE 17a
Sources and numbers (000s) of salmon imported during 1993-1997

	EU Member States	Ova		Total	Parr and Smolt EU Member States
		Australia			
1993	4,439	470		4,909	-
1994	5,823	240		6,063	72
1995	1,470	600		2,070	2,662
1996	6,690	1,355		8,045	2,553
1997	2,305	1,200		3,505	2,168

Imports of ova dropped in 1997 from 8.0 to 3.5 million, due to increased availability of Scottish produced ova. The Republic of Ireland was the main source for imported ova. The numbers of ova imported from Australia, and of parr and smolts from EU Member States were similar to those in 1996.

EXPORTS

TABLE 17b
Destinations and numbers (000s) of salmon ova exported during 1994-1998
from fish broodstock spawned in the previous year

Export year	Chile	Farmed origin		Total	Wild origin Total
		EU	Others		
1994	9,467	7,540	40	17,047	0.5
1995	22,691	7,242	40	31,833	0.5
1996	17,542	7,937	20	25,499	0.6
1997	28,585	13,729	-	42,314	0.6
1998	34,165	7,289	20	41,474	0.5

In 1998 a total of 41.5 million (1997) ova were exported. Exports to EU Member States dropped by 6.4 million from 13.7 to 7.3 million whilst exports to Chile increased by 5.6 million from 28.6 to 34.2 million. The Republic of Ireland was the main EU recipient market. Trade in wild fish ova was targeted at restocking European river systems. No parr or smolts were exported.

In 1997 an estimated 186 million ova were produced (i.e. spawned between October and December 1996). Of these 86 million (46%) were laid down to hatch, 42 million (22%) exported, and the remaining 58 million (31%) discarded and destroyed because of inferior quality or disease status.

Ova and Smolt Production Records

TABLE 18
Records of ova laid down to hatch and actual and forecasted smolt production during 1988-1999

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Ova (million) laid down to hatch												
Number laid down ¹	80.4	75.3	64.6	50.7	56.9	68.7	46.7	64.9	78.4	85.8	-	-
Estimated number	67.5	85.1	90.8	50.4	60.4	54.4	49.1	46.5	71.6	76.6	69.6	-
Smolt production (million)												
Smolts put to sea ¹	20.9	23.8	21.4	20.3	20.5	20.5	22.0	26.8	30.8 ³	42.8	-	-
Smolts produced ²	22.5	25.8	24.9	22.4	20.8	21.0	23.1	26.5	33.6	38.2	-	-
Estimated smolts produced ²	23.1	28.7	26.2	24.1	21.5	21.8	22.1	25.2	31.8	41.6	45.3	49.6
Ratio of ova laid down to smolts produced⁴	3.6	2.9	2.6	2.3	2.7	3.3	2.0	2.4	2.3	2.2	-	-

¹ Salmon growers' data; ² Smolt producers' data; ³ excludes 2.1 million smolts imported from Ireland; ⁴ based on number of smolts produced

Since 1992 the number of ova laid down and the number of smolts produced have increased from 56.9 to 85.8 million, and 20.8 to 38.2 million respectively. Increases of 3.7 million and 4.3 million in smolt production are estimated for 1998 and 1999.

Each year there are discrepancies in the number of smolts produced (smolt producers data) and the numbers of smolts put to sea (salmon growers data). In 1997 smolt production was recorded as 38.2 million and smolts put to sea as 42.8 million, the latter including 2.1 million imported smolts. Figures for smolt production and smolts put to sea were accurate to within 7%.

The ratio of ova laid down to hatch to smolts produced in 1997 was 2.2:1, an improvement on the 1995 and 1996 figures. An estimated 5-10% mortality occurs annually during the hatching and first feeding stages, but the greatest mortality is due to culling which follows inadequate growth in the first summer.

Scale of Production

TABLE 19
Smolt producing farms and smolt production (number 000s) of smolts produced during 1988-1997

Year	1-10	10-25	26-50	51-100	101-250	251-500	501-1,000	>1,000	No. of farms in production	Total smolts produced
1989	7	18	20	16	37	20	10	3	131	25,825
1990	3	15	19	20	29	19	9	4	118	24,874
1991	2	11	17	22	26	26	5	2	111	22,404
1992	3	8	14	17	41	23	4	0	110	20,828
1993	1	9	15	17	32	21	9	0	104	21,043
1994	4	5	13	24	37	17	13	0	113	23,117
1995	1	6	15	29	30	26	14	1	122	26,540
1996	1	7	13	29	33	26	17	3	129	33,619
1997	0	3	13	22	39	24	18	6	125	38,187

Note: These data refer only to farms producing smolts, farms holding only ova, fry and/or parr are excluded.

Since 1988 there has been a significant increase in the numbers of smolts produced per farm. The number of farms producing <50,000 smolts annually has decreased from 47 to 16, whilst the number of farms producing >250,000 smolts has increased from 26 to 48. The number of farms producing in excess of one million smolts doubled from three to six in 1997. It is likely that the trend towards increased on-farm production will continue as more intensive smolts units are introduced.

Production of Ova and Smolt by Production Area

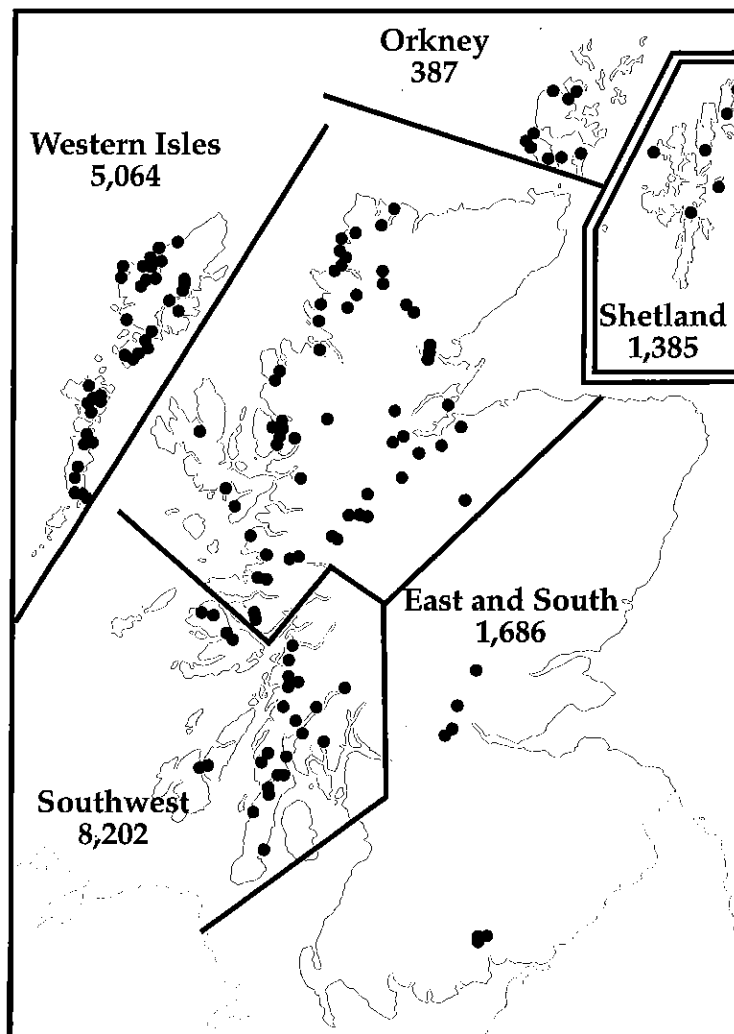
TABLE 20

Staffing, ova laid down to hatch and smolt production by region in 1996 and 1997 and projected in 1998 and 1999

REGION	Number of staff employed in 1997		Ova laid down to hatch (000s)		Smolt production (000s)		Estimated smolt production (000s)	
	F/T	P/T	1996	1997	1996	1997	1998	1999
Northwest	141	81	46,339	38,201	16,735	21,464	25,173	26,845
Orkney	7	9	1,370	852	286	387	710	815
Shetland	22	18	3,800	6,054	1,364	1,385	3,370	4,422
Southwest	91	35	15,172	24,869	8,439	8,202	8,199	6,996
Western Isles	70	14	8,703	11,707	5,135	5,064	7,053	8,143
East and South	13	9	3,055	4,120	1,660	1,686	760	2,390
All Scotland	344	166	78,439	85,803	33,619	38,187	45,266	49,611

The Northwest followed by Southwest and Western Isles were the main ova and smolt producing areas and employed the greatest numbers of staff. Increases in the numbers of ova laid down in 1997 were reported in four areas. A large increase in smolt production was reported in the Northwest whilst in other areas it was similar to 1996 levels. All areas anticipate increased smolt production in 1998 and in 1999.

Figure 4. The distribution of active smolt farms and the numbers (000s) of smolts produced by area in 1997



Vaccines

TABLE 21
Number of farms using vaccines and number of fish vaccinated during 1987-1997

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
No. of farms	8	29	65	59	61	71	73	85	102	112	118
No. of fish vaccinated (million)	-	-	-	-	-	-	-	19.4	25.3	31.8	37.9

Vaccines – designed to give protection against furunculosis, a septicaemic infection caused by the bacterium *Aeromonas salmonicida* – were used on 118 smolt producing farms, vaccinating 37.9 million (99%) of the 38.2 million smolts produced. Both monovalent vaccines – designed specifically to combat furunculosis – and polyvalent vaccines – designed to give added protection against Hitra and cold water *Vibrio* infections – were used. In addition, 19 farms vaccinated an estimated 9.3 million parr against enteric redmouth disease (ERM), caused by the bacterium *Yersinia ruckeri*. Vaccination against ERM is by bath immersion whereas vaccination against furunculosis is by injection.

Production Fish (Atlantic Salmon)

Production

Annual survey questionnaires were sent to 101 companies covering 340 active farms. One hundred percent returns were received from companies covering all farms

TABLE 22a
Annual production of Atlantic salmon given as the combined tonnage in each calendar year 1985-1997 and estimated tonnage in 1998

Year	Tonnes	Year	Tonnes
1985	10,337	1992	36,101
1986	10,337	1993	48,691
1987	12,721	1994	64,066
1988	17,951	1995	70,060
1989	28,553	1996	83,121
1990	32,351	1997	99,197
1991	40,593	1998	115,483*

*farmers' estimate based on perceived harvest on current stock

Total production of salmon in Scotland has increased annually since 1992 to reach a record level of 99,197 tonnes in 1997, an increase of 16,076 tonnes (19%) on the 1996 figure of 83,121 tonnes.

TABLE 22b
Number (000s) and weight (tonnes) of salmon harvested and mean fish weight (kg) per smolt year class in 1993-1997

	Year of smolt input	Year of harvest	Number (000s)	Production Tonnes	Mean weight (kg) at harvest
Harvest in year 0 (i.e. in year of input)	1993	1993	47	78	1.7
	1994	1994	261	388	1.5
	1995	1995	207	369	1.8
	1996	1996	315	638	2.0
	1997	1997	282	585	2.1
Harvest in year 1	1992	1993	11,102	32,738	3.0
	1993	1994	13,446	41,865	3.1
	1994	1995	14,420	47,775	3.3
	1995	1996	17,132	57,998	3.4
	1996	1997	20,245	71,349	3.5
Harvest in year 2	1991	1993	4,675	15,975	3.4
	1992	1994	5,096	21,812	4.3
	1993	1995	5,137	21,916	4.3
	1994	1996	5,408	24,485	4.5
	1995	1997	6,195	27,263	4.4

Increases were reported in the number and weight harvested in 1- and 2- year old fish, whilst mean fish weights remained similar to those in 1996. One year old fish comprised 71% by weight of production and demonstrated the rapid growth rates now achievable with improved foodstuffs and modern husbandry practices. The harvest of young fish in the year of input (year 0) decreased slightly and indicated that demand for small fish was limited. As in previous years larger fish tended to go for smoking.

TABLE 22c
Weight (tonnes) and number (000s) of grilse and pre-salmon harvested in 1993-1997

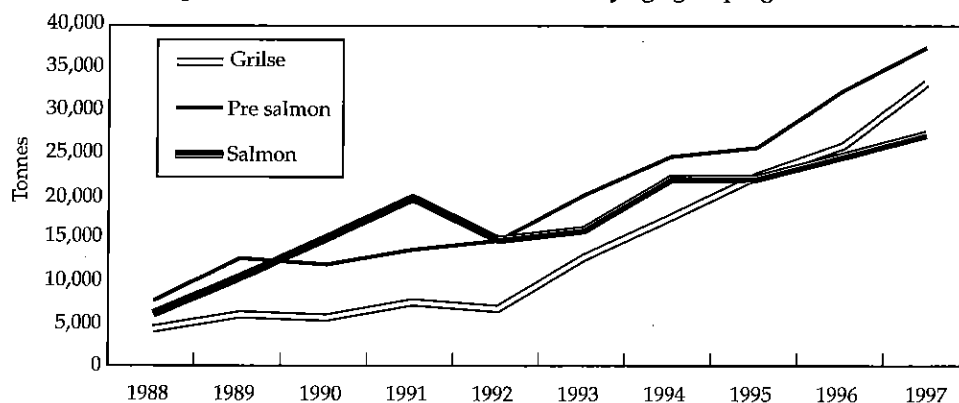
Year	Grilse (Jan - Aug)			Pre-salmon (Sep - Dec)		
	Number (000s)	Tonnes	Mean weight (kg)	Number (000s)	Tonnes	Mean weight (kg)
1993	4,969	12,739	2.6	6,133	19,999	3.3
1994	6,435	17,386	2.7	7,011	24,479	3.5
1995	7,610	22,235	2.9	6,809	25,540	3.8
1996	8,669	25,776	3.0	8,462	32,222	3.8
1997	10,489	34,227	3.3	9,756	37,122	3.8

TABLE 22d
Proportion of annual production (% weight) by growth stage in 1993-1997

Year	1993	1994	1995	1996	1997
Input year fish	<1	<1	<1	<1	<1
Grilse	26	27	32	31	35
Pre-salmon	41	38	37	39	37
Salmon	33	34	31	29	27

Production of 1-year old fish was recorded separately for the periods January-August, to cover the traditional grilse period (grilse), and September-December for non-maturing fish (pre-salmon). All 2-year old fish were classed as salmon. A large proportion of the grilse harvested were from photoperiod smolts (S0 or S_{1/2}) put to sea in late 1995, whereas the pre-salmon harvest tended to be dominated by smolts put to sea as S1s in early 1996. A modest increase in mean fish weight (0.3kg) was recorded in the grilse, whilst pre-salmon mean weight remained constant at 3.8kg. Salmon mean weight decreased by 0.1kg. The similarity in mean fish weight reflected market demand for fish in the 3-4kg size range, and also farmers' ability to produce fish in this size range throughout the year.

Figure 5. Production (tonnes) of salmon by age grouping in 1988-1997



Survival and Production in Smolt Year Classes

TABLE 23
Survival and production (harvest) in smolt year classes put to sea in 1985-1997

Year of smolt input	Smolt input (000s)	HARVEST YEAR 0				HARVEST YEAR 1				HARVEST YEAR 2				Total % of year class harvested	Year class weight (tonnes)
		Number (000s)	Weight (tonnes)	Mean weight (kg)	% Harv-ested	Number (000s)	Weight (tonnes)	Mean weight (kg)	% Harv-ested	Number (000s)	Weight (tonnes)	Mean weight (kg)	% Harv-ested		
1985	5,586	-	-	-	-	2,409	5,988	2.5	43.1	1,522	5,521	3.7	27.3	70.4	11,508
1986	6,595	-	-	-	-	3,285	7,200	2.1	49.8	1,750	6,086	3.5	26.5	76.3	13,286
1987	12,858	-	-	-	-	5,167	11,866	2.3	40.2	3,267	10,312	3.2	25.3	65.5	22,178
1988	20,921	-	-	-	-	7,890	18,240	2.3	37.7	5,382	14,891	2.8	25.7	63.4	33,131
1989	23,839	-	-	-	-	7,683	17,459	2.3	32.2	6,123	19,567	3.2	25.7	57.9	37,026
1990	21,408	-	-	-	-	8,877	21,026	2.4	41.5	4,315	14,728	3.4	20.1	61.6	35,754
1991	20,227	-	-	-	-	8,864	21,373	2.4	43.8	4,675	15,875	3.4	23.1	66.9	37,248
1992	20,527	-	-	-	-	11,102	32,738	3.0	54.1	5,096	21,812	4.3	24.8	78.9	54,550
1993	20,541	46	78	1.7	0.2	13,446	41,865	3.1	65.5	5,135	21,916	4.2	25.0	90.7	63,859
1994	21,953	260	388	1.5	1.2	14,420	47,775	3.3	65.7	5,408	24,485	4.5	24.6	91.5	72,629
1995	26,786	206	269	1.8	0.8	17,132	57,998	3.4	64.0	6,195	27,263	4.4	23.1	87.8	85,530
1996	32,906	315	638	2.0	1.9	20,245	71,349	3.5	61.5	-	-	-	-	-	-
1997	42,766	282	585	2.1	0.7	-	-	-	-	-	-	-	-	-	-

In the last year for which smolt survival can be calculated, 1995, survival was 87.8%. This was a decrease of 3.7% compared with 1994 year class and was due to a variety of reasons including disease, environmental factors—jellyfish, algal blooms—escapes, predation by seals and poor husbandry.

Of the 1996 year class an estimated 63.4% was harvested as 0 or 1- year old fish, similar to that of the 1995 year class. Additional production from this year class in 1998 can be calculated assuming that a similar proportion (23.1%) of the year class of similar mean fish weight (4.4kg) is harvested as 2-year old fish as was harvested from the 1995 year class in 1997. On this basis, the 1996 year class is expected to provide a harvest of 33,446 tonnes in 1998. If a similar proportion (61.5%) of the 1997 year class of fish mean weight 3.5kg are harvested, a projected figure of 92,054 tonnes can be expected in 1998. Also, assuming that 600 tonnes of the 1998 year class will be harvested as 0-year old fish in 1998, total production in 1998 is estimated to be 126,100 tonnes. Farmers' forward estimate of production in 1998 is 115,483 tonnes.

Smolts to Sea

TABLE 24
Number (000s) and origin of smolts put to sea in 1992-1997

Year	Smolts to sea (000s)				Total (000s)	England origin (000s)		Other origin (000s)	
	S ^{1/2}	S1	S1 ^{1/2}	S2		(000s)	%	(000s)	%
1992	-	19,418	-	1,109	20,527	992	5	-	-
1993	-	19,843	-	698	20,541	827	4	-	-
1994	1,865	19,701	113	274	21,953	1,451	7	-	-
1995	2,442	23,081	589	674	26,786	852	3	-	-
1996	5,527	26,157	180	974	32,906	1,166	4	2,138	6
1997	8,936	33,274	182	374	42,766	2,957	7	2,028	5

The total number of smolts put to sea in 1997 was 42.8 million, an increase of 9.8 million (30%) on 1996. As in previous years, production comprised predominantly S1s (33 million, 78%). The number of smolts put to sea as S^{1/2}s in 1997 increased by 3.4 million to 8.9 million and comprised 21% of the total smolts put to sea. The increased use of S^{1/2}s allowed stocking and subsequent growth to match more closely year round market demand for fish of specific size. The small input of older smolts (S1^{1/2} and S2) reflected the small numbers of these age groups produced. Approximately 7% of smolts put to sea in 1997 came from English sources but were predominantly of Scottish origin.

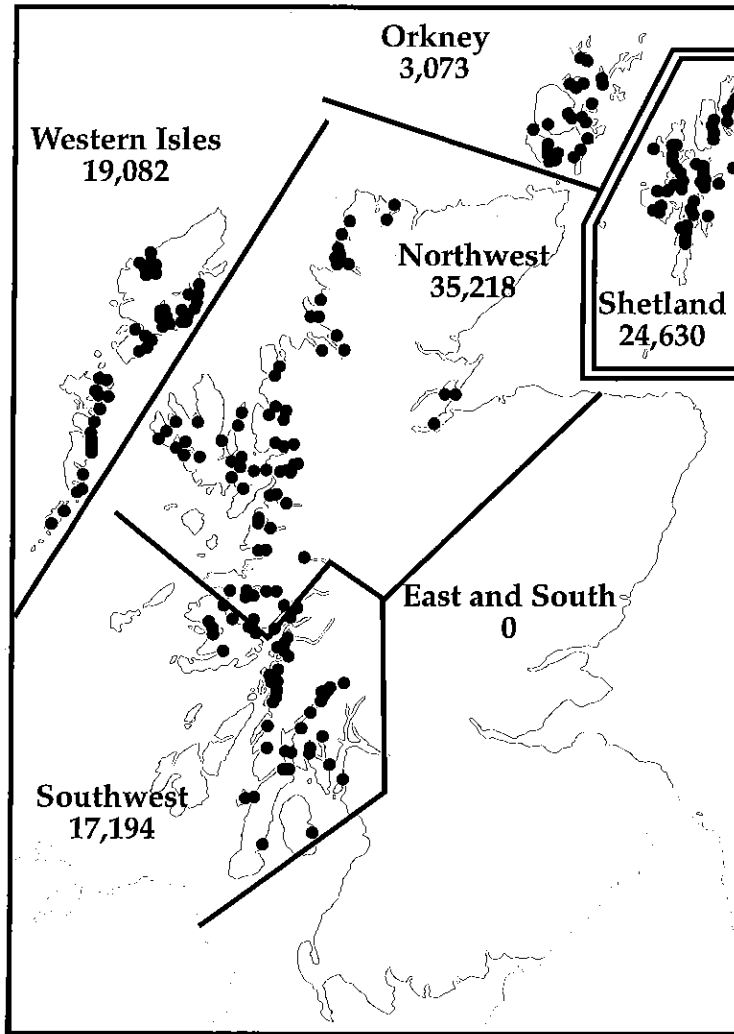
Survival and Production in Smolt Year Classes by Production Area

TABLE 25
Number (000s) of smolts put to sea, year class survival and total production (tonnes) by Production Area in 1991-1997

Region	Smolts to sea (000s)		Harvest in Year 0			Harvest in Year 1			Harvest in Year 2			Total harvest (= survival)	
	Year	No.	Year	No.	%	Year	No.	%	Year	No.	%	No.	%
Northwest	1991	11,107	1991	-	-	1992	3,755	33.8	1993	1,730	15.6	5,485	49.4
	1992	7,650	1992	-	-	1993	5,160	67.5	1994	1,647	21.5	6,807	89.0
	1993	7,684	1993	47	0.6	1994	5,405	70.3	1995	1,927	25.1	7,379	96.2
	1994	7,914	1994	108	1.4	1995	4,721	59.7	1996	1,438	18.2	6,267	79.2
	1995	9,428	1995	60	0.6	1996	7,500	79.6	1997	1,153	12.2	8,713	92.4
	1996	12,438	1996	99	0.8	1997	8,335	67.0	-	-	-	-	-
	1997	11,228	1997	112	1.0	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Orkney	1991	746	1991	-	-	1992	236	31.6	1993	208	27.9	444	59.5
	1992	681	1992	-	-	1993	236	34.7	1994	217	31.9	453	66.6
	1993	726	1993	-	-	1994	478	65.8	1995	176	24.2	654	90.0
	1994	754	1994	-	-	1995	399	52.9	1996	222	29.4	621	82.3
	1995	1,127	1995	-	-	1996	508	45.1	1997	430	38.1	938	83.2
	1996	1,175	1996	-	-	1997	428	36.4	-	-	-	-	-
	1997	1,506	1997	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Shetland	1991	4,643	1991	-	-	1992	2,012	43.3	1993	1,135	24.4	3,147	67.8
	1992	5,014	1992	-	-	1993	2,342	46.7	1994	1,248	24.9	3,590	71.6
	1993	4,591	1993	-	-	1994	3,354	73.1	1995	993	21.6	4,347	94.7
	1994	5,012	1994	24	0.5	1995	3,055	61.0	1996	1,846	36.8	4,925	98.3
	1995	5,811	1995	41	0.7	1996	3,021	52.0	1997	2,622	44.4	5,643	95.5
	1996	6,234	1996	-	-	1997	3,825	61.4	-	-	-	-	-
	1997	13,276	1997	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Southwest	1991	4,597	1991	-	-	1992	1,355	29.5	1993	981	21.3	2,336	50.8
	1992	3,989	1992	-	-	1993	1,667	41.8	1994	1,182	29.6	2,849	71.4
	1993	5,131	1993	-	-	1994	2,300	44.8	1995	1,215	23.6	3,515	68.5
	1994	4,614	1994	-	-	1995	2,994	64.9	1996	1,460	31.6	4,454	96.5
	1995	6,437	1995	25	0.4	1996	3,268	50.8	1997	1,349	21.0	4,642	72.1
	1996	9,924	1996	64	0.6	1997	3,317	33.4	-	-	-	-	-
	1997	11,540	1997	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Western Isles	1991	2,946	1991	-	-	1992	1,506	51.1	1993	620	21.0	2,126	72.2
	1992	3,195	1992	-	-	1993	1,742	54.5	1994	802	25.1	2,544	79.6
	1993	2,805	1993	-	-	1994	1,909	68.1	1995	825	29.4	2,734	97.5
	1994	4,002	1994	125	3.1	1995	3,252	81.3	1996	442	11.0	3,819	95.4
	1995	3,983	1995	80	2.0	1996	2,836	71.2	1997	641	16.1	3,557	89.3
	1996	5,137	1996	152	3.0	1997	4,340	84.5	-	-	-	-	-
	1997	5,274	1997	170	3.2	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-

The distribution of active salmon grower farms and production tonnage by area is given in Figure 6. The areas are classed as SOAEFD production areas to avoid confusion between the many different areas in current usage by various official bodies. The SOAEFD areas correspond with the areas listed in previous reports under the former Scottish local government Regions.

Figure 6. Distribution of active salmon farms and production tonnage by area in 1997



Staffing

TABLE 26
Number of staff employed in salmon production in 1988-1997

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Staff: full-time	991	1,102	1,165	1,014	985	976	1,003	1,104	1,150	1,088
part-time	329	316	326	272	275	248	242	251	241	207
Total staff	1,320	1,418	1,491	1,286	1,260	1,224	1,245	1,355	1,391	1,295
Mean productivity (tonnes/man)	13.6	20.1	21.7	31.6	28.7	39.8	51.4	51.7	59.8	76.6

The total number of staff employed in salmon production in 1997 was 1,295, an overall decrease of 96 on the 1996 figure. Full-time staff decreased by 62 and part-time staff by 34. The figures above refer specifically to staff associated with the production of salmon and does not include staff associated with processing or marketing. Productivity, measured as tonnes produced per man, has increased sixfold in the last 10 years to reach a peak of 77 tonnes per man in 1997.

Production Methods

TABLE 27
Production methods, capacity, tonnage and ratio of production (kgs) to capacity (m³) in 1995-1997

Method	Number of farms			Total capacity (000s cubic metres)			Production (tonnes)		
	1995	1996	1997	1995	1996	1997	1995	1996	1997
Sea water tanks	5	5	5	23	23	23	598	490	515
Sea water cages	263	272	271	7,313	8,433	10,587	69,462	82,631	98,682
For cage farms: Ratio of production (kgs) to cage capacity (m ³)							9.5	9.8	9.3

A total of 98,682 tonnes (99%) was produced in sea water cages whilst 515 tonnes (1%) was produced in tanks. The low production from tank farms reflected the relatively high installation and energy costs incurred in operating this system.

Sea cage capacity increased by 2.2 million cubic metres in 1997 despite there being 2 farms less in production. The increase in cubic capacity was principally due to the increased usage of large cubic capacity cages, particularly those of round plastic construction. Production efficiency in cages, measured as the ratio of kilograms fish weight produced per cubic metre cage capacity, decreased by 0.5kg in 1997.

Company Productivity

TABLE 28
Productivity (tonnes/man) by companies grouped by scale of production in 1996 and 1997

Total tonnage		0-100	101-200	201-400	401-700	701-1000	1001-2000	<2,000	Total
No. companies	1996	28	17	25	12	10	9	6	107
	1997	15	20	17	21	6	12	7	98
No. tonnes	1996	1,073	2,551	7,445	6,434	8,176	13,445	43,997	83,121
	1997	561	3,080	5,186	11,230	6,987	16,974	58,079	99,197
Manpower (total)	1996	104	93	168	159	124	196	547	1,391
	1997	62	99	87	171	99	195	582	1,295
Productivity (tonnes/man)	1996	10	27	44	40	66	69	80	60
	1997	9	31	60	66	71	87	100	77

Company productivity was estimated by relating company production tonnage to the manpower employed. Productivity can be used as a measure of efficiency and was found to be directly related to the scale of production, and the manpower employed by the company. Greatest productivity (100 tonnes/man) was achieved in those companies having the greatest production and least (≤ 31 tonnes/man) in the smallest producing companies. Compared with 1996, mean company productivity increased from 60 tonnes/man to 77 tonnes/man in 1997. Increases in productivity were noted in all companies producing more than 200 tonnes.

Manpower and Production by Production Area

TABLE 29
Manpower and production by production area in 1992-1997 and estimated production in 1998

Region	Year	Staff		Annual production*	Production (t/man)	Year of Input		Grilse		Pre-salmon		Salmon	
		F/T	P/T			Tonnes	Mean wt (kg)	Tonnes	Mean wt (kg)	Tonnes	Mean wt (kg)	Tonnes	Mean wt (kg)
Northwest	1992	372	63	13,980	32	-	-	3,352	2.2	5,791	2.6	4,837	3.3
	1993	372	52	20,279	48	78	1.7	7,177	2.5	7,225	3.2	5,800	3.4
	1994	407	59	25,003	54	170	1.6	7,392	2.7	9,991	3.7	7,450	4.5
	1995	401	54	22,509	49	99	1.6	7,291	2.7	7,433	3.6	7,686	4.0
	1996	405	45	32,282	72	200	2.0	14,824	3.1	10,789	3.9	6,469	4.5
	1997	392	40	35,218	82	221	2.0	14,879	3.2	14,669	3.9	5,449	4.7
	1998			36,063*									
Orkney	1992	35	21	1,046	19	-	-	163	2.4	412	2.4	471	2.8
	1993	38	16	1,245	23	-	-	212	2.3	428	3.0	605	2.9
	1994	48	19	2,107	31	-	-	371	2.5	957	3.0	780	3.6
	1995	58	11	1,903	28	-	-	392	2.7	849	3.4	662	3.8
	1996	55	13	2,444	36	-	-	511	2.5	1,023	3.3	910	4.1
	1997	36	20	3,073	67	-	-	277	2.6	1,119	3.5	1,677	3.9
	1998			4,011*									
Shetland	1992	213	96	10,679	34	-	-	851	2.6	4,636	2.8	5,192	3.9
	1993	191	116	11,659	38	-	-	1,246	2.6	6,013	3.2	4,400	3.9
	1994	193	106	14,278	48	23	1.0	3,371	2.6	5,967	2.9	4,918	3.9
	1995	201	109	15,523	50	59	1.4	4,204	3.2	6,908	3.9	4,352	4.4
	1996	209	114	19,710	61	-	-	2,042	2.8	8,814	3.9	8,854	4.8
	1997	224	83	24,630	84	-	-	3,207	2.9	10,002	3.7	11,421	4.4
	1998			35,647*									
Southwest	1992	206	46	6,458	26	-	-	1,154	2.0	2,108	2.7	3,196	3.2
	1993	199	32	8,675	38	-	-	2,107	2.8	3,366	3.7	3,202	3.3
	1994	173	35	13,184	63	5	1.0	3,277	2.8	4,249	3.8	5,653	4.8
	1995	247	51	15,777	53	47	1.9	4,641	3.0	5,505	3.8	5,584	4.6
	1996	273	44	17,223	54	68	1.1	3,889	2.8	6,895	3.7	6,371	4.4
	1997	197	19	17,194	80	-	-	6,186	3.2	4,705	3.4	6,303	4.7
	1998			26,300*									
Western Isles	1992	159	49	3,938	19	-	-	1,203	1.8	1,703	2.1	1,032	2.7
	1993	176	32	6,834	33	-	-	1,998	2.5	2,968	3.1	1,868	3.0
	1994	182	23	9,493	46	191	1.5	2,976	2.7	3,316	4.2	3,011	3.8
	1995	197	26	14,348	64	164	2.0	5,707	2.9	4,845	3.8	3,632	4.4
	1996	208	25	11,462	49	370	2.4	4,510	2.8	4,701	3.8	1,881	4.3
	1997	239	45	19,082	67	364	2.1	9,678	3.5	6,627	4.2	2,413	3.8
	1998			13,462*									
All Scotland	1992	985	275	36,101	29	-	-	6,723	2.1	14,650	2.6	14,728	3.4
	1993	976	248	48,691	40	78	1.7	12,740	2.7	20,077	3.2	15,875	3.4
	1994	1,003	242	64,066	51	389	1.5	17,386	2.7	24,479	3.5	21,812	4.3
	1995	1,104	251	70,060	52	368	1.8	22,235	2.3	25,540	3.8	21,916	4.3
	1996	1,150	241	83,121	60	638	2.0	25,776	3.0	32,222	3.8	24,485	4.5
	1997	1,088	207	99,197	77	585	2.0	34,227	3.3	37,122	3.8	27,263	4.4
	1998			115,483*									

* Estimated production in 1998

Production within areas has tended to be limited to the availability of suitable marine grower farms. Many of the grower farms are located in the more remote areas of the Scottish mainland and on the islands where the salmon industry continued to be a major source of local employment.

The Northwest area is the most extensive geographically, and again recorded the greatest number of staff employed, and the greatest production tonnage. Conversely, Orkney is the smallest area and recorded the lowest number of staff and produced the lowest tonnage. Productivity, measured as tonnes produced per man, increased in all areas in 1997, and ranged between areas from 36-72 tonnes per man in 1996 to 67-84 tonnes per man in 1997.

Company and Farm Data

Table 30
Number of companies and farms engaged in salmon production in 1992-1997

Year	Number of companies			Number of farms		
	Producing	Non-producing	Total	Producing	Non-producing	Total
1992	140	6	146	279	68	347
1993	132	12	144	283	86	369
1994	119	12	131	262	101	363
1995	108	12	120	268	91	359
1996	106	1	107	278	56	334
1997	98	3	101	275	65	340

The number of companies registered with SOAEFD was 101. Of these 98 were recorded as in production, whilst three companies recorded no production. Included in the production company total was a number of satellite companies of larger parent companies as well as companies which had entered into contract growing arrangements. Overall production was dominated by a small number of large companies, the four largest of which accounted for more than 50% of the total production.

A total of 440 salmon grower farms were registered with SOAEFD. Of these 340 farms were recorded as Active and 100 as Inactive. Inactive farms may be restocked at any time depending on the grower company's production schedule.

Fallowing

TABLE 31
Number of sea cage farms employing a fallow period in 1993-1997

Year	0	Fallowing period (weeks)					Total
		<4	4-8	8-26	26-51	≥52	
1993	135	7	47	74	13	86	362
1994	118	13	48	64	12	103	358
1995	110	14	60	73	6	91	354
1996	112	12	71	70	13	56	334
1997	122	6	54	77	11	65	335

Of the 340 farms recorded as being part of a production cycle in 1997, 148 farms were fallow for a variable period whilst 64 farms were fallow throughout 1997. The normal production cycle in sea water is over a two year period and the introduction of a fallow period between cycles serves as a natural method of cleaning and resting farms particularly from a disease perspective. It is noticeable that 128 farms were stocked throughout the year, although the survey did not determine how many of these farms held one or more year classes of salmon.

The Marine Laboratory Aberdeen strongly advises farmers—

- to incorporate a fallow period between growing cycles to break any cyclical disease that might be present
- that the fallowing period should be as long as possible
- that farms using shared waters (for example where there are two or more farms in a sea loch or voe) should be stocked in the same year and have a common fallow period where two or more such farms are used by different companies a formal agreement to achieve this type of stocking should be set in place.

Scale of Production by Farm

TABLE 32
Grouping of salmon production farms in relation to tonnage produced in 1992-1997

Production grouping (tonnes)	Number of farms per production grouping							Total	
	0	1-50	51-100	101-200	201-500	501-1000	>1000	Farms	Tonnes
No of farms 1992	139	59	48	40	43	15	1	347	36,101
1993	144	53	44	50	61	10	7	369	48,691
1994	154	29	31	49	64	27	9	363	64,066
1995	162	24	23	37	68	32	13	359	70,060
1996	125	20	28	49	66	25	21	334	83,121
1997	120*	21	22	41	63	43	28	340	99,197
% share of production 1992	0	4	10	20	37	27	3		
1993	0	3	7	14	38	19	18	-	-
1994	0	1	4	12	33	31	19	-	-
1995	0	1	2	8	31	32	26	-	-
1996	0	1	3	9	27	22	39	-	-
1997	0	1	2	6	20	28	43	-	-

* Includes farms stocked in 1997 but having no production.

The trend for companies to concentrate and increase production at individual farms was again evident in 1997. Since 1992 the number of farms producing less than 200 tonnes annually has decreased from 149 to 84 whilst the number of farms producing more than 200 tonnes has increased from 59 to 134. In 1997 production on 28 farms exceeded 1000 tonnes. The concentration of production onto fewer, larger farms has obvious economic benefits for producer companies, but is not without risk. It is particularly important that health standards are maintained as the spread of an infectious disease could result in a major financial loss.

The total biomass of fish permitted on a farm is governed by the discharge consent permitted by the Scottish Environment Protection Agency (SEPA). In recent years there has been an increasing use of 'nursery' farms into which smolts are input and held for 6-9 months on-growing before their subdivision and transfer to other farms. This strategy allows farms to stay within their discharge consent, whilst allowing stocking levels to be as close to the permitted biomass level for a large proportion of the production cycle.

The Marine Laboratory Aberdeen strongly advises farmers that the currently highly effective controls on disease are more likely to fail as stocking densities and movements of fish from sea water site to sea water farm increases.

Broodstock Farms

TABLE 33
Number of farms holding broodstock in 1988-1997

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Broodstock farms	31	44	35	27	15	21	24	18	28	37

The number of farms holding broodstock, including fresh water and sea water stripping farms, in 1997 was 37, an increase of 11 on 1996. An estimated 20,000 female fish were stripped to yield 186 million ova (123 million in 1996), giving an average ova yield per fish of approximately 10,000. This was broadly similar to the long term expectation. The fecundity data are somewhat uncertain due to various ratios of male to female fish being stripped at various farms. In general, ova production tends to increase in relation to fish size and age.

CONCLUSIONS ATLANTIC SALMON

Large increases in production were recorded in all sectors of the salmon growing industry in 1997. The harvest of production fish was at an all time high. Productivity (tonnes/man) was also greater and reflected an increase in use of automation and technology as well as other efficiencies in husbandry. In terms of employment salmon rearing continued to be of significant importance to communities on the west coast and islands of Scotland.

The long term trend to increase the numbers of smolt produced continued in 1997 and forecasts are for further increases over the next two years. Although the majority of smolts produced continued to be S1s the number of S¹/₂s produced increased significantly. By using early and late maturing broodstocks, temperature control of ova development and photo adapted smolts, restocking over nine months of the year is now possible. The increase in smolt production was due largely to smolt producers having invested in new rearing technology, particularly that aimed at producing photoperiod adapted smolts and to improved husbandry methods. Concurrent with the increase in smolt production was an increase in the number of staff employed.

Smolt producers tended to favour northern hemisphere derived smolts rather than smolts of 'out of season' southern hemisphere origin. Imports of smolts from Ireland, first recorded in 1996, are likely to continue as salmon grower companies expand their fields of operation across national boundaries. The export market for ova also continued to expand and was a target market for a number of companies. Chile was again the main recipient market with smaller quantities going to other EU Member States.

A small quantity of ova derived from wild fish was again supplied to river systems on mainland Europe for restocking purposes.

Increases in stocking densities were recorded in both cage and tank rearing systems, but indications were that production, (in terms of biomass held), in cage systems was close to the maximum permitted in relation to the amount phosphate wastes allowed to be discharged into the environment. The increase in numbers of smolts produced in cages tended to be compensated for in a reduction in mean body weight. Mean productivity (smolts produced/man) was slightly less than in 1996. Experience has shown that the use of high density tank rearing systems using recirculated water is not without its dangers and operators must ensure that high health standards are maintained at all times. Smolt producers awareness of the efficacy of vaccines in counteracting furunculosis was demonstrated with the establishment of several mobile independent vaccinating teams.

The trend across the salmon grower sector of the industry in recent years has been one of increasing production and forecasts, based on the numbers of ova and smolt produced in 1997. This trend is set to continue. However, the current outbreak of infectious salmon anemia (ISA) – which has occurred in Scottish sea water farms for the first time – may have an effect on 1998/99 production, although it is not possible to estimate or measure the effect at this stage.

R Stagg
J A Gauld
September 1998

ACKNOWLEDGEMENT

Members of the aquaculture industry and associated bodies both in Scotland and abroad will note that the name of Dr A L S Munro is missing from the this year's report. Dr Munro OBE retired in November 1997 and the present authors would like express their appreciation for the efforts he put into not only in advancing our knowledge in understanding and controlling fish diseases but also the guidance he has given the industry from its developmental years to the present. In his capacity as head of the Fish Cultivation team at the Marine Laboratory Dr Munro was one of the originators of this series of reports on aquaculture production in Scotland. I am sure all those associated with the industry would like to wish Dr Munro a long and happy retirement.

Dr A D Hawkins
Director, Marine Laboratory Aberdeen

Appendix 2

Glossary and abbreviations

Ova	Eggs
Alevin	Young salmon, at stage from hatching to end of dependence on yolk sacs as primary source of nutrition.
Fry	Young salmon at stage from independence of yolk sac as primary source of nutrition to dispersal from the redd.
Parr	Young salmon at stage from dispersal from redd to migration as a smolt.
Smolt	Fully silvered juvenile salmon ready to be transferred or to migrate to sea.
Fingerling	A term commonly applied to young stages of salmonid fish.
Eyed-ova/eggs	Fish egg(s) at the stage of development when the heavily pigmented eyes of the embryo are sufficiently developed to be clearly visible.
Cohort	A group of fish spawned at a given period.
Pre-salmon	Non-mature salmon usually after one winter at sea.
Milt	Sperm.
Grilse	Salmon maturing after one winter at sea.
Grilsing period	Period during first year at sea when gonads are maturing (salmon).
Non-maturing	Gonads not maturing.
Fecundity	Fertility of an organism.
S^{1/2}	Salmon or sea trout smolting at approximately six months from hatch (usually by photoperiod and/or temperature manipulation)
S1	Salmon or sea trout smolting at approximately one year from hatch.
S1^{1/2}	Salmon or sea trout smolting at approximately 18 months from hatch.
S2	Salmon or sea trout smolting at approximately two years from hatch.
Diploid	Fish with the normal two sets of chromosomes.
Triploid	Genetically modified fish which have three sets of chromosomes instead of two.
Active	Fish farms in a production growing cycle which may contain stock or br fallow.
Inactive	Fish farms not in a production cycle and without stock.
Fallow	Fish farm having no stock, but still part of a growing cycle.
Ongrowing	Farm producing fish for the table market.
GB approved	EU recognised zone clear of List II diseases. health zone
Redd	Spawning depression in the stream bed created by salmon or trout.
Raceway	Concrete or brick channels used for farming fish.

Approved Zone Status	EU recognition of an area clear of listed disease(s).
Photoperiod	Alteration of light regime.
Biomass	Weight of organisms in an area.
Monovalent	Vaccine to produce a protective immune response against a single pathogen.
Polyvalent	Vaccine to produce a protective immune response against several pathogens.
0-year fish	Fish in their first year of life.
Third Country	Country outside the EU.
IHN	Infectious haemopoietic necrosis.
VHS	Viral haemorrhagic septicaemia.
ERM	Enteric redmouth.
RTFS	Rainbow trout fry syndrome.
Recreational Fisheries	Angling fishery.
First feeder	Refers to the youngest feeding fish on a farm.
Year Class	Fish hatched or put to sea in a given year.