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**HIGH SEAS AND HOMEWATER EXPLOITATION OF AN IRISH REARED SALMON  
STOCK**  
by

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**Abstract**

In 1991, over 292,000 reared finclipped and microtagged salmon smolts were estimated to have migrated from the River Shannon, County Limerick, as part of an on-going programme to rehabilitate the river following hydroelectric development. This represents the largest single release of tagged smolts into a river system in Ireland in one year. Significant tag recoveries were generated from the high seas fisheries at West Greenland and Faroes, and also from homewater net and rod fisheries. An assessment of adult upstream escapement was made using a video linked resistivity counter in the fish pass of the hydroelectric dam at Ardnacrusha. Exploitation and survival was estimated using the Run Reconstruction Model developed for North East Atlantic salmon stocks.

**INTRODUCTION**

A major hydro-electric power scheme was initiated on the River Shannon, (Figure 1) in 1927 when the river was partially blocked. The last natural run was in 1935 when flooding commenced behind the completed dam. A hatchery and rearing station were built in 1959 and ova and fry only were stocked until 1961 when the production and release of smolts began.

Returning fish move upstream though the fish ladder at Parteen and the Borland lift at Ardnacrusha. There is a physical count at Parteen where the broodstock is taken and an electronic counter at Ardnacrusha. Thus all of the upstream migrants can be counted.

(3)

A national microtag programme was initiated in 1980 to provide information on the exploitation rates by commercial and recreational fisheries based on recaptures of tagged reared and wild salmon.

With the co-operation of the Electricity Supply Board (ESB), salmon tagging has been carried out using Shannon hatchery stock since 1980. The average number tagged annually has been in the region of 40,000 but in 1991 the entire output of smolts was tagged.

This report is a summary of the data from 1991-released salmon smolts, and includes recapture rates of 1SW salmon returning in 1992 and 2SW salmon returning in 1993. It provides estimates of exploitation in the various fisheries and by various catching methods. It also provides a tentative estimate of the contribution of Irish salmon to the West Greenland fishery.

## METHODS

Batches of smolts were tagged using binary coded nose tags from September to December of 1990 and released at various locations in the Shannon system. In all, 36 separate groups were released using strategies which varied by time, place and method of release. The estimated number of hatchery smolts migrating in 1991 was 292,046.

Catches from homewater fisheries (drift nets, draft nets, angling etc.) were scanned at 15 major salmon landing ports in Ireland during the summers of 1992 and 1993. Data on declared salmon landings in each of the corresponding areas were collected by the seven regional fisheries boards and compiled into a national dataset by the Department of the Marine. Salmon landings were also provided by the Foyle Fisheries Commission and tag recovery information is provided by the Department of Agriculture for Northern Ireland. The number of adult recaptures taken in these fisheries is estimated by multiplying the number of tags recovered in each fishery area (Figure 1) by the ratio of the reported commercial catch in these areas to the sample size examined. There is also a non-catch fishing mortality (NCFM) associated with these fisheries which includes all sources of losses from nets and non-reporting of catches. An estimate of NCFM is derived annually from local knowledge and experience. This is used to expand the tag recovery numbers to estimates of numbers of tagged fish taken in each fishery.

This analysis assumes that the tags are randomly distributed throughout the fishery and that non-recognition or non-detection of tags is minimal. Exploitation is estimated by dividing the number of fish caught in a fishery by the number available to the fishery.

In the Autumn of 1992 scientists from Denmark, UK, Canada, USA. and Ireland scanned the salmon catch at West Greenland for tags. Temporal and spatial raising factors were generated for Greenland tag recoveries based on estimates given by Russell et al (1993). Details are provided in Anon (1993). Since 1991 there has been no commercial fishery at Faroe. There was

however an experimental fishery in 1992. All the fish caught were scanned for tags

An upstream/downstream resistivity counter has been operating in the fish pass at Ardnacrusha for 20 years. The operation of the fish lift is described by Hennessy (1960).

A video camera was attached to the counter in 1990 to allow all fish passing through the fish pass to be detected and to allow for verification of previous counts of salmon from other years. This camera was linked to a high speed SVHS video recorder. This video enabled all fish to be examined in daylight hours. A correction factor was added for night time counts. This enabled a total upstream count to be taken and also allowed discrimination between clipped (hatchery) salmon and unclipped (wild) salmon.

Fish are intercepted annually at Parteen from September and retained as broodstock. This allowed an estimate to be made of the numbers of hatchery and wild fish passing into the upper Shannon in this way. A correction was made to allow for a small number of salmon which migrated upstream before September in 1992. In 1993 all the fish were trapped and counted at Parteen.

An estimate of the rod catches in the system was made from angling tag returns and local information. The total stock returning to the river is estimated by summing the counts of reared salmon moving upstream, together with those taken by the recreational fishery.

## RESULTS

Over 7,000 tags were recovered in the micro tag recovery programme from the 1991 smolt release. This represents an overall tag recovery of 2.4%. This value compares favourably with those from other rivers in Ireland where tagged salmon were released.

Figure 2 gives the overall distribution of both 1SW and 2SW tagged salmon broken down by sea capture area and river returns. The category 'general' covers tag recoveries in areas other than those named or tags where the exact origin is not known.

The tag recoveries were raised to the national catch and include an estimate of non-catch fishing mortality (NCFM). Distributions of tag returns indicate that the highest numbers of 1SW fish were taken in the Galway/Limerick sea areas and in the Shannon estuary. The catch of Shannon salmon taken in Donegal, Kerry, Cork and the South coast was relatively small.

There were very few Shannon salmon taken in the Faroes longline fishery. However, over 100 were caught in the Greenland drift net fishery in autumn 1992 as 1SW salmon. These fish would potentially have been 2SW salmon on their return from Greenland to Irish waters. Considering the low numbers of 2SW salmon which return to homewaters (Figure 2), the Greenland catch

is significant. There are 2SW salmon in drift net catches from Donegal to Kerry but the numbers taken are relatively small.

A total of 2,431 salmon used the fish pass at Ardnacrusha in 1992 in their upstream migration. This comprised of 792 fin clipped salmon (32.6% hatchery) and 1,639 unclipped salmon (67.4% wild). The proportion of clipped to unclipped salmon using the lift throughout the season is shown in Figure 3. The main run of fish past Ardnacrusha occurs in June with over 40% of the upstream counts occurring in this month. Both runs (clipped and unclipped) are characterised by a second peak of fish movement in October and November with fish running until December. Overall the run of hatchery and wild salmon is very similar in terms of monthly movement upstream through Ardnacrusha.

The upstream counts at Ardnacrusha and Parteen relative to the smolt release in 1991 were 852 as 1SW fish in 1992 and 20 as 2SW fish in 1993.

The numbers of 1SW in 1992 and 2SW in 1993 returning to the Irish coast were determined by summing the estimates for the various sectors. This enabled the production of a run reconstruction model for the River Shannon, Table 1.

The total stock returning to the Irish coast was 15,879 1SW salmon and 541 2SW salmon.

Approximately 77% of the 1SW stock returning to the Shannon was intercepted by drift nets while the figure for 2SW salmon was 48%. Exploitation at Faroe was 0.08% on 1SW fish and 0.22% on 2SW fish. Exploitation at West Greenland was on potential 2SW salmon only and was estimated to be just over 18%.

Rod exploitation on 1SW fish was just over 14% while on 2SW fish it was 33%.

Pre-fishery abundance estimates for 1SW and 2SW salmon are made by projecting the total stock numbers backwards to a point before the fishery began. For 1SW salmon that is October following their release and for 2SW salmon the following July. Both of the estimates can be projected back to the October following release. The model projects that over 17,000 1SW pre-fishery recruits were required in October while the figure for 2SW fish was 641. This enables the model to apportion the smolt release to numbers destined to become 1SW and 2SW salmon.

The overall release of 292,046 smolts represents a survival to the coast of 5.4% (1SW) and 0.19% (2SW) if the number of smolts released is considered. If however the number of smolts destined to produce 1SW salmon and 2SW salmon are modelled then the survival to the coast of 1SW fish is 5.6% while the survival of 2SW fish is 5.1%.

The Run Reconstruction Model developed by the North Atlantic Salmon Working Group (Anon 1988a, 1991a, Anon 1992) was applied to the Shannon data and scaled to the total Irish catch. As an estimate of the Irish proportion of MSW to 1SW salmon in the national catch has not been made since 1989, an average value of 127 tonnes for the 5 year period 1981-1985 was used to model the Irish stock. No modification was made to the run input variables and it is assumed, for the purpose of this run at least, that the Shannon hatchery stock reflects the entire national stock. The relevant results are summarised in Table 2. According to the model, the number of Irish fish that could have been at West Greenland was approximately 111,000 and over 20,000 of these would have been exploited if the exploitation rate was 18%. If a proportion of the fish are not available to the fishery at West Greenland then the exploitation rate will be higher. The model also reflects a low exploitation on Irish stocks by the Faroes fishery.

However, the model appears to underestimate the total number of 1SW salmon taken in the rod fisheries, and the final population of 1SW salmon spawning in Irish rivers.

### DISCUSSION

The estimates assume that all the fisheries take place over a very short time span and that natural mortality over each fishery is negligible.

Exploitation on the Shannon stock by drift nets on 1SW salmon is high at approximately 77%. This is slightly higher than the exploitation values of 70% for Burrishoole hatchery salmon in 1992 (O' Maoileidigh et al 1994). The exploitation rates at Faroe are low for both 1SW and 2SW fish and this is in keeping with the general findings of the North Atlantic Salmon Working Group. (Anon 1993). Exploitation rates for angling for both 1SW and 2SW fish are within the range for other European rivers, (Solomon and Potter, 1992.)

The most significant exploitation figures are the estimates for West Greenland of just over 18% and the low figures of less than 1% for both 1SW and 2SW salmon at Faroe. This is the first direct estimate of exploitation at West Greenland for a European stock. It contrasts with estimates of mean exploitation on non maturing 1SW North American salmon (potential 2SW) at West Greenland based on a constraints model of between 34-51% ( Anon 1993)

The model here assumes that all of the 2SW fish that return to Ireland were available to both the West Greenland fishery and the Faroes fishery and all the 1SW fish that return were available to the Faroes fishery at their time of execution. Thus both exploitation estimates will increase if a proportion of the stock is not available to these fisheries.

It is probably reasonable to assume that the bulk of the salmon are available to the West Greenland fishery and some of these become available to the Faroes fishery as they return home.

One 2SW River Shannon tag was recovered at Faroe in 1993 and occasional 2SW recoveries from fish released into the River Shannon have occurred there. The 2SW salmon may be available to the Faroes fishery as they return from West Greenland or a portion of the stock may go to the Faroes area and be available only to the fishery there. Exploitation values for the 2SW Norwegian Drammen river stock have been as high as 45% (Anon 1993), while few Irish 2SW were caught suggesting that few of the Irish 2SW fish are available for exploitation at Faroe.

The text table below shows how the percentage exploitation changes at West Greenland depending on the proportion of the stock available to the fishery.

% available to W. Greenland Fishery	Exploitation %
100	18
80	23
60	30
40	46
20	91

As the numbers of Irish 2SW fish taken in the Faroes catch is small then it is reasonable to assume that the exploitation at Greenland is closer to the top end of the table below (approx. 18%).

Survival figures back to the coast at 5.4% for 1SW and 0.19% for 2SW, and total survival of 5.6%, are low. The combined figure for survival into the river of 1.4% is also low and compares with a figure of 2.2% back to the River Burrishoole in 1992. (O'Maoileidigh et al. 1994). Figures for the Burrishoole suggest that the overall marine survival has been low for a number of years and this is reflected in the Shannon figures. The highest survival back to the coast for the Burrishoole was almost 29% in 1986.

The smolts were partitioned into potential 1SW and 2SW smolts and the survival back to the coast was 5.4% for 1SW and 5.15 for 2SW fish. (Table 1).

The figures suggest a very high post smolts mortality for the Shannon stock of 94%.

Browne and Piggins (1986) suggested that the rate of exploitation at Greenland on salmon originating from Irish rivers was high. The estimated number of European origin salmon taken in West Greenland in 1992 was 46,900. Anon 1993. The run reconstruction model (Table 2) suggests that the

Irish contribution to the catch was over 20,000 salmon. The provisionally estimated number of 2SW fish in the national catch is 28,000 fish.

The model, based on Shannon data alone, appears to underestimate the 1SW rod catch and spawning population when applied on a national level. The purpose of the analysis was to examine the exploitation rates at West Greenland and no attempt was made to scale the model for wild stocks. The national model will be developed further with results from other Irish monitored rivers to improve the assessment of the life history, exploitation and survival of Irish salmon using the Run Reconstruction model.

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Figure 1

Recapture areas for the salmon tag recovery programme

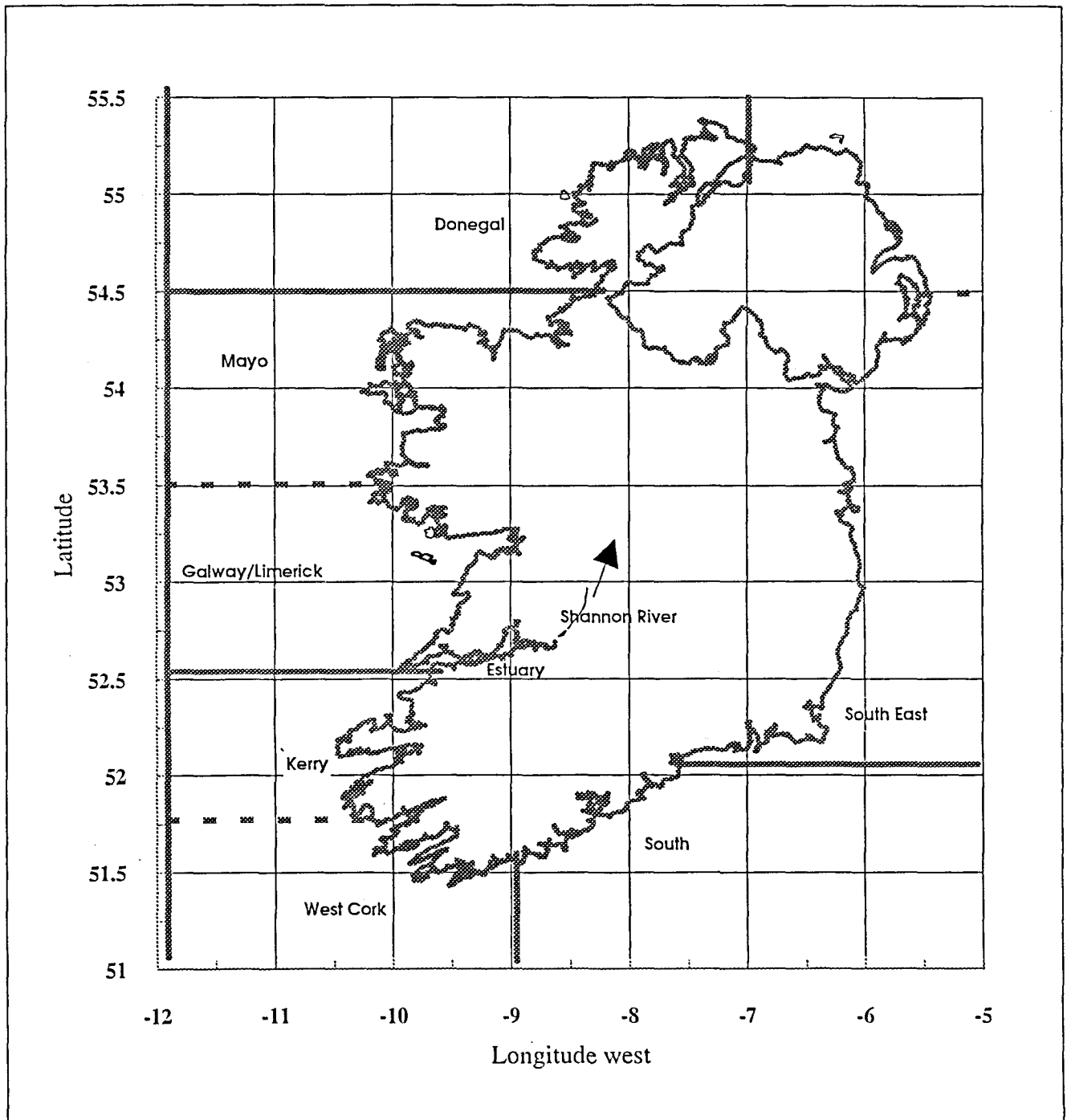


Figure 2

Estimated capture (numbers) of salmon derived from smolts released in 199  
(The tag numbers are raised and include an estimate of NCFM)

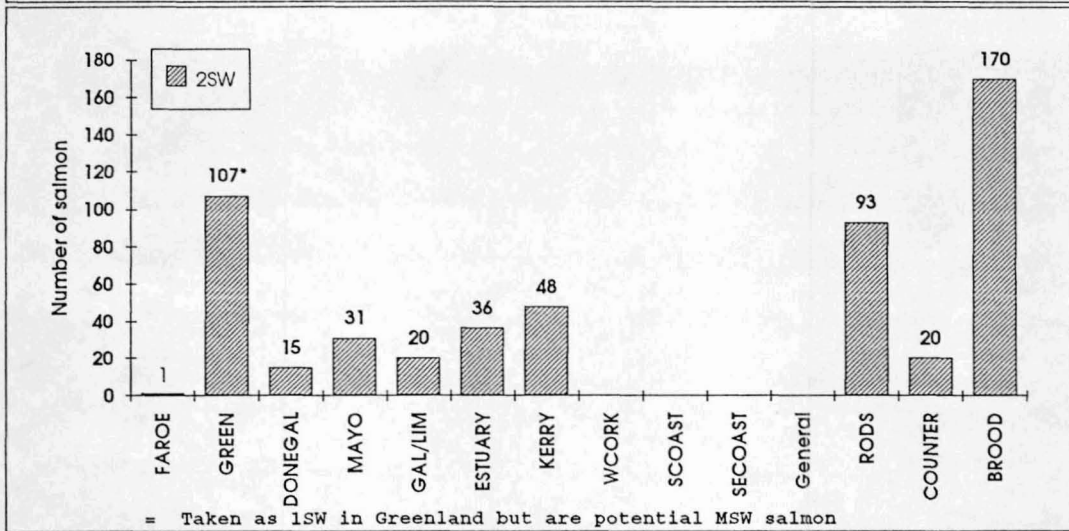
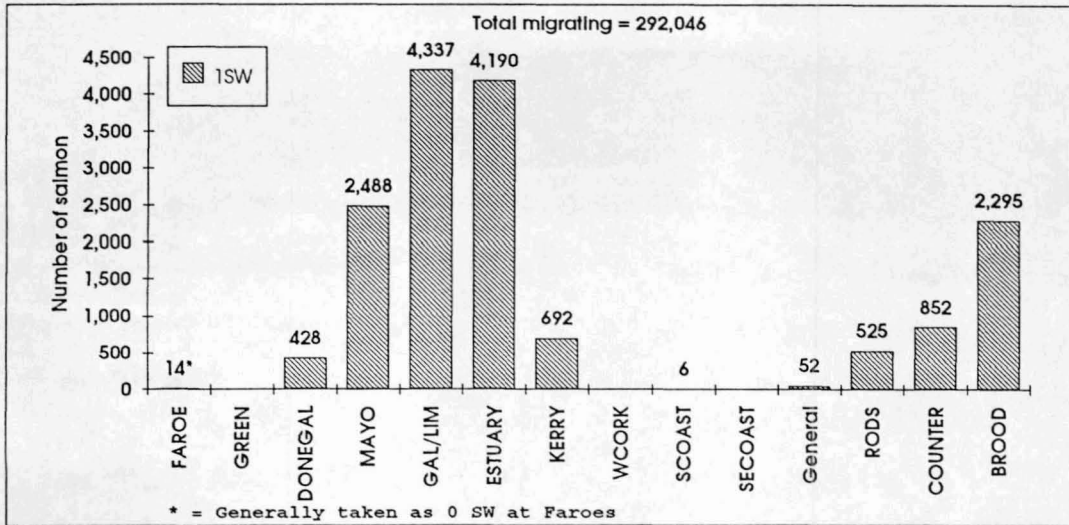


Figure 3

Monthly distribution of clipped and unclipped salmon at Ardnacrusha In 1992

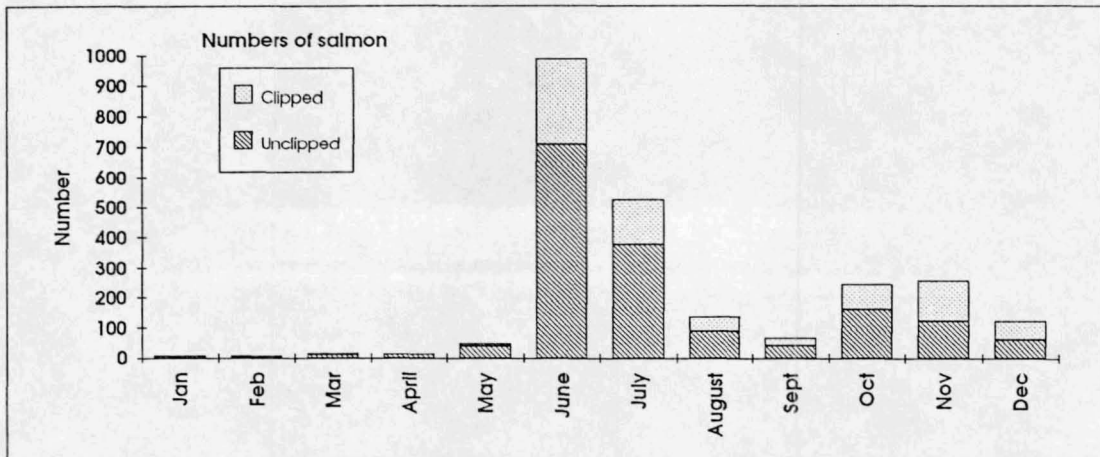


Table 1 Exploitation and survival of River Shannon salmon			
No. Migrating Year N		292,046.00	
Recapture Area	Year N+1	Year N+2	Totals
Faroe Islands	14	1	15
Donegal	428	15	443
Mayo	2,488	31	2,519
Gal/Lim	4,337	20	4,357
Kerry	692	48	740
S. Coast	6		6
Others	52		52
Shannon Estuary	4,190	36	4,226
Greenland		107	107
Rods	525	93	618
Counter	852	20	872
Broodstock	2,295	170	2,465
Numbers to Coast, Total Stock	15,879	541	16,420
No. available to Faroes Fishery	17,030	460	17,491
No. available to WG Fishery		586	586
Taken By Nets	12,207	258	12,465
Entering River	3,672	283	3,955
Exploitation by Nets	76.88	47.69	
Exploitation in Estuary	53.29	8.45	
Exploitation by Rods	14.30	32.86	
Exploitation at Faroe	0.08	0.22	
Exploitation at Greenland		18.26	
% Survival to coast	5.44	0.19	5.62
% Survival to River	1.26	0.10	1.35
Pre-fishery abundance Dec.	17,030	641	17,672
Pre-fishery abundance Aug		592	592
Smolts Required	281,449	10,597	292,046
% Survival Post smolts	5.64	5.10	
% Survival to River	1.30	2.67	
Post smolt mortality	93.95	93.95	

**Table 2 North East Atlantic Run Reconstruction Model.**  
 (using River Shannon tag recovery data scaled to national catch)

Fishery:	Tagging results	Scaling up to national figures:	
		stocks	catches
Smolts (thou's)	292,046	6783	
NEA catch 1sw	14	399,290	325
NEA catch 2sw	1	85,444	94
NEA catch 3sw	0	0	0
WG catch 1sw	107	110,839	20,111
WG catch 2sw	0	0	0
Intercept'n 1sw	0	281,272	0
Intercept'n 2sw	0	82,827	0
Intercept'n 3sw	0	0	0
H-W net 1sw	12,193	270,243	207,213
H-W net 2sw	150	82,003	28,222
H-W net 3sw	0	0	0
Rod catch 1sw	525	62,403	8,922
Rod catch 2sw	93	53,246	17,498
Rod catch 3sw	0	0	0
Spawners 1sw	3,147	53,481	
Spawners 2sw	190	35,748	
Spawners 3sw	0	0	