ENVIRONMENT AGENCY
SOUTH WEST REGION

FISHERIES TECHNICAL REPORT

RIVER DART SALMON SPAWNING TARGET AND COMPLIANCE ASSESSMENT.

December 1998
FRCN/98/05

Josée Peress

W. L. Grigg
Regional Water Manager

ENVIRONMENT AGENCY

EA - South West / 99 - 40

TABLE OF CONTENTS

RIVER DART SALMON SPAWNING TARGET SETTING AND COMPLIANCE ASSESSMENT

This paper presents the Environment Agency methodology used to set up the spawning target for the River Dart and to assess its compliance. It also provides details of which and how data are collected.

A-SPAWNING TARGET SETTING

The methodology relies on the Environment Agency transportation process from the River Bush to the River Dart, based on habitat classification by stream order and altitude range (SAP Guidelines version 1), and on river specific information such as:

-the accessible stream area for salmon;

-percentage of spawners assumed within each combination of altitude range and stream order, ie, spawners distribution within the river catchment;

-percentage of grilse of the River Dart salmon population;

-percentage of females;

-fecundity;

And on national means, such as:

-juvenile density, with proportion of fry and parr; and

-marine survival .

After assessing these data, the transportation process uses a specific spreadsheet, presented in **Table 1**, to calculate the total egg target for the River Dart.

1-Calculation of the accessible stream area for salmon.

The SAP guideline indicates the catchment area of the River Dart (upstream from Totnes, ie, 289.5 km^2), its boundary and which tributary is included, with its upstream limit and stream order, which is shown on the GIS map provided with the SAP guidelines. From this, the accessible stream area for salmon is calculated as follows.

1.1 Calculation of the accessible stream length:

Obstacles which always prevent salmon migration, irrespective of flow, are identified from field observation and professional knowledge and recorded on the GIS map provided with the SAP guideline.

The inaccessible lengths are measured for each habitat class (stream order and altitude class) on the GIS map and are removed from the total length (accessible and inaccessible) within each habitat category given **in table XII.1 in appendix XII of the SAP guideline**.

For the River Dart, the inaccessible sections are on the Bidwell brook, the Am brook, the Dean Burn, the Ashburn River, the East Webburn, and the River Mardle. The location of obstacles to salmon migration is shown on the GIS map in **Figure 1**.

The inaccessible sections measured have been grouped by habitat class. **Table 1 of Annex 1** shows the inaccessible length in each habitat class which are only stream order 1.

1.2 River wetted width within each habitat class.

To complete the assessment of accessible area, the stream widths have been measured during electrofishing. At each electrofishing site, an average width is calculated from individual width measures 5 metres apart. Then after assigning to each width measurements its habitat class, the mean width per habitat class is calculated.

If no measures have been taken for a habitat class, a default value is used which is an intermediary or successive value. **The table 2 of Annex 1** shows the mean width per habitat category, the default values appear in italic.

By combining length and width, the accessible area per habitat class is calculated. The total accessible area, or total useable area, is equal to **1 316 649 m^2 (Table 1).**

2- Juveniles density within each habitat class:

The carrying capacity for parr and fry in each habitat class is given by the extented HABSCORE database for 398 sites with access to salmon in Britain. This is shown in **annex 2 and in table 1**.

3- Assumed distribution of spawners in the catchment within each habitat class:

The total accessible stream area is not used by the salmon in a uniform way. The transportation process allows adjustment for the distribution of the spawners in the catchment within habitat class.

Field observation of the habitat features and local knowledge indicate that spawning is distributed as follows:

1-**70%** of the adults is assumed to spawn upstream of Darmeet, which represents **42%** of the area.

FRCN/98/05, Environment Agency , South West Region

RIVER DART SALMON SPAWNING TARGET AND COMPLIANCE ASSESSMENT.

J. Peress

UPDATE WITH 1998 FIGURES.

Please find attached updated table 3, figure 2, annex 3 to 5 with 1998 figures.

Plus updated paragraph:

C-SHORTFALL CALCULATION.

The shortfall estimate is based on the last ten year (1989-98) mean of the difference between the egg spawning target which is a fixed value and the egg deposition which varies annually depending on the rod catch.

For the River Dart , the shortfall is equal to 2.1 million eggs.

This is equivalent to 521 grilse and to 223 MSW in the spawning escapement.

FIGURE 2: Compliance With Salmon Spawning Target with Uall = 21%, 1962-1998, River DART

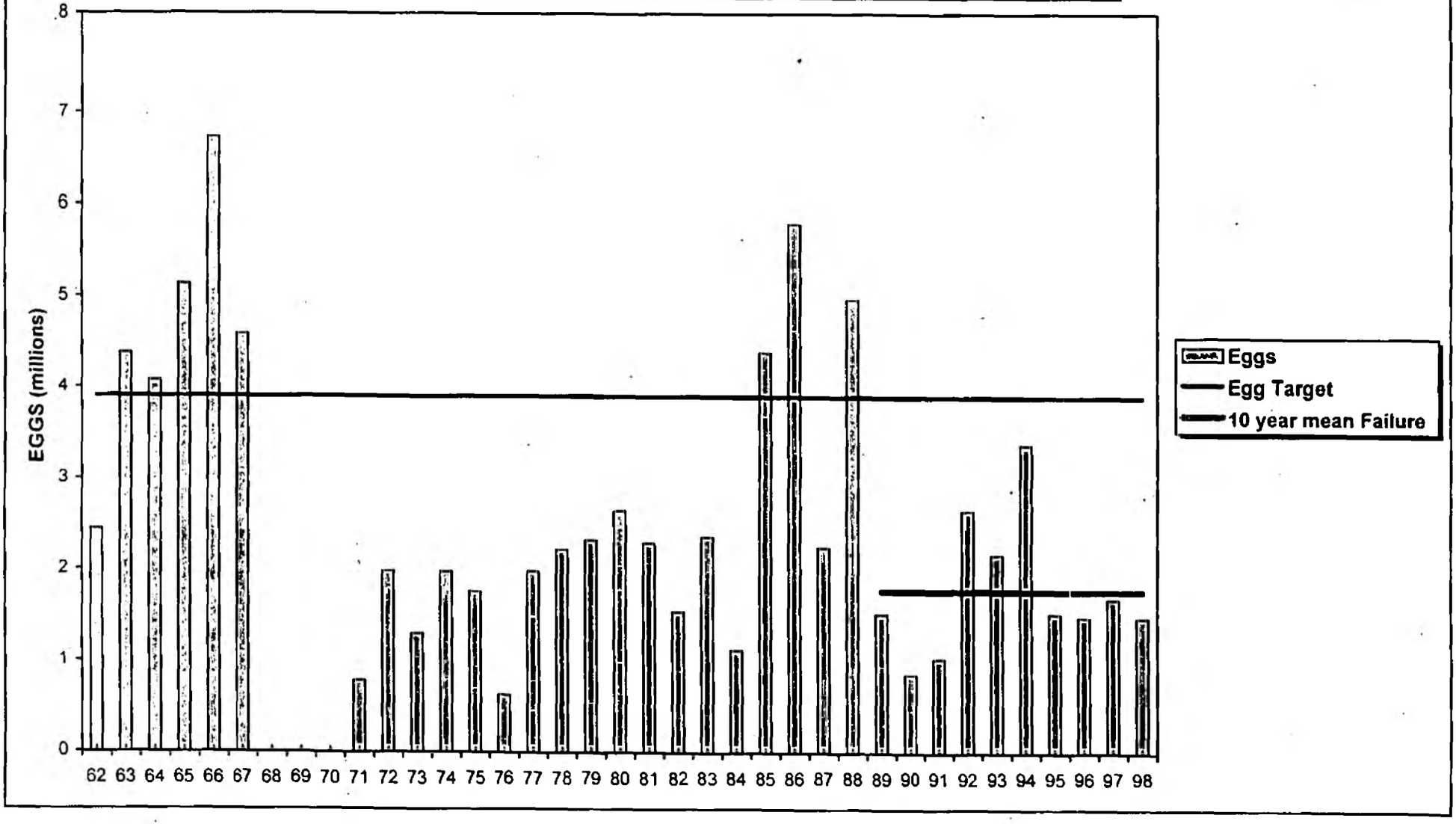


TABLE 3: Annual egg deposition, River Dart

Salmon spawning Target =3.9 million eggs

year	eggs (million)
1962	2.45
1963	4.369
1964	4.071
1965	5.129
1966	6.752
1967	4.57
1968	?
1969	?
1970	?
1971	0.783
1972	1.989
1973	1.303
1974	1.987
1975	1.77
1976	0.632
1977	1.989
1978	2.229
1979	2.338
1980	2.662
1981	2.308
1982	1.557
1983	2.378
1984	1.1337
1985	4.382
1986	5.775
1987	2.264
1988	4.955
1989	1.539
1990	0.8664
1991	1.042
1992	2.67
1993	2.196
1994	3.382
1995	1.543
1996	1.505
1997	1.705
1998	1.52
Last 10 year mean	**1.79684**

ANNEX 3

RIVER DART- PROPORTION OF GRILSE IN NET CATCHES

River	Year	Percentage
Dart	1962	23%
Dart	1963	29%
Dart	1964	14%
Dart	1965	13%
Dart	1966	4%
Dart	1967	36%
Dart	1968	unknown
Dart	1969	unknown
Dart	1970	unknown
Dart	1971	24%
Dart	1972	35%
Dart	1973	45%
Dart	1974	53%
Dart	1975	37%
Dart	1976	35%
Dart	1977	42%
Dart	1978	30%
Dart	1979	67%
Dart	1980	25%
Dart	1981	36%
Dart	1982	32%
Dart	1983	60%
Dart	1984	59%
Dart	1985	58%
Dart	1986	61%
Dart	1987	80%
Dart	1988	64%
Dart	1989	66%
Dart	1990	53%
Dart	1991	50%
Dart	1992	81%
Dart	1993	71%
Dart	1994	83%
Dart	1995	68%
Dart	1996	67%
Dart	1997	88%
Dart	1998	75%
last 10 year average		**70%**

Source:
South west catch stat. Database (Access 97)

ANNEX 4

Dart Salmon Nets

1998

	1SW	MSW	TOTAL	% Grilse	% MSW
MARCH	0	0	0		
APRIL	0	3	3		
MAY	0	16	16		
JUNE	4	24	28		
JULY	133	17	150		
AUGUST	50	3	53		
TOTAL	187	63	250	**75%**	**25%**

1997

	1SW	MSW	TOTAL		
MARCH	0	1	1		
APRIL	0	8	8		
MAY	1	19	20		
JUNE	12	3	15		
JULY	165	7	172		
AUGUST	100	1	101		
TOTAL	278	39	317	**88%**	**12%**

1996

	1SW	MSW	TOTAL		
MARCH	0	1	1		
APRIL	0	18	18		
MAY	9	52	61		
JUNE	13	54	67		
JULY	153	21	174		
AUGUST	132	6	138		
TOTAL	307	152	459	**67%**	**33%**

1995

	1SW	MSW	TOTAL		
MARCH	0	0	0		
APRIL	0	16	16		
MAY	0	88	88		
JUNE	53	58	111		
JULY	212	26	238		
AUGUST	170	13	183		
TOTAL	435	201	636	**68%**	**32%**

ANNEX 5

RIVER DART - NUMBER OF DECLARED ROD SALMON CATCHES

River	Year	Total
Dart	1962	178
Dart	1963	321
Dart	1964	291
Dart	1965	366
Dart	1966	475
Dart	1967	340
Dart	1968	185
Dart	1969	326
Dart	1970	128
Dart	1971	57
Dart	1972	148
Dart	1973	99
Dart	1974	153
Dart	1975	132
Dart	1976	47
Dart	1977	153
Dart	1978	164
Dart	1979	187
Dart	1980	198
Dart	1981	172
Dart	1982	115
Dart	1983	188
Dart	1984	91
Dart	1985	344
Dart	1986	455
Dart	1987	188
Dart	1988	394
Dart	1989	123
Dart	1990	67
Dart	1991	80
Dart	1992	154
Dart	1993	119
Dart	1994	326
Dart	1995	139
Dart	1996	137
Dart	1997	160
Dart	1998	133
Last 10 year mean		**144**

Source:

*Salmon and Migratory Trout statistics for England and Wales, 1951-90, MAFF, Fisheries Research Data Report N0 38.

*South west catch stat. Database (Access 97)

2-0% of the adults is assumed to spawn between Dartmeet and Holne Bridge, plus main section of the Webburn and in part of the catchment downstream of Staverton Bridge (includes Am Brook and Bidwell Brook), which represents **25%** of the area.
3-**30 %** of the adults is assumed to spawn on all the rest, which represents **33%** of the area.

Therefore three areas are identified with 3 different proportions of spawners.

1-0% spawners on 25 % of the total accessible area
2-30% spawners on 33 % of the total accessible area
3-70% spawners on 42 % of the total accessible area

This distribution is identified within the habitat classes and is adjusted according to the percentage of spawners in each of these three groups of stream area. The calculcation is as follows:

If there is a proportion **Q** of spawners in a proportion **P** of the accessible stream area, the proportion of adults assumed to spawn per habitat class, **s**, is:

$$s = Q\,a / P$$ where **a** , the percentage of the area of the habitat class.

To help the calculation on the spreadsheet, each habitat class shown on the spreadsheet (**table 1**) is assigned a group 1, 2 or 3 by representing it with three different borders.

Q% of the spawners are in P% of the accessible stream area

0% of the spawners are in 25% of the accessible stream area
30% of the spawners in 33% of the accessible stream area
70% of the spawners in 42% of the accessible stream area

The following table explains the process on the transportation spreadsheet:

Reach	Altitude range (m)	Stream order	Definition Targets Report	% Area, a	% Spawners Assumed, s
6	0-49	1	A1	3	0
5	50-99	1	B1	1.8	1.6
4	100-149	1	C1	0.8	0.7
3	150-199	1	D1	0.4	0.4
2	200-299	1	E1	4.3	7.1
1	300-399	1	F1	13.8	22.9
	400-499	1	G1	7.8	13.0
	500-599	1	H1	2.1	3.5

For example, in the habitat H1 which represent 2.1% of the accessible area, 70% X 2.1% ÷ 42% , ie, 3.5% of the adults are assumed to spawn.

4- Marine survival:

For grilse: **25%** is used as default value from literature.
For MSW: **15%** is used as default value from literature.

These survival rates are to the high seas fisheries.

5-Percentage of grilse:

The percentage used for the replacement line is the mean proportion of grilse over the last 10 years, $\mathbf{Pg_{10y}}$, is calculated from monthly weight frequency distribution analyse, $\mathbf{Pg_{net}}$ or **Pg**, of net caught fish, summed for separate seasons.

The sea age composition of the net catches is assumed to be more representative of the sea age composition of the river Dart population then the rod catches. It is recognised that the salmon running in the river after the net season can alter the sea age composition.

For the River Dart , $\mathbf{Pg_{10y} = 69.1\%}$.

Details of the figures, $\mathbf{Pg_{net}}$, are shown in **annex 3**. **Annex 4** gives the detail of the weight distribution analysis.

6-Percentage of female:

A relationship linking the proportion of female 1SW, **Fg**, to the catchment size allows us to calculate the sex ratio for the grilse (in **Salmon Action Plan Guidelines appendix VI**).
The catchment areas for the River Dart is 289.5 km2 (given **in Appendix VIII of the guidelines**). The sex ratio is considered to be constant throughout the years.

For the River Dart, **Fg** is **53.2%**. For MSW fish, **Fm** is a default mean value of **68.7 %**.

Then by combining the proportion of grilse and MSW, $\mathbf{Pg_{10y}}$ and $\mathbf{Pm_{10y}}$, the overall percentage of female, **F**, for the replacement line, is calculated as follows:

$$\mathbf{F = F_g \times Pg_{10y} + F_m \times Pm_{10y}}$$

Thus $\mathbf{F = 53.2 \times 69.1 + 68.7 \times 39.9 = 58\ \%}$

7- Fecundity:

Fecundity is not measured directly. A relationship between length and fecundity allows us to calculate it for each sea age category, fg for grilse and fm for MSW, **(Appendix VII of the guidelines)**.

The mean weight per sea age category, **Wg** for grilse and **Wm** for MSW, defined from scale reading of net catches from 1962 to 1972 is converted in length with the appropriate formula (in **Appendix VII of the guidelines**). **Wg** is equal to **6.05 lb** for grilse and for MSW, **Wm** is equal to **10.36 lb**.

Then the overall fecundity, f, for the replacement line, is calculated by combining the proportion of grilse and salmon as follows:

$$f = f_g \times Pg_{10y} + f_m \times Pm_{10y}$$

With f_g = **4128 eggs per female**
And f_m = **6273 eggs per female**
this gives an overall fecundity, f = **4791 eggs per female**

8- Calculation of the spawning target.

The model used for the transportation is designed on the spreadsheet with the river specific adjustment. **Table 1** gives an overall egg target for the river Dart of **3.90 million eggs**.

B-ANNUAL EGG DEPOSITION ASSESSMENT.

For the River Dart, the spawning escapement is estimated from the yearly declared rod catch returns.

1-Estimation of the number of salmon available for spawning from declared rod catches.

On the declared rod catches, a correction is applied in order to take into account catches that have not been reported.

Ct= Cd / p

Where **Ct** = total corrected rod catches
Cd = Declared rod catches
p = proportion of declared rod catches, which varies from 53% to 91% depending on the year (SAP guideline ,in **Guy Mawle added paper 6.3.97**).

From the corrected total rod catches, the size of the run for each age category is estimated using:

1-the extant rod exploitation rate for grilse, **Ug** and for MSW, **Um** (which is the proportion of fish taken by the rod fishery from the total annual run),

2- the proportion of grilse and MSW, **Pg** and **Pm**, estimated from the yearly net catches by weight frequency distribution analysis.
This proportion is the most representative of the population age composition, so Pg_{net} = Pg and Pm_{net} = Pm (as in **part A-5**).

The **exploitation rate** for all sea ages, **Uall**, is estimated from a relationship between the angling effort which is expressed as days fished per km^2 of catchment area, and the catchment size (**appendix V SAP guideline version1**).
The angling effort is calculated from the 1993 to 1995 catch per licence day and declared rod catch, **Cd** (**Salmonid and Freshwater Fisheries Statistics For England and Wales, 1995, 1994, 1993**). The mean for this period is **4007 days**.

The angling effort is obtained by dividing the declared rod catch, Cd, by the catch per licence day.

The extant rod exploitation rates, **Ug** and **Um**, are **26.3%** and respectively **18.8%**. As there is no information on any variation these rates are assumed to be constant within and between years.

The proportion of grilse and MSW in the total corrected rod catches, $\mathbf{Pg_{rod}}$ and $\mathbf{Pm_{rod}}$, is estimated as follows:

$$\mathbf{Pg_{rod} = (Ug \times Pg_{net}) / [(Ug \times Pg_{net}) + (Um \times Pm_{net})]}$$

This is used to calculate the number of each sea age category in the total rod catch, **Ctg** and **Ctm**, in order to get the total number of spawning grilse and MSW , Sg and **Sm**.

The number of grilse available for spawning: $\mathbf{Sg = [(Ctg / Ug)-Ctg] \times sg}$

With the number of grilse in the rod catch $\mathbf{Ctg = Ct \times Pg_{rod}}$

With **sg**, **sm** for MSW, post rod fishery survival = **0.91**

The same calculation is done for MSW fish.

The number of fish released by anglers have been declared on rod licence returns from 1993 to 1997 so these fish are added to the escapement. The number of grilse and the number of MSW released are calculated with the proportions **Pg** and **Pm**. The post rod fishery survival used is 0.91.

2- Conversion of the annual spawning escapement into a number of eggs.

The spawning escapment is then converted into a number of eggs, **E**, as follows:

$$E = Sg \times Fg \times fg + Sm \times Fm \times fm$$

Where **Fg = 53.2%,** (Salmon Action Plan Guidelines appendix VI).
fg = 4128 eggs per female, estimated from the mean weight of each age class from scale reading of net catches from 1962 to 1972 (see **part 1**).

Where **Fm = 68.7%** (default value)
fm = 6273 eggs per female, estimated from the mean weight of each age class from scale reading of net catches from 1962 to 1972 (see **part 1**.).

NB: Fecundity and sex ratio are considered as constant across the years.

An example of these calculation is shown in **Table 2. Table 3** gives the annual egg deposition from 1962 to 97.
Annex 5 gives all the rod catches from 1962 to 1997.

The annual egg deposition is then compared with the spawning target. Following the rule in **SAP guidelines part 3.5**, periods of failure to meet the spawning target are identified. **Figure 2** shows that the River Dart has failed to comply in the last ten years.

C-SHORTFALL CALCULATION.

The shortfall estimate is based on the last ten year (1988-97) mean of the difference between the egg spawning target which is a fixed value and the egg deposition which varies annually depending on the rod catch.

For the River Dart , the shortfall is equal to **1.76 million eggs.**

This is equivalent to **426 grilse** and to **191 MSW** in the spawning escapement.

The split is calculated with the last ten year mean of proportion of grilse from weight distribution of the yearly net catches and with the same estimate of fecundity and the same proportion of females used to assess egg deposition.
Figure 2 summarises the compliance assessment of the River Dart.

TABLE 1: RIVER DART SALMON SPAWNING TARGET TRANSPORTATION

River Dart - revised target based on adjusted mean widths and excluding inaccessible reaches

Reach	Altitude ranges (m)	Stream order	Definition Taranis Report	Width (m) HABSCORE	Length (m) GIS ACCESSIBLE	Area (m2)	% Area	Length (m) GIS USABLE	Area (m2)	% Area	% Spawners required
9	0-49	1	A1	3 88	10810	39521	0 030	10810	39521	0 030	0 000
8	50-99	1	B1	4 02	5875	23618	0 018	5875	23618	0 018	0 016
4	100-149	1	C1	5 22	1905	9935	0 008	1905	9935	0 008	0 007
3	150-199	1	D1	4 03	1348	5424	0 004	1348	5424	0 004	0 004
2	200-299	1	E1	4 25	13218	56177	0 043	13218	56177	0 043	0 071
1	300-399	1	F1	8 53	32909	181067	0 138	32909	181067	0 138	0 229
	400-499	1	G1	8 03	17051	102618	0 078	17051	102618	0 078	0 130
	500-599	1	H1	6 00	4628	27768	0 021	4628	27768	0 021	0 035
	600-699	1	I1		0	0	0 000	0	0	0 000	0 000
	700-799	1	J1		0	0	0 000	0	0	0 000	0 000
12	0-49	2	A2	5 81	4900	28145	0 020	4900	28145	0 020	0 000
11	50-99	2	B2	6 00	272	1632	0 001	272	1632	0 001	0 001
10	100-149	2	C2	7 78	1783	13716	0 010	1783	13716	0 010	0 000
9	150-199	2	D2	9 00	236	2142	0 002	236	2142	0 002	0 000
8	200-299	2	E2	10 89	5907	64298	0 049	5907	64298	0 049	0 081
7	300-399	2	F2	8 86	6274	54333	0 041	6274	54333	0 041	0 069
	400-499	2	G2	4 17	0	0	0 000	0	0	0 000	0 000
	500-599	2	H2	4 17	0	0	0 000	0	0	0 000	0 000
	600-699	2	I2		0	0	0 000	0	0	0 000	0 000
	700-799	2	J2		0	0	0 000	0	0	0 000	0 000
18	0-49	3	A3	21 79	18189	396338	0 301	18189	396338	0 301	0 272
17	50-99	3	B3	34 71	5688	140650	0 107	5688	140650	0 107	0 000
16	100-149	3	C3	19 93	3297	65709	0 050	3297	65709	0 050	0 000
15	150-199	3	D3	15 00	2451	36765	0 028	2451	36765	0 028	0 000
14	200-299	3	E3	11 63	5676	67773	0 051	5676	67773	0 051	0 068
13	300-399	3	F3	6 21	0	0	0 000	0	0	0 000	0 000
	400-499	3	G3	5 98	0	0	0 000	0	0	0 000	0 000
	500-599	3	H3	5 78	0	0	0 000	0	0	0 000	0 000
	600-699	3	I3		0	0	0 000	0	0	0 000	0 000
	700-799	3	J3		0	0	0 000	0	0	0 000	0 000
24	0-49	4	A4	15 72	0	0	0 000	0	0	0 000	0 000
23	50-99	4	B4	14 66	0	0	0 000	0	0	0 000	0 000
22	100-149	4	C4	13 49	0	0	0 000	0	0	0 000	0 000
21	150-199	4	D4	12 49	0	0	0 000	0	0	0 000	0 000
20	200-299	4	E4	11 14	0	0	0 000	0	0	0 000	0 000
19	300-399	4	F4	9 55	0	0	0 000	0	0	0 000	0 000
	400-499	4	G4	8 20	0	0	0 000	0	0	0 000	0 000
	500-599	4	H4	7 03	0	0	0 000	0	0	0 000	0 000
	600-699	4	I4		0	0	0 000	0	0	0 000	0 000
	700-799	4	J4		0	0	0 000	0	0	0 000	0 000
30	0-49	5	A5	15 72	0	0	0 000	0	0	0 000	0 000
29	50-99	5	B5	14 66	0	0	0 000	0	0	0 000	0 000
28	100-149	5	C5	13 49	0	0	0 000	0	0	0 000	0 000
27	150-199	5	D5	12 49	0	0	0 000	0	0	0 000	0 000
26	200-299	5	E5	11 14	0	0	0 000	0	0	0 000	0 000
25	300-399	5	F5	9 55	0	0	0 000	0	0	0 000	0 000
	400-499	5	G5	8 20	0	0	0 000	0	0	0 000	0 000
	500-599	5	H5	7 03	0	0	0 000	0	0	0 000	0 000
	600-699	5	I5		0	0	0 000	0	0	0 000	0 000
	700-799	5	J5		0	0	0 000	0	0	0 000	0 000
36	0-49	6	A6	15 72	0	0	0 000	0	0	0 000	0 000
35	50-99	6	B6	14 66	0	0	0 000	0	0	0 000	0 000
34	100-149	6	C6	13 49	0	0	0 000	0	0	0 000	0 000
33	150-199	6	D6	12 49	0	0	0 000	0	0	0 000	0 000
32	200-299	6	E6	11 14	0	0	0 000	0	0	0 000	0 000
31	300-399	6	F6	9 55	0	0	0 000	0	0	0 000	0 000
	400-499	6	G6	8 20	0	0	0 000	0	0	0 000	0 000
	500-599	6	H6	7 03	0	0	0 000	0	0	0 000	0 000
	600-699	6	I6		0	0	0 000	0	0	0 000	0 000
	700-799	6	J6		0	0	0 000	0	0	0 000	0 000
proportion p of spawners in x % of the accessible area					142188	1318649	1 000	142188	1318649	1 000	1 000

p % spw	x % area
0 00	0.2465
0.30	0.33
0.70	0.42

Fry max dens HABSCORE	Fry % smolt Bush SR	Fry survival Bush SR	Parr max dens HABSCORE	Parr % smolt Bush SR	Parr survival Bush SR	MG1a	MG1aB	MS1a	MS1aB	SR
9.63	0.0428	0.128	1.87	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
4.79	0.0428	0.128	3.33	0.438	0.0389	0.000	0.000	0.000	0.000	0.020
5.09	0.0428	0.128	6.39	0.438	0.0389	0.000	0.000	0.000	0.000	0.021
8.77	0.0428	0.128	11.61	0.438	0.0389	0.000	0.000	0.000	0.000	0.019
25.38	0.0428	0.128	18.08	0.438	0.0389	0.001	0.000	0.001	0.000	0.356
44.84	0.0428	0.128	7.02	0.438	0.0389	0.002	0.000	0.002	0.000	0.618
44.84	0.0428	0.128	7.02	0.438	0.0389	0.001	0.000	0.001	0.000	0.350
44.84	0.0428	0.128	7.02	0.438	0.0389	0.000	0.000	0.000	0.000	0.004
44.84	0.0428	0.128	7.02	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
44.84	0.0428	0.128	7.02	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
14.11	0.0428	0.128	3.48	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
12.08	0.0428	0.128	5.33	0.438	0.0389	0.000	0.000	0.000	0.000	0.003
17.04	0.0428	0.128	7.27	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
27.27	0.0428	0.128	8.87	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
38.34	0.0428	0.128	9.70	0.438	0.0389	0.001	0.000	0.001	0.000	0.383
1.88	0.0428	0.128	7.40	0.438	0.0389	0.000	0.000	0.000	0.000	0.117
1.88	0.0428	0.128	7.40	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
1.88	0.0428	0.128	7.40	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
1.88	0.0428	0.128	7.40	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
1.88	0.0428	0.128	7.40	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
18.73	0.0428	0.128	3.93	0.438	0.0389	0.002	0.000	0.002	0.000	0.664
18.67	0.0428	0.128	6.39	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
34.15	0.0428	0.128	7.70	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
80.20	0.0428	0.128	7.83	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
14.83	0.0428	0.128	8.39	0.438	0.0389	0.001	0.000	0.001	0.000	0.183
14.83	0.0428	0.128	4.29	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
14.83	0.0428	0.128	6.38	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
14.83	0.0428	0.128	5.38	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
14.83	0.0428	0.128	0.90	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
14.83	0.0428	0.128	8.39	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.98	0.0428	0.128	2.68	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
20.67	0.0428	0.128	0.73	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
40.84	0.0428	0.128	7.68	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
64.88	0.0428	0.128	0.21	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
3.08	0.0428	0.128	11.68	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
3.08	0.0428	0.128	11.68	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
3.08	0.0428	0.128	11.68	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
3.08	0.0428	0.128	11.68	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
3.08	0.0428	0.128	11.68	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
3.88	0.0428	0.128	11.68	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.58	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.64	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.68	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.68	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.56	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.66	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.66	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.58	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.68	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.64	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.60	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.66	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.58	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.64	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.68	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.64	0.0428	0.128	2.60	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.66	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.68	0.0428	0.128	2.60	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.68	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
22.68	0.0428	0.128	2.66	0.438	0.0389	0.000	0.000	0.000	0.000	0.000
						0.000	0.000	0.000	0.000	2.738

Survival - grilse	25
Survival - MSW	15
% grilse	60.1
% females	68.0
fecundity	4790.5
Overall surv	20.7
repl	676

Targets	Estimate	Guess	Smolt
max gain	297	297	2.806
max smolts	369	369	2.865
Any		600	2.738

Total egg target at max gain = 3904086.8

[redacted]

TABLE2: EGG DEPOSITION , RIVER DART 1997

Salmon spawning targets: Egg deposition estimates

River:	dart	Year:	1997
Total wetted area (m2) =			
Total useable area (m2) =		1316649	
Catchment area (km2) =		289.25	
Mean angling effort (days) 1993-94 =			
catch per licence day 1995=			
Mean angling effort (days) 1993-95 =			
Number of Grilses caught by nets in the year=			278
Number of MSW caught by nets in the year=			39
Proportion of Grilses caught in nets			0.88
Proportion of MSW caught in nets			0.12
Declared catch - all sea ages (Cd) =			160
Rod catch reporting rate (r) =			0.91
Corrected total catch - all sea ages (Ct) =			176
Undeclared catch - all sea ages (Cn) =			16
Proportion 1SW fish in rod catch			0.836
Proportion MSW fish in rod catch			0.164
Proportion 1SW fish in undeclared catch (Png) =			0.836
Proportion MSW fish in undeclared catch (Pmn) =			0.164
Undeclared catch - 1SW fish (Cng) =			13
Undeclared catch - MSW fish (Cnm) =			2.60
Extant rod exploitation rate - all sea ages (Uad) =			0.210
Extant rod exploitation rate - 1SW fish (Ug) =			0.188
Extant rod exploitation rate - MSW fish (Um) =			0.263
Post-rod fishery survival - 1SW fish (sg) =			0.91
Post-rod fishery survival - MSW fish (sm) =			0.91
Proportion female 1SW fish (Pfg) =			0.532
Proportion female MSW fish (Pfm) =			0.687
Mean weight (lbs) grilse (1962,63,64,65,66,67,71,72)=			6.05
Mean lenght (cm) grilse=			62.62
Mean weight (lbs)MSW (1964,65,66,67,68,71,72)=			10.36
Mean lenght (cm) MSW=			75.16
Total 1 SW rod catch =		147	
Total 1SW spawners (Sg) =		580	
Mean fecundity 1SW fish (fg) =		4128	
Total egg deposition 1SW fish (Edg) =		1,271,598	
Total MSW rod catch		29	
Total MSW spawners (Sm) =		74	
Mean fecundity MSW fish (fm) =		6273	
Total egg deposition MSW fish (Edm) =		318,038	
Total egg deposition - all sea ages (Et) =			1,589,636
Egg deposition per 100m2 useable area (Ed) =			121
Egg deposition target per 100m2 useable area =			297
% Compliance against egg deposition target =			40.7
Number of fish released in rod	35		
Number of eggs ADDED	97751.3231		
Total egg deposition			1,687,387
Egg deposition per 100m2 useable area (Ed) =			128
% Compliance against egg deposition target =			43.2

TABLE 3: Annual egg deposition, River Dart

Salmon spawning Target =3.9 million eggs

year	eggs (million)
1962	2.45
1963	4.369
1964	4.071
1965	5.129
1966	6.752
1967	4.57
1968	?
1969	?
1970	?
1971	0.783
1972	1.989
1973	1.303
1974	1.987
1975	1.77
1976	0.632
1977	1.989
1978	2.229
1979	2.338
1980	2.662
1981	2.308
1982	1.557
1983	2.378
1984	1.1337
1985	4.382
1986	5.775
1987	2.264
1988	4.955
1989	1.539
1990	0.8664
1991	1.042
1992	2.67
1993	2.196
1994	3.382
1995	1.543
1996	1.505
1997	1.705
Last 10 year mean	**2.14034**

FIGURE 1

River Dart

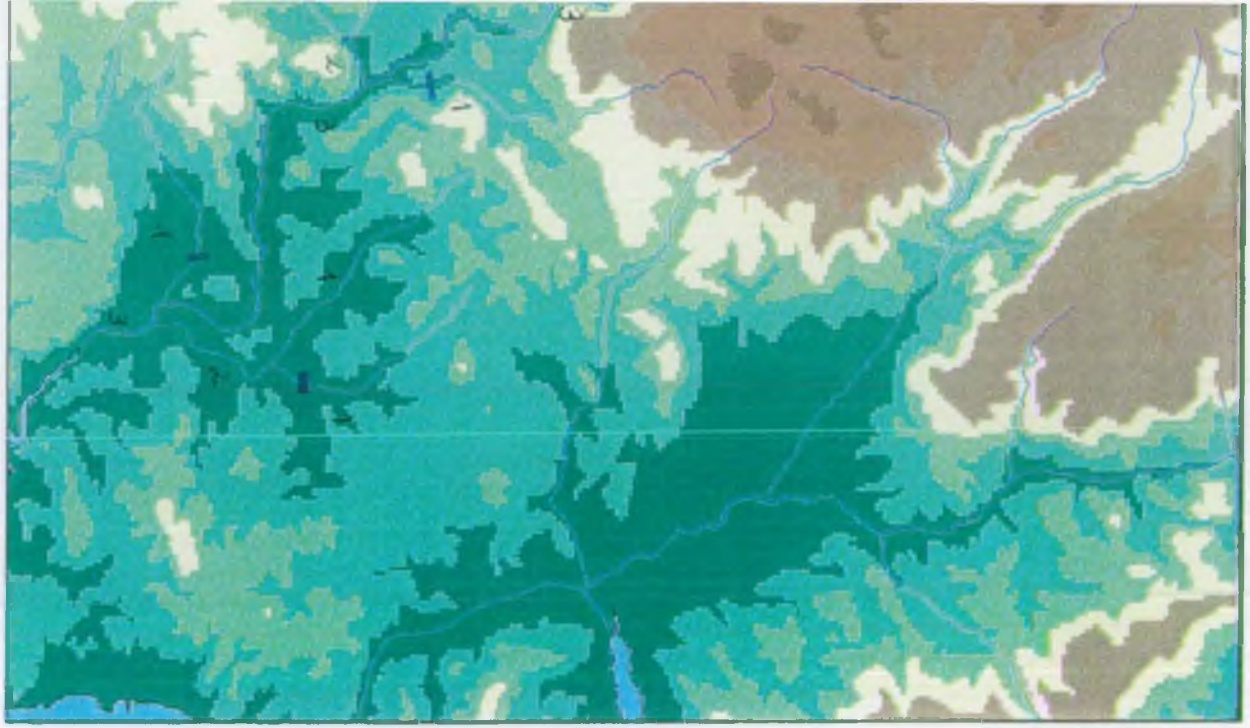
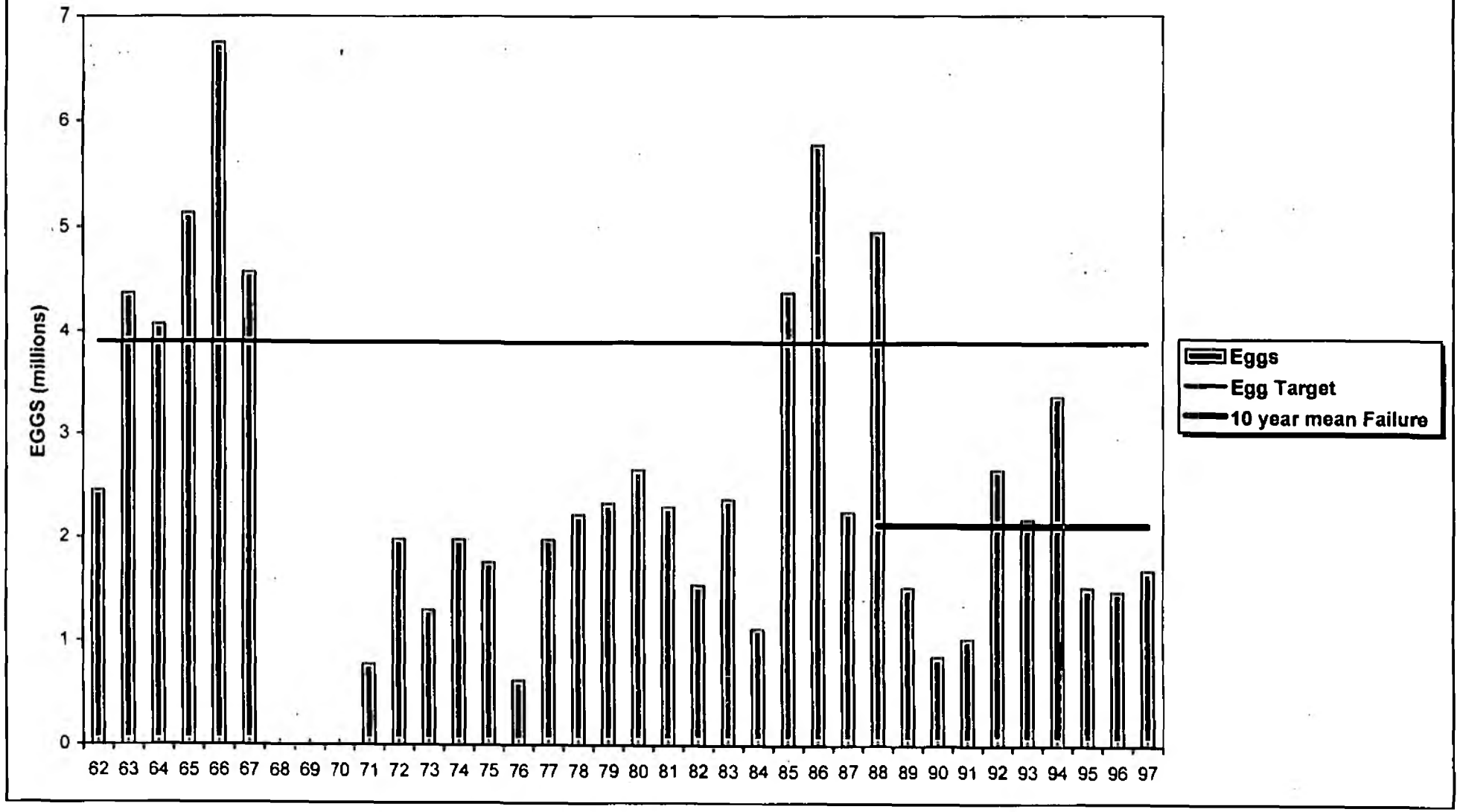


FIGURE 2: Compliance With Spawning Targets, Uall=21%, 1962-1997,DART



annex

ANNEX 1

TABLE 1 **dart**

inaccessible length (km)

		stream order 1
Altitude (m)	<49	5.55
	50.99	7.3
	100.149	4.4
	150.199	3.1
	200.299	6.2
	300.399	4.9
	400.499	1.1
	>500	

TABLE 2

dart

width (m)

		stream order		
		1	2	3
Altitude (m)	<49	3.66	5.81	21.79
	50.99	4.02	*6*	24.71
	100.149	5.22	7.78	19.93
	150.199	4.03	*9*	*15*
	200.299	4.25	10.89	11.53
	300.399	5.53	8.66	
	400.499	6.03		
	>500	*6*		

ANNEX 3

RIVER DART- PROPORTION OF GRILSE IN NET CATCHES

River	Year	Percentage
Dart	1962	23%
Dart	1963	29%
Dart	1964	14%
Dart	1965	13%
Dart	1966	4%
Dart	1967	36%
Dart	1968	unknown
Dart	1969	unknown
Dart	1970	unknown
Dart	1971	24%
Dart	1972	35%
Dart	1973	45%
Dart	1974	53%
Dart	1975	37%
Dart	1976	35%
Dart	1977	42%
Dart	1978	30%
Dart	1979	67%
Dart	1980	25%
Dart	1981	36%
Dart	1982	32%
Dart	1983	60%
Dart	1984	59%
Dart	1985	58%
Dart	1986	61%
Dart	1987	80%
Dart	1988	64%
Dart	1989	66%
Dart	1990	53%
Dart	1991	50%
Dart	1992	81%
Dart	1993	71%
Dart	1994	83%
Dart	1995	68%
Dart	1996	67%
Dart	1997	88%
last 10 year average		**69%**

Source:
South west catch stat. Database (Access 97)

ANNEX 4

Dart Salmon Nets

1997

	1SW	MSW	TOTAL	% Grilse	% MSW
MARCH	0	1	1		
APRIL	0	8	8		
MAY	1	19	20		
JUNE	12	3	15		
JULY	165	7	172		
AUGUST	100	1	101		
TOTAL	278	39	317	**88%**	**12%**

1996

	1SW	MSW	TOTAL		
MARCH	0	1	1		
APRIL	0	18	18		
MAY	9	52	61		
JUNE	13	54	67		
JULY	153	21	174		
AUGUST	132	6	138		
TOTAL	307	152	459	**67%**	**33%**

1995

	1SW	MSW	TOTAL		
MARCH	0	0	0		
APRIL	0	16	16		
MAY	0	88	88		
JUNE	53	58	111		
JULY	212	26	238		
AUGUST	170	13	183		
TOTAL	435	201	636	**68%**	**32%**

1994

	1SW	MSW	TOTAL		
MARCH	0	1	1		
APRIL	0	10	10		
MAY	0	59	59		
JUNE	108	27	135		
JULY	379	33	412		
AUGUST	163	7	170		
TOTAL	650	137	787	**83%**	**17%**

1993

	1SW	MSW	TOTAL		
MARCH	0	1	1		
APRIL	0	11	11		
MAY	0	73	73		
JUNE	11	41	52		
JULY	200	15	215		
AUGUST	158	10	168		
TOTAL	369	151	520	**71%**	**29%**

1992

	1SW	MSW	TOTAL		
MARCH	0	0	0		
APRIL	0	11	11		
MAY	5	55	60		
JUNE	51	82	133		
JULY	408	21	429		
AUGUST	320	14	334		
TOTAL	784	183	967	**81%**	**19%**

1991

	1SW	MSW	TOTAL		
MARCH	0	1	1		
APRIL	0	5	5		
MAY	0	60	60		
JUNE	10	70	80		
JULY	87	28	115		
AUGUST	73	8	81		
TOTAL	170	172	342	**50%**	**50%**

1990

	1SW	MSW	TOTAL		
MARCH	0	2	2		
APRIL	0	63	63		
MAY	0	252	252		
JUNE	71	116	187		
JULY	259	53	312		
AUGUST	241	15	256		
TOTAL	571	501	1072	**53%**	**47%**

1989

	1SW	MSW	TOTAL
MARCH	0	2	2
APRIL	0	16	16
MAY	0	201	201

JUNE	47	267	314		
JULY	588	166	754		
AUGUST	674	12	686		
TOTAL	1309	664	1973	**66%**	**34%**

1988

	1SW	MSW	TOTAL		
MARCH	0	22	22		
APRIL	0	114	114		
MAY	0	299	299		
JUNE	127	227	354		
JULY	768	24	792		
AUGUST	358	7	365		
TOTAL	1253	693	1946	**64%**	**36%**

1987

	1SW	MSW	TOTAL		
MARCH	0	5	5		
APRIL	0	32	32		
MAY	25	113	138		
JUNE	348	213	561		
JULY	1108	96	1204		
AUGUST	400	19	419		
TOTAL	1881	478	2359	**80%**	**20%**

1986

	1SW	MSW	TOTAL		
MARCH	0	5	5		
APRIL	0	129	129		
MAY	10	405	415		
JUNE	279	258	537		
JULY	843	44	887		
AUGUST	215	25	240		
TOTAL	1347	866	2213	**61%**	**39%**

1985

	1SW	MSW	TOTAL		
MARCH	0	0	0		
APRIL	0	12	12		
MAY	0	271	271		
JUNE	111	314	425		
JULY	766	192	958		
AUGUST	240	13	253		
TOTAL	1117	802	1919	**58%**	**42%**

1984

	1SW	MSW	TOTAL		
MARCH	0	2	2		
APRIL	0	44	44		
MAY	0	137	137		
JUNE	35	212	247		
JULY	426	149	575		
AUGUST	401	44	445		
TOTAL	862	588	1450	**59%**	**41%**

1983

	1SW	MSW	TOTAL		
MARCH	0	13	13		
APRIL	0	54	54		
MAY	24	73	97		
JUNE	81	190	271		
JULY	386	150	536		
AUGUST	265	23	288		
TOTAL	756	503	1259	**60%**	**40%**

1982

	1SW	MSW	TOTAL		
MARCH	0	15	15		
APRIL	0	62	62		
MAY	0	151	151		
JUNE	19	215	234		
JULY	68	38	106		
AUGUST	153	33	186		
TOTAL	240	514	754	**32%**	**68%**

1981

	1SW	MSW	TOTAL		
MARCH	0	7	7		
APRIL	0	112	112		
MAY	0	331	331		
JUNE	61	377	438		
JULY	394	241	635		
AUGUST	167	25	192		
TOTAL	622	1093	1715	**36%**	**64%**

1980

	1SW	MSW	TOTAL
MARCH	0	12	12
APRIL	0	115	115
MAY	0	521	521

JUNE	17	313	330		
JULY	187	73	260		
AUGUST	141	11	152		
TOTAL	345	1045	1390	**25%**	**75%**

1979

	1SW	MSW	TOTAL		
MARCH	0	1	1		
APRIL	0	39	39		
MAY	6	102	108		
JUNE	20	61	81		
JULY	298	45	343		
AUGUST	192	11	203		
TOTAL	516	259	775	**67%**	**33%**

1978

	1SW	MSW	TOTAL		
MARCH	0	4	4		
APRIL	0	132	132		
MAY	0	262	262		
JUNE	37	130	167		
JULY	141	27	168		
AUGUST	60	6	66		
TOTAL	238	561	799	**30%**	**70%**

1977

	1SW	MSW	TOTAL		
MARCH	0	6	6		
APRIL	0	109	109		
MAY	0	180	180		
JUNE	31	79	110		
JULY	180	40	220		
AUGUST	103	17	120		
TOTAL	314	431	745	**42%**	**58%**

1976

	1SW	MSW	TOTAL		
MARCH	0	11	11		
APRIL	0	191	191		
MAY	0	284	284		
JUNE	89	207	296		
JULY	185	201	386		
AUGUST	227	43	270		
TOTAL	501	937	1438	**35%**	**65%**

1975

	1SW	MSW	TOTAL		
MARCH	0	26	26		
APRIL	0	292	292		
MAY	0	285	285		
JUNE	61	156	217		
JULY	285	28	313		
AUGUST	112	3	115		
TOTAL	458	790	1248	**37%**	**63%**

1974

	1SW	MSW	TOTAL		
MARCH	0	16	16		
APRIL	0	67	67		
MAY	0	159	159		
JUNE	85	85	170		
JULY	232	17	249		
AUGUST	66	18	84		
TOTAL	383	362	745	**51%**	**49%**

1973

	1SW	MSW	TOTAL		
MARCH	0	58	58		
APRIL	0	105	105		
MAY	0	192	192		
JUNE	89	79	168		
JULY	252	16	268		
AUGUST	41	9	50		
TOTAL	382	459	841	**45%**	**55%**

ANNEX 5

RIVER DART - NUMBER OF SALMON CAUGHT IN RODS

River	Year	Total
Dart	1962	178
Dart	1963	321
Dart	1964	291
Dart	1965	366
Dart	1966	475
Dart	1967	340
Dart	1968	185
Dart	1969	326
Dart	1970	128
Dart	1971	57
Dart	1972	148
Dart	1973	99
Dart	1974	153
Dart	1975	132
Dart	1976	47
Dart	1977	153
Dart	1978	164
Dart	1979	187
Dart	1980	198
Dart	1981	172
Dart	1982	115
Dart	1983	188
Dart	1984	91
Dart	1985	344
Dart	1986	455
Dart	1987	188
Dart	1988	394
Dart	1989	123
Dart	1990	67
Dart	1991	80
Dart	1992	154
Dart	1993	119
Dart	1994	326
Dart	1995	139
Dart	1996	137
Dart	1997	160

Source:

*Salmon and Migratory Trout statistics for England and Wales, 1951-90, MAFF, Fisheries Research Data Report N0 38.

*South west catch stat. Database (Access 97)