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Executive Summary

The following report details the daily upstream counts of migratory salmonids recorded at Restormel Weir fish counting station (SX 107 613) in 1998. The report includes the period of the commercial migratory salmonid net buy-back scheme, which was in operation between 2 March to 15 June 1998, inclusive.

The weir at Restormel is 'Crump' sectioned with three open channels. It is situated on the River Fowey, approximately 2-km upstream of the tidal limit. The fish counter at Restormel is a resistivity based system (Logie 2100A – Aquantic limited) and operates over all three channels of the weir.

- The 1998 upstream count for salmon / large sea trout was 882. The total salmon run size was 543, which was exactly the same as 1997. The count estimate was made using counts recorded between July and February, effectively excluding the majority of the large salmon sized sea trout.

- The 1998 upstream count for sea trout was 3590. This equates to a 2% decrease in the total number of sea trout when compared to 1997.

The run pattern observed for salmon and sea trout in 1998 is consistent with that of previous years. However, the total combined annual count of salmon and sea trout migrating upstream on the River Fowey was 6% lower than that achieved in previous years.

Modem-based telemetry has recently been installed at the counter site and will enable the counter to be remotely downloaded and monitored. This is expected to lead to an increase in counter efficiency and a reduction in unplanned downtime.

1.0 Introduction

The following report presents salmon and sea trout counts, with respect to daily mean flow (cumecs) recorded at Restormel fish counting station (SX 107 613) on the River Fowey, in 1998. The flow data reflects the residual flow that exists at Restormel weir following abstraction at Restormel Water Treatment Works (WTW) by South West Water Limited (SWWL).

1.1 Background

The counter at Restormel is a resistivity based system (Logie 2100A - Aquantic Limited) and was installed at Restormel in 1994. Data collection commenced in 1995. A description detailing the operation of the resistivity fish counter at Restormel is provided in Appendix 1 (Page 24).

The gauging weir at Restormel is situated on the River Fowey, approximately 2-km upstream of the tidal limit. The weir is 'Crump' sectioned with three open channels, a centre channel (3.5 metres) and two side channels (6.5 metres each). The counter operates over each of these three channels, allowing complete coverage of the river, a total width of 17 metres.

The counter at Restormel is the second resistivity-based system operated by the Cornwall Area Fisheries Science Team. The other counter is located on the River Tamar at Gunnislake Weir (SX 435 713).

1.2 Net Buy-Back

As in 1997, a buy-back of commercial migratory salmonid netting time was operated on the River Fowey in 1998. This took place from 2 March to 15 June 1998, inclusive. The main aim of the buy-back scheme was to mitigate for sea trout spawning, which was lost due to the construction of Colliford Reservoir.

1.3 Species Apportionment

The counter has the ability to record electrical changes that are directly proportional to the size of fish that have traversed the counter electrodes. Species apportionment is possible due to the relationship that exists between fish length and deflection size. However, it is not possible to distinguish between a salmon and a sea trout of comparable size. It is therefore inevitable that the salmon count may include some large sea trout. As this situation is most likely to exist between March and the end of June, a data handling protocol has been developed to minimise this eventuality. This is described in Appendix 2 (Page 25).

1.4 Validation of counter efficiency

Validation studies carried out on the counter in 1997 (Ref: 01), showed that the Restormel fish counter was:

- 90% efficient in detecting upstream migrating fish greater than 45 cm in length.
- 60% efficient in detecting upstream migrating fish less than 45 cm in length.

Data from fish trapping studies carried out between 1979 and 1984 has been used to establish the mean length for one sea-winter (grilse) and multi sea-winter salmon on the River Fowey. Data from the same study has also been used to calculate the mean length for sea trout (all sea age categories).

Mean Lengths for Salmon and Sea Trout Caught at Restormel Fish Trap 1979 – 1984.

		Mean Length (cm)	
Salmon	One Sea-Winter Fish (Grilse)	61.62	
	Multi Sea-Winter Fish		78.79
Sea Trout*	School Peal (+)	29.46	
	Maiden / Single Spawners (.1+/.2+)	42.21	
	Multiple Spawners (2Sm+)	52.96	

Data extracted from Sambrook, 1985

**Individual fish lengths were unavailable for the sea trout trapped in this study. The means shown have been calculated from average fish lengths to give an indication of the size split between the age classes and this should be borne in mind when interpreting the data.*

A summary of the data used to calculate the average lengths (above) for salmon and sea trout (mean lengths) caught at Restormel fish trap between 1979 - 1984 is provided in Appendix 3,4,5 and 6 (Pages 26 & 27).

The data presented above supports the relationship between fish length and deflection size that has been established independently using counter data and video footage from the Restormel fish counter site. It also supports the use of deflection sizes to differentiate between salmon / large sea trout and sea trout.

2.0 Results

The migratory salmonid counts obtained for the River Fowey recorded at Restormel fish counting station are presented as follows:

Figure 1 (Page 9): This presents the monthly upstream counts for salmon / large sea trout recorded at Restormel weir in 1998. The total number of salmon / large sea trout counted moving up the river in 1998 was 882 (Table 1).

Figure 2 (Page 10): Presents the monthly upstream counts for sea trout recorded at Restormel weir in 1998. The total number of sea trout counted moving up the river in 1998 was 3590 (Table 2). This equates to a 2% reduction in the run size when compared to last years figures.

Figure 3 (Page 11): Presents the monthly upstream counts for salmon / large sea trout and sea trout, in relation to monthly mean flow (cumecs) at Restormel weir in 1998.

Figures 4 – 27 (Pages 12 – 23): Each of these figures presents daily upstream counts for salmon / large sea trout and sea trout, for each month, in relation to daily mean flow (cumecs) recorded at Restormel weir.

Note:

- To aid in interpretation of the data, axis scaling may differ between the monthly summary plots. Care should therefore be taken when interpreting the data within each figure.

3.0 Discussion

Figures 1 and 2 indicate that the run pattern observed for salmon and sea trout on the River Fowey in 1998 is consistent with previous years. However, there is a reduction in the annual total count of both salmon and sea trout migrating upstream on the River Fowey when compared to previous years.

3.1 Salmon / Large Sea Trout counts recorded on the River Fowey 1995 - 1998.

The upstream counts obtained during March - June indicate that a large number of salmon sized fish are entering the river at this time. Traditionally salmon, predominantly one sea-winter fish (grilse) are known to enter the Fowey from the end of June with a late run of fish from October – January. Historic rod catch and trapping data indicates that only small numbers of salmon enter the River Fowey prior to the end of June. It is therefore highly likely that the majority of these fish are large sea trout. Analysis of video data taken in May / June (channel 1) and anecdotal evidence tend to confirm this.

Counter data from previous years indicates a general increase in the number of these larger fish over the last four years, with the exception of 1995, which was a drought year. Bearing this in mind, counts recorded for salmon between July and February probably provide a more reliable estimate of the salmon run size, as this would effectively remove the majority of the larger sea trout from the count. The count between July and February in 1998 was 543, which was exactly the same as the 1997 counts over the same period.

There is an increase in the size of the run in October and November, which can probably be attributed to increased flows during this period. However the counter data suggests that there is a general decline in the overall size of the salmon runs over successive years. Counter data from previous years indicates that the late run of salmon has progressively decreased in size since 1996, the run in January 1998 being the lowest recorded over the last four years.

3.2 Sea Trout Counts Recorded on the River Fowey 1995 - 1998.

Traditionally, the main sea trout run on the River Fowey is consistent with that of many other rivers in the South West. The main sea trout run is concentrated predominantly in the months of June and July with the peak movement of sea trout, predominantly school peal, occurring in July. Smaller runs occur in April, May and August with numbers declining sharply near the end of August and only small numbers moving upstream thereafter.

The counter data indicates that the sea trout runs in 1998 were smaller in size than those of previous years but were extended over a longer period (April – August). The lower counts in

June and July reflect this fact with the main run of sea trout beginning in May. This resulted in the May 1998 sea trout count being twice the size of that recorded in previous years and the counts in July 1998 being the lowest recorded in previous years. High river flow rates in the spring of 1998, those in April being particularly high, may have caused these fish movements, inducing the fish to migrate upstream earlier than usual.

The low counts in December can be attributed to the counter being out of action from the 15 December to the end of the year. This was due to a faulty internal power supply unit. The counts around this period were not considered to be consistent enough to make a reliable estimate for the lost count data. However, the counts after and prior to the counter being out of action, together with data from previous years suggests that the numbers of fish traversing the weir are likely to be low and would therefore have little effect on the overall run patterns.

4.0 Data Processing

The data presented in this report represents final adjusted counts, which take into account such things as maintenance work on the weir i.e. cleaning, which may have caused false counts. Weir cleaning was initiated in May 1998, data from previous years was not considered to be affected by this activity. The data for 1998, presented in the initial monthly summary reports, were intended to give a general indication of the movements of migratory salmonids and have been superseded by the data included in this report.

5.0 Future Work

i. A telephone line has been linked to the fish counter hut at Restormel and telemetry equipment has now been installed. The installation of the telemetry system has also included an upgrade of the fish counter software and is expected to offer the following benefits:

- The counter can be remotely downloaded – at present, the site needs to be visited on a weekly basis to be downloaded.

- The operation of the counter can be remotely checked on a daily basis, which should identify potential problems and so reduce downtime.

- Increased efficiency, as the operational parameters can be closely monitored and adjusted remotely from the office at Launceston, according to environmental conditions.

- More time can be devoted to the further development and improvement of the counter due to the reduction in the number of man-hours needed to travel to and from the counter site to download data.

- An EPROM upgrade - a component of the central processing unit (CPU) - and compliance testing for all fish counter equipment is in progress and will ensure that the counter at Restormel should not fail due to the Year 2000 date change.

ii. Video validation will still be carried out during the summer months to assess the efficiency of the counter.

6.0 Downtime

The counter operated for 349 of the 365 days. The downtime of 16 days, excluding days in 1999, was due to a faulty internal power supply unit, which supplies the power for the CPU and electrode interface cards (ERICs). The fault was detected on 31 December. The initial cause of the fault is unknown but is thought to have been due to a power surge.

7.0 References

01. " A preliminary assessment of the ability of Restormel fish counter to enumerate the passage of migratory salmonids on the River Fowey"; Environment Agency, South West Region, September 1998.

02. Sambrook, H. T. "Upstream Migration of Salmonids into the River Fowey Catchment, Restormel Trap 1979 – 1984. South West Water, Dept. of Env. Serv., Environmental Section – West, Vol II, 1985.

Figure 1 – Monthly Upstream Counts for Salmon / Large Sea Trout at Restormel 1995 – 1998.

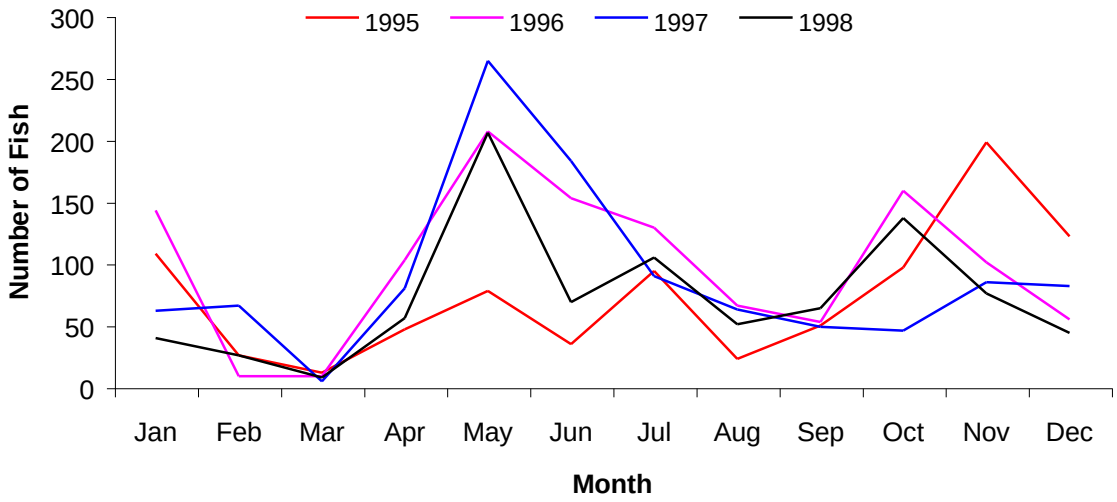


Table 1 – Monthly Upstream Counts for Salmon / Large Sea Trout at Restormel 1995-1998.

Month	1995	1996	1997	1998
Jan	108	143	62	40
Feb	26	9	66	26
Mar	12	9	5	8
Apr	47	103	80	56
May	78	207	264	206
Jun	35	153	183	69
Jul	94	129	90	105
Aug	23	66	63	51
Sep	50	53	49	64
Oct	97	159	46	137
Nov	198	101	85	76
Dec	122	55	82	44
Totals	890	1187	1075	882

Figure 2 – Monthly Upstream Counts for Sea Trout at Restormel 1995 – 1998.

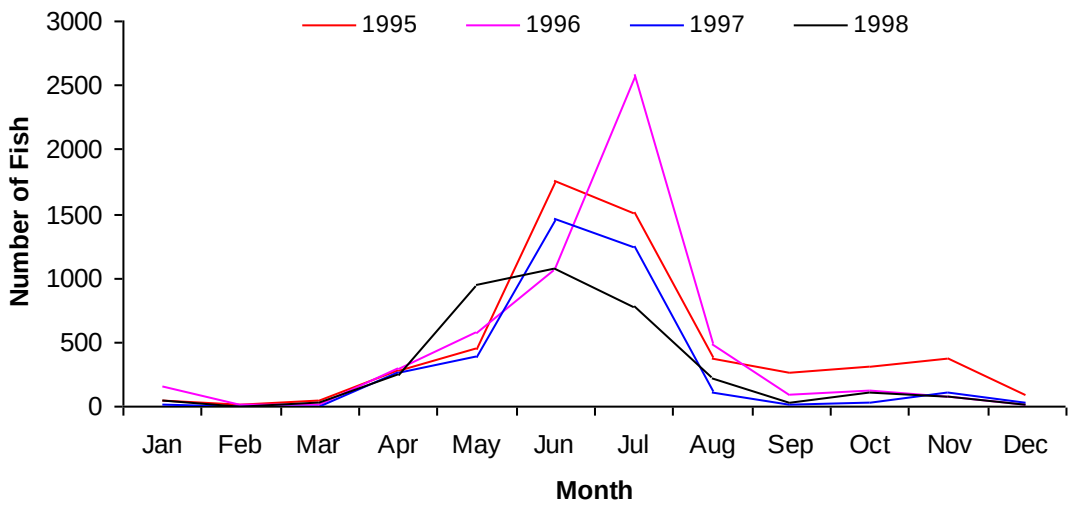


Table 2 – Monthly Upstream Counts for Sea Trout at Restormel 1995 – 1998.

Month	1995	1996	1997	1998
Jan	52	156	13	46
Feb	8	10	4	6
Mar	47	18	1	35
Apr	274	303	264	256
May	446	573	388	948
Jun	1759	1065	1454	1070
Jul	1513	2578	1237	770
Aug	368	489	116	214
Sep	263	92	21	36
Oct	310	125	36	107
Nov	368	84	113	82
Dec	98	18	30	20
Totals	5506	5511	3677	3590

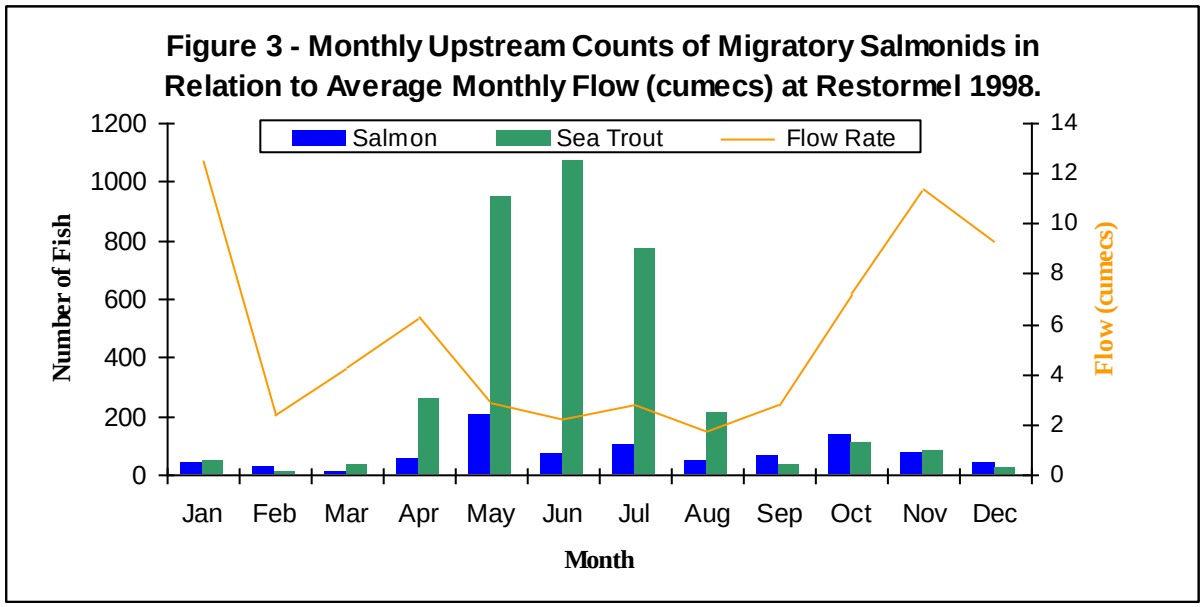
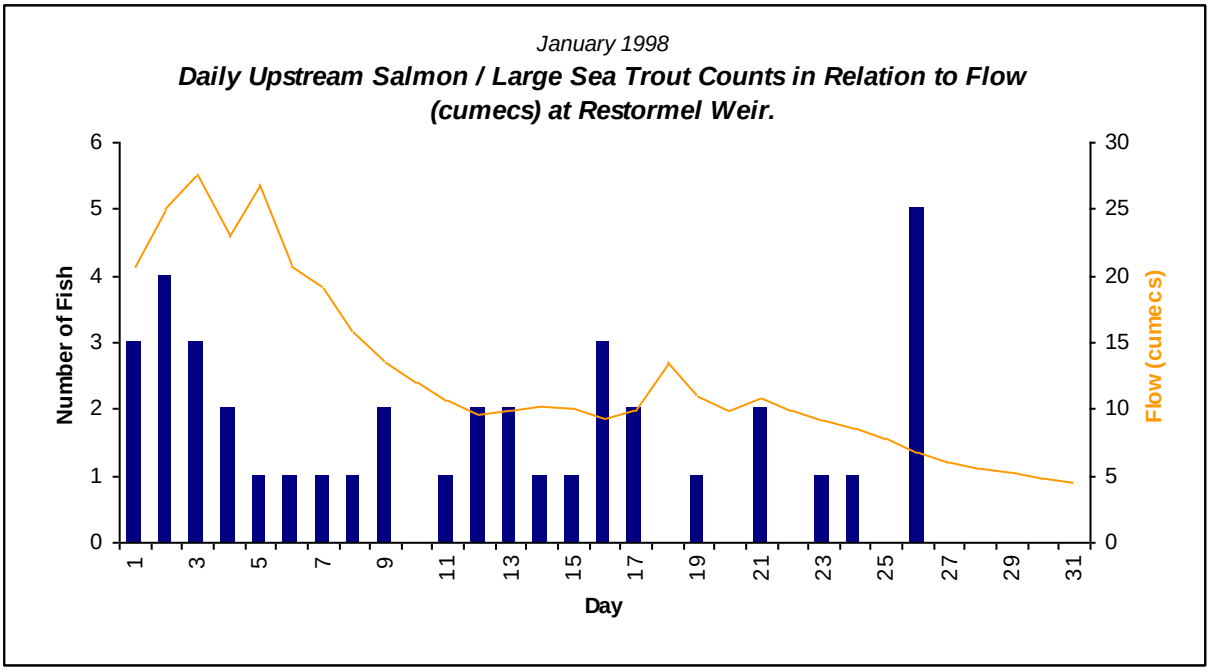


Figure 3 - Monthly Upstream Counts of Migratory Salmonids in Relation to Average Monthly Flow (cumecs) at Restormel 1998.
Salmon
Sea Trout
Flow Rate
Number of Fish
Flow (cumecs)
1200
1000
800
600
400
200
0
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Figure 4.



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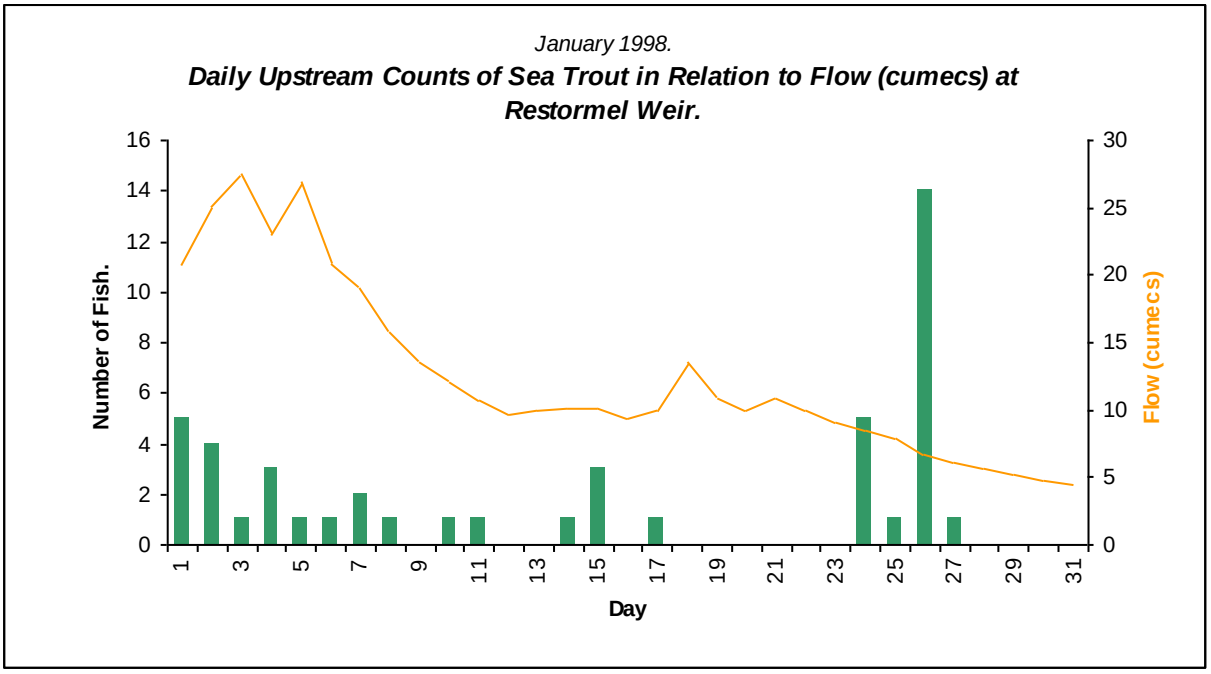
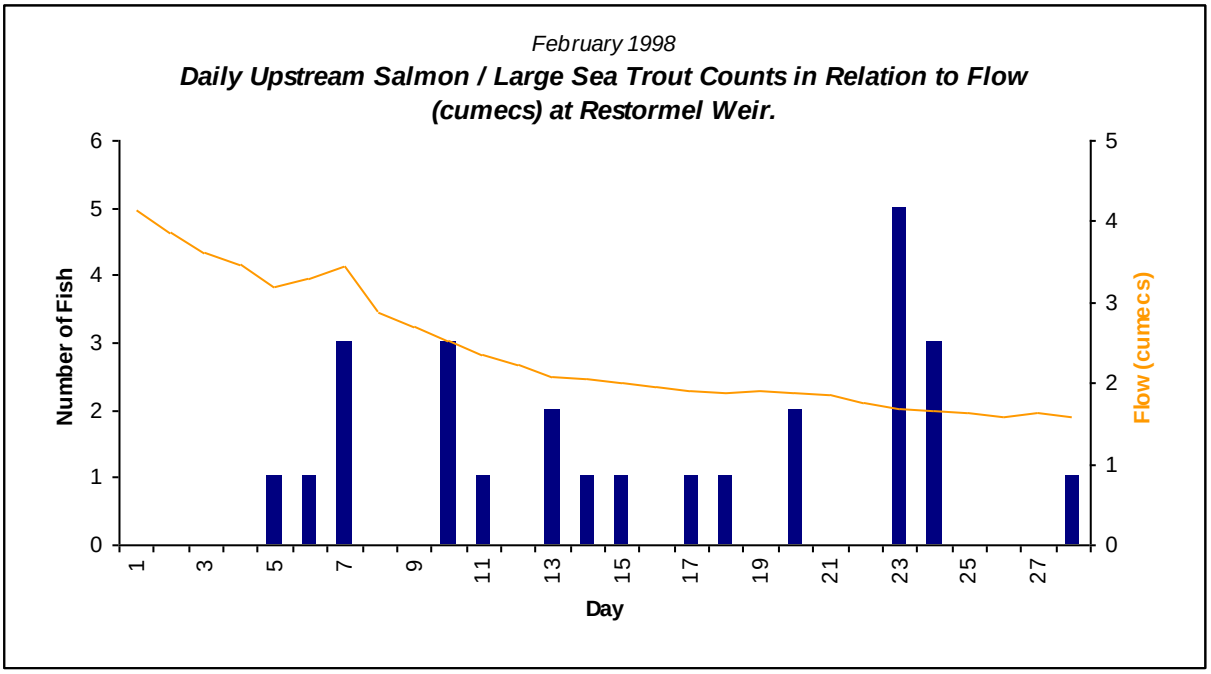


Figure 6.



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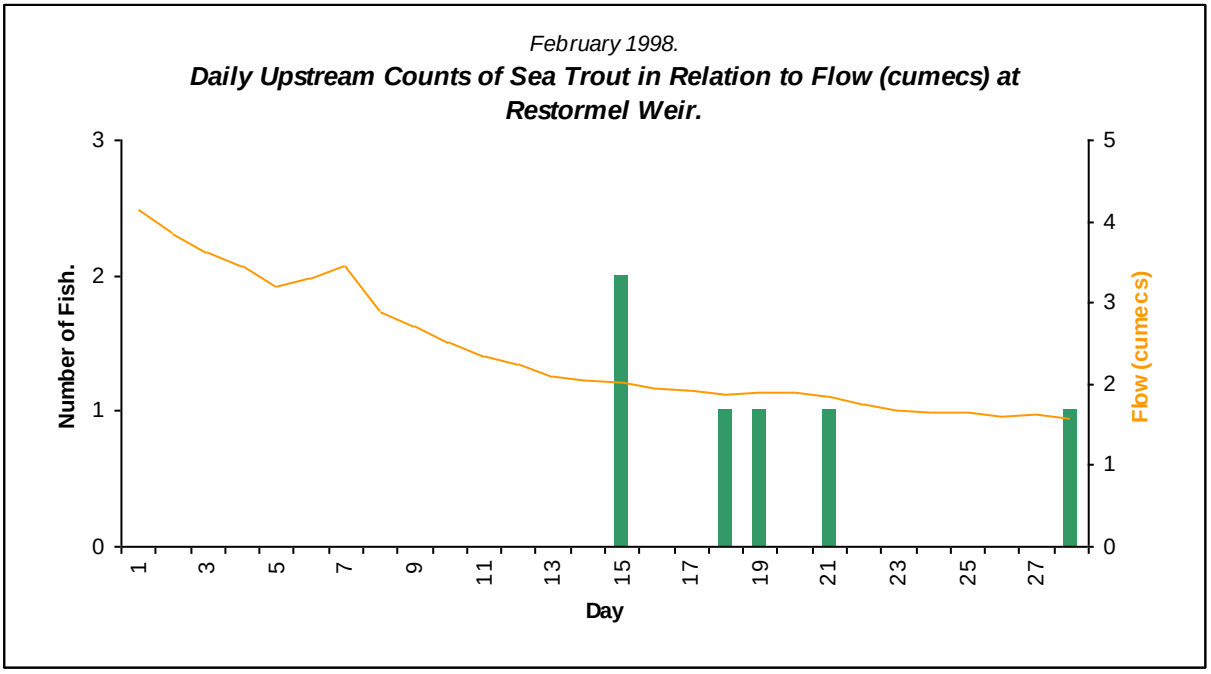

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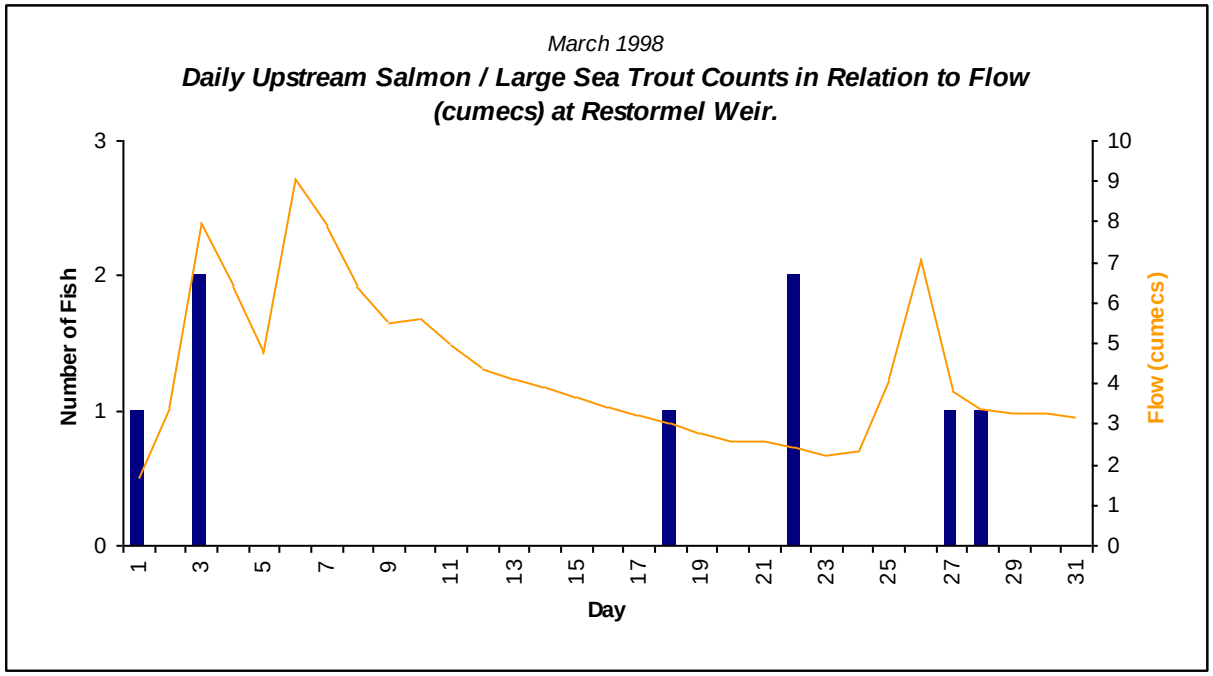

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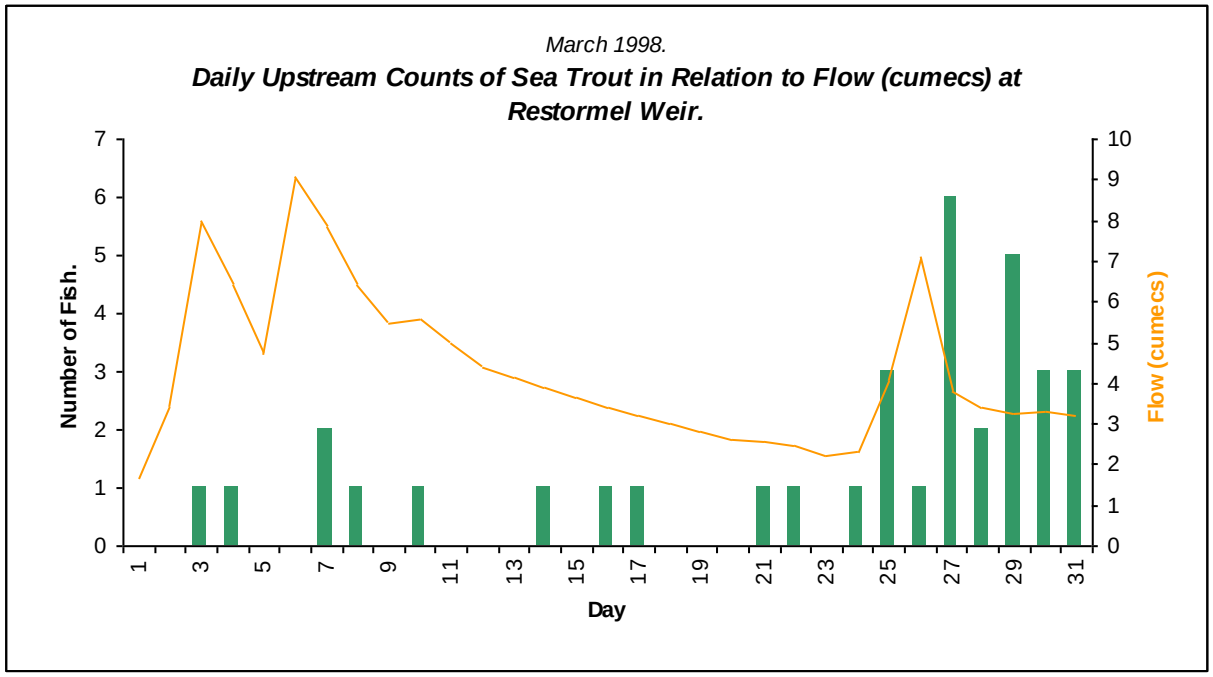

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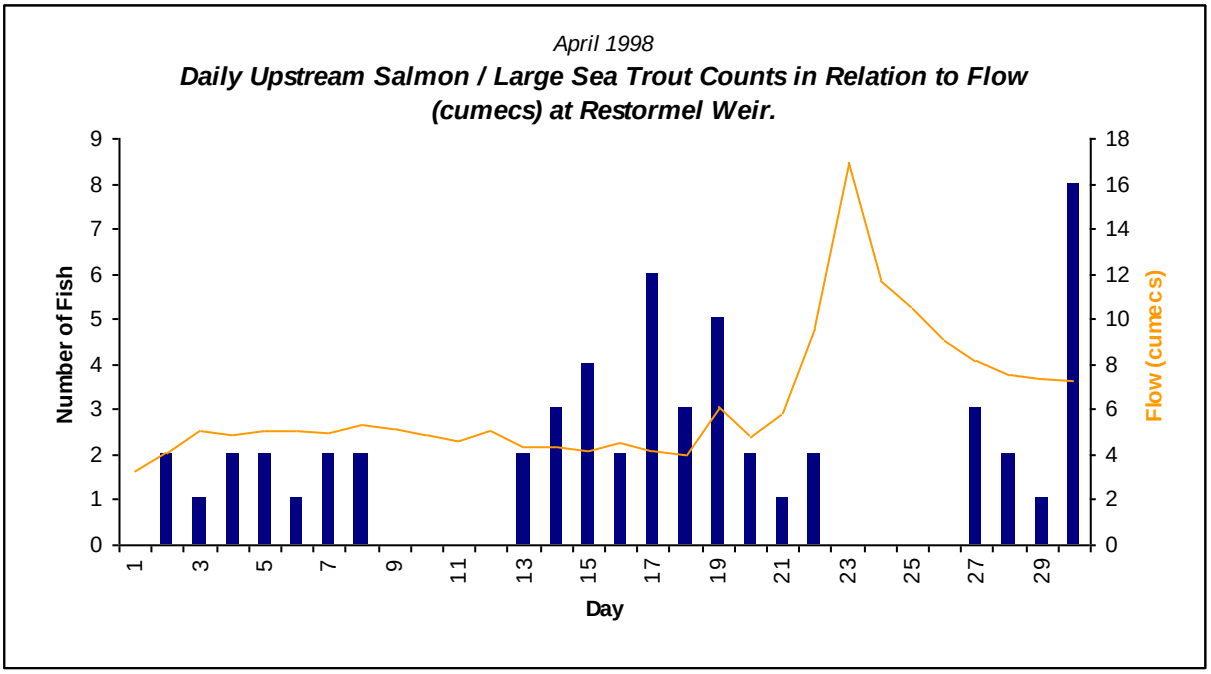

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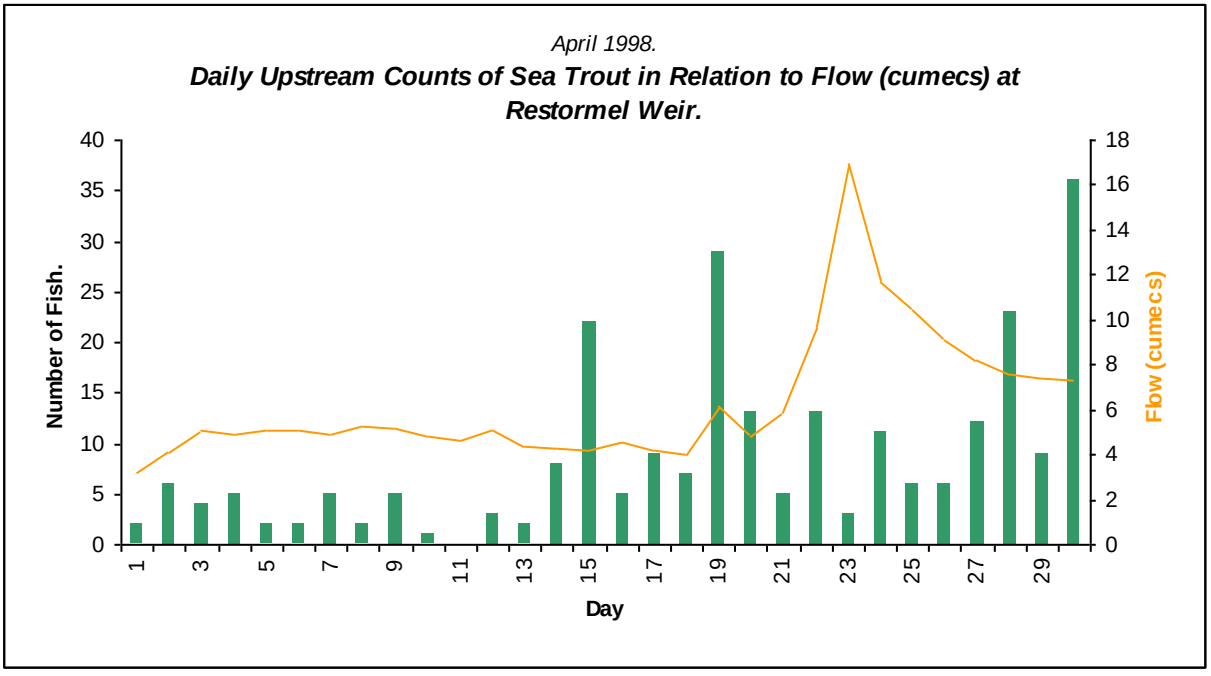
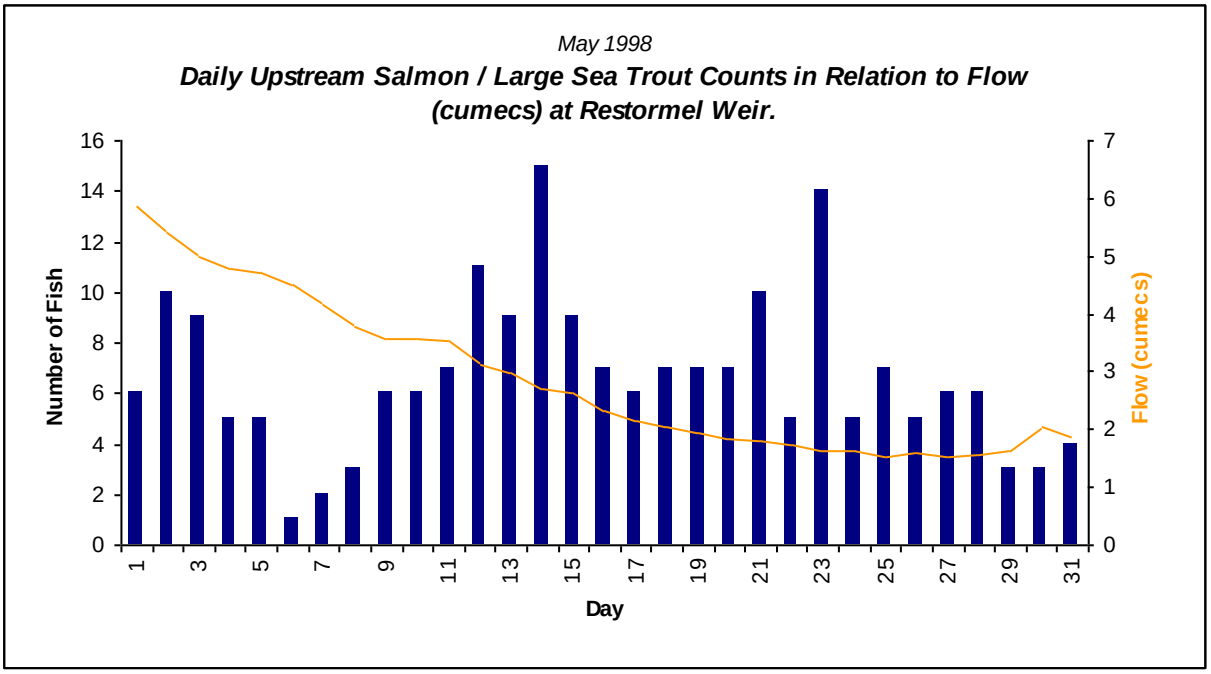


Figure 12.



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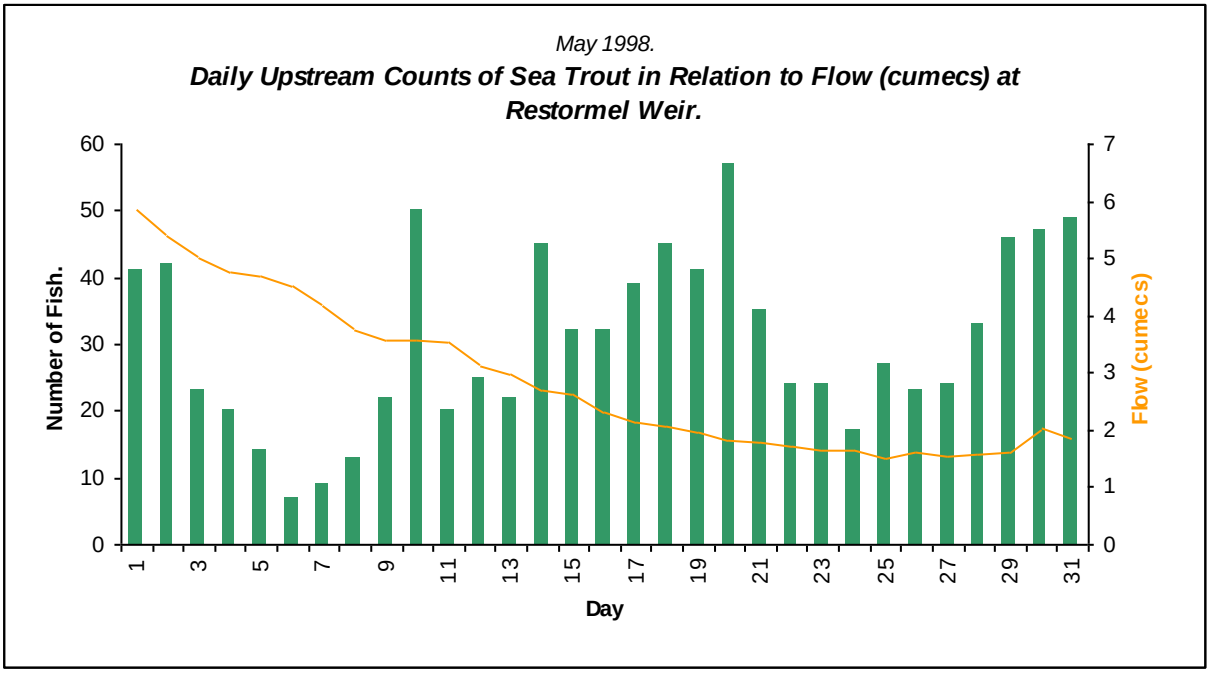

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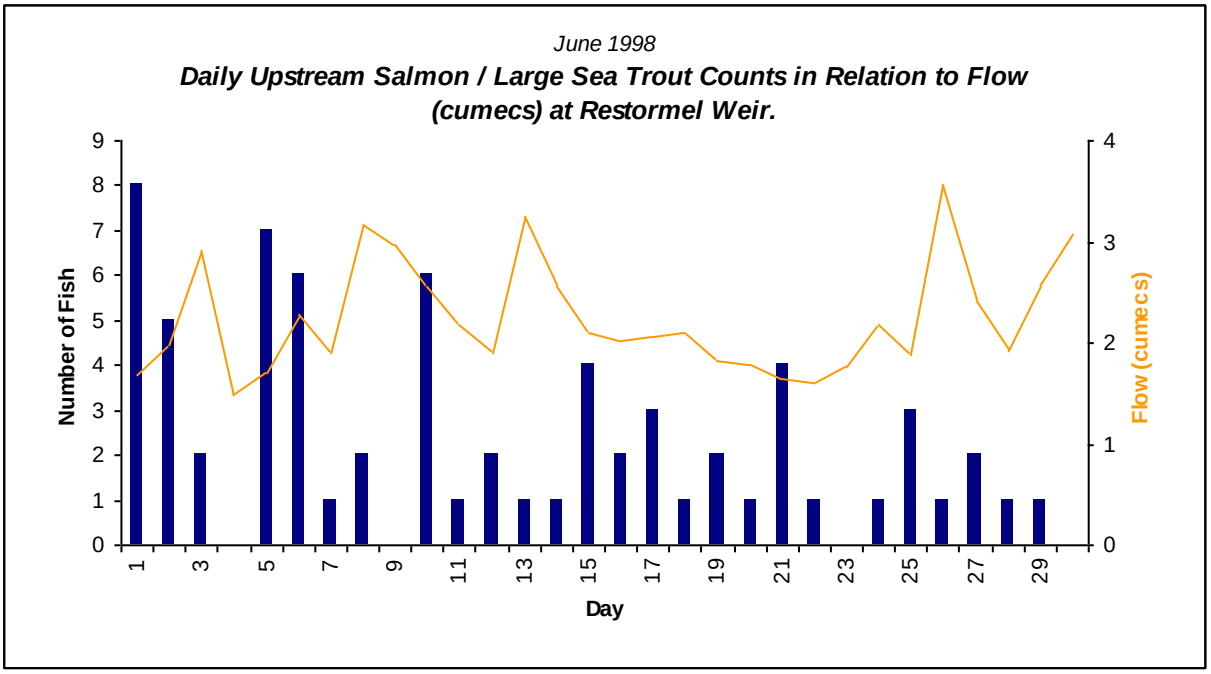

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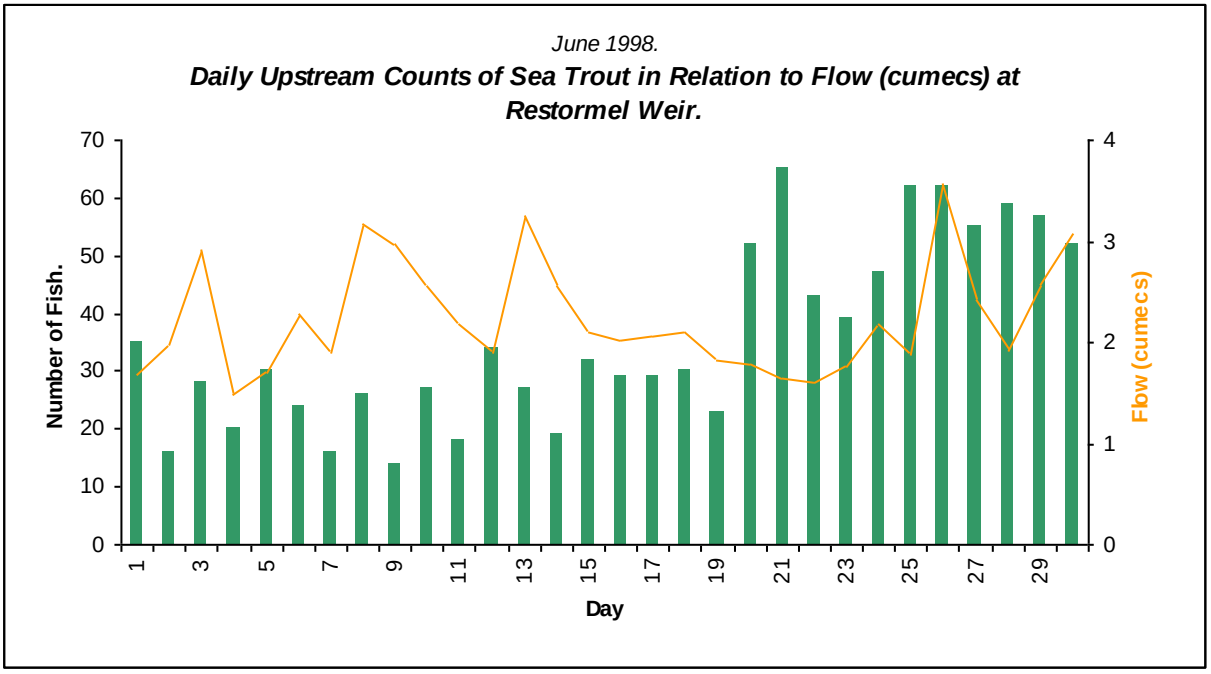

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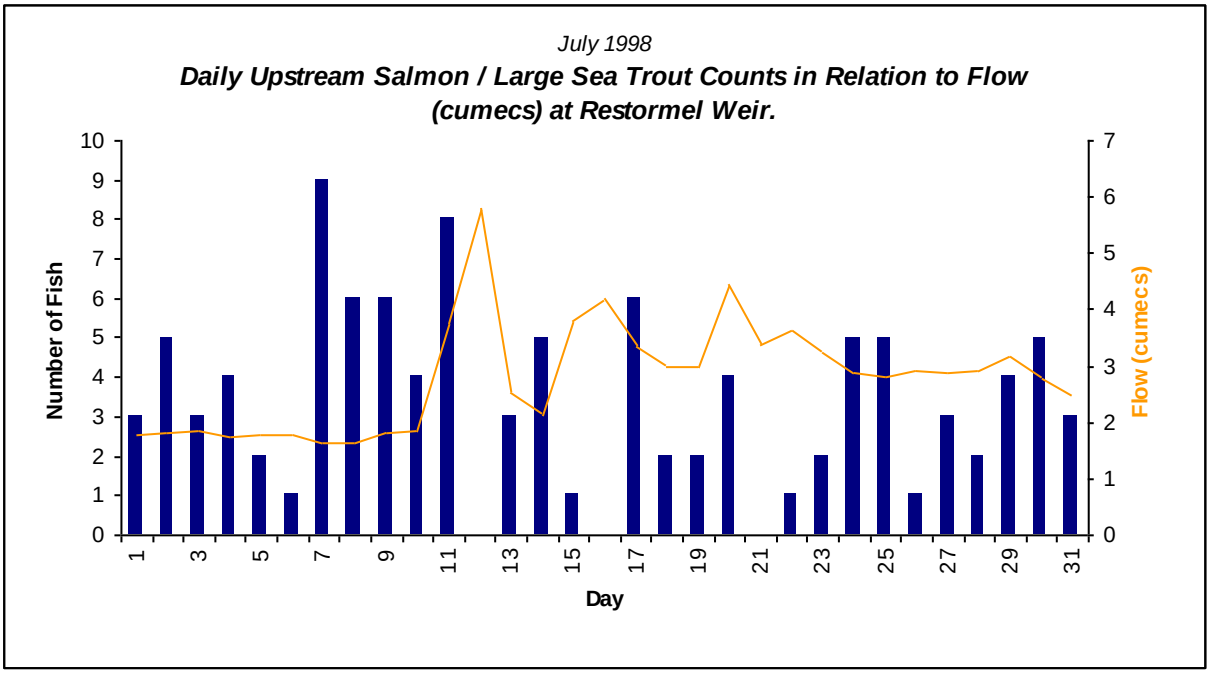

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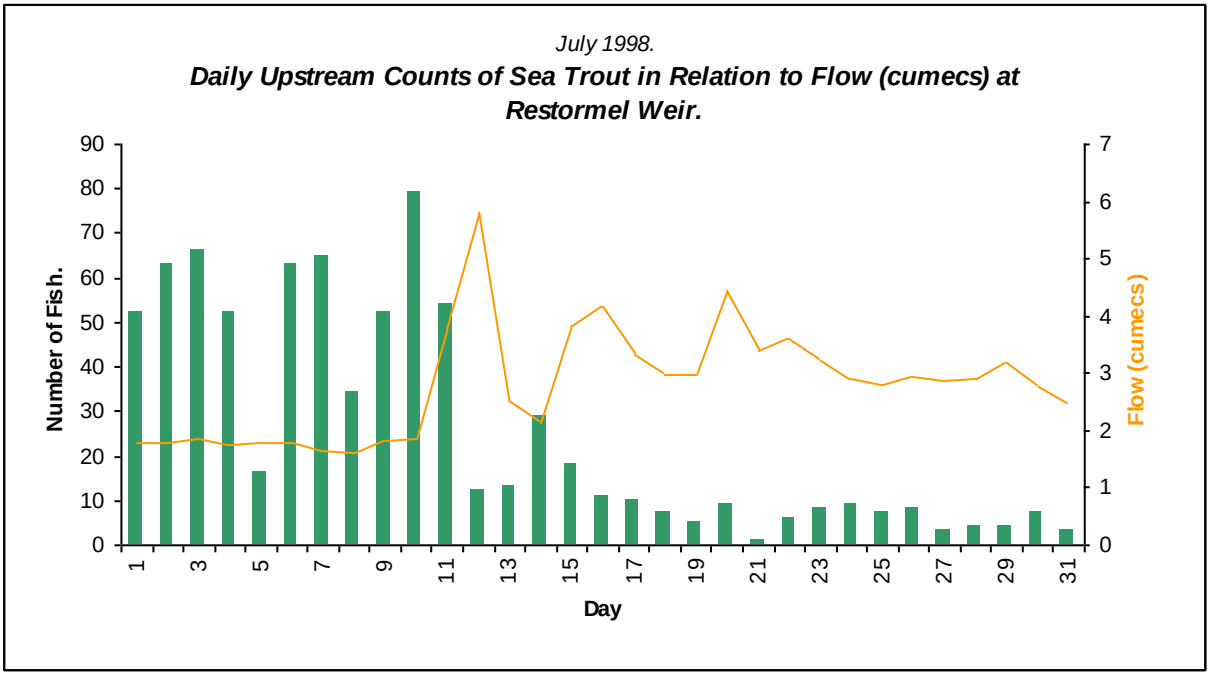

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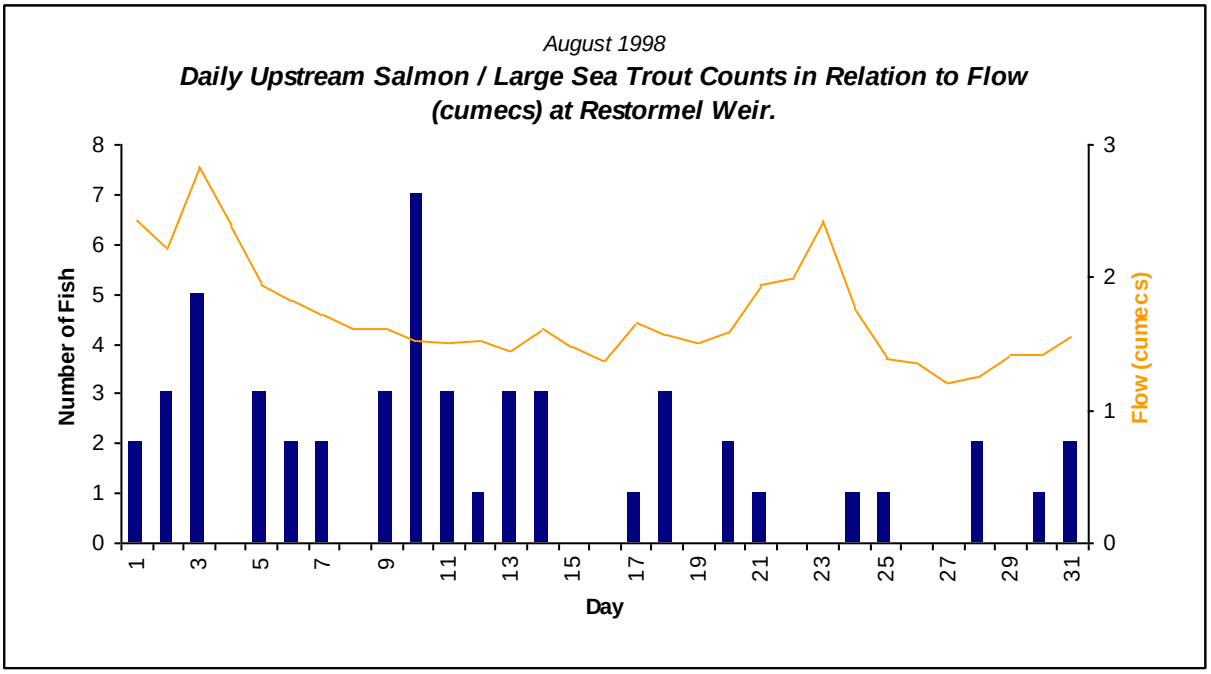

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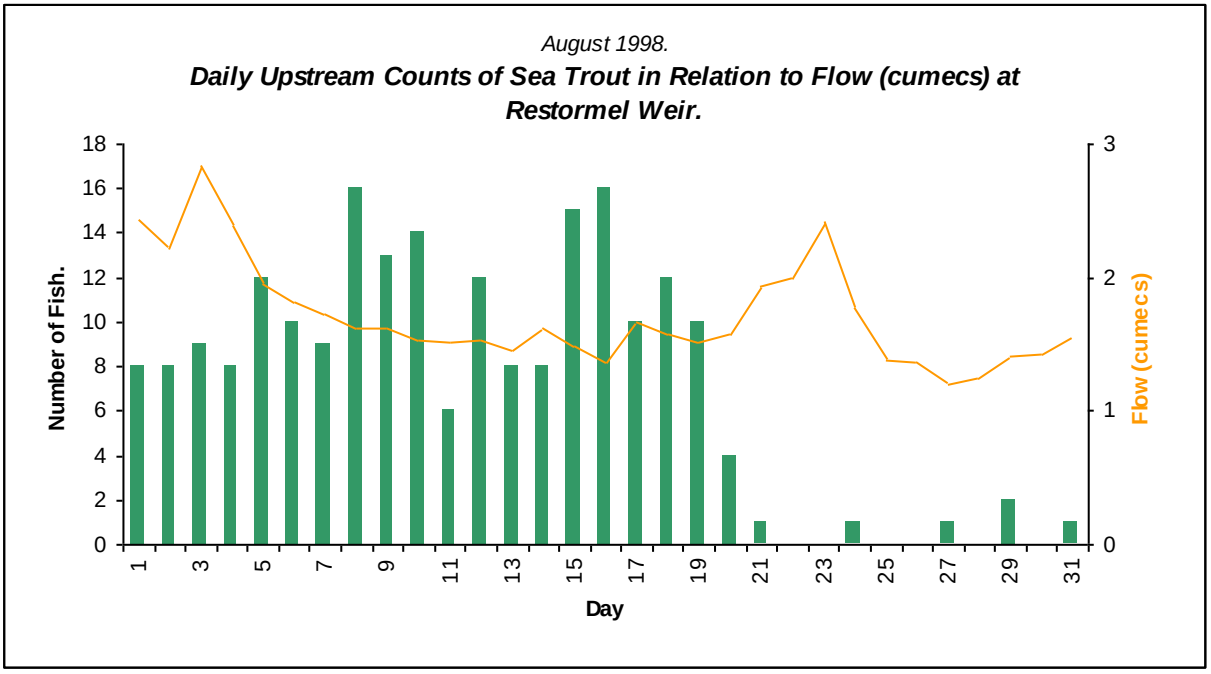
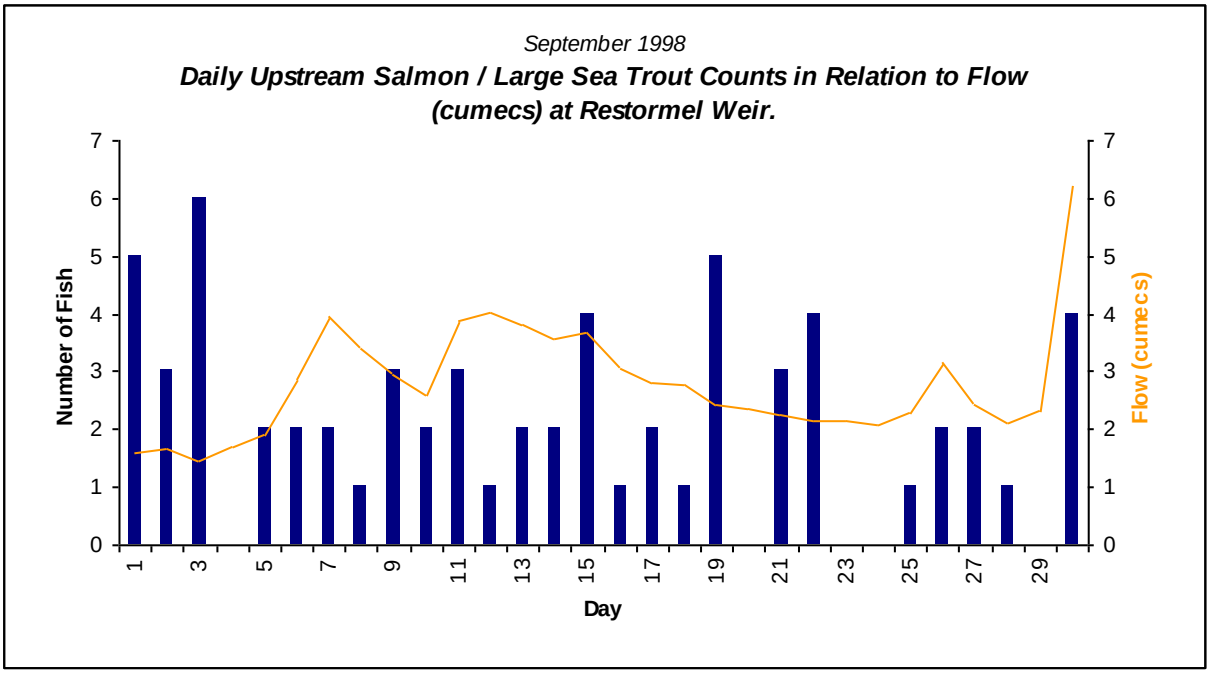


Figure 20.



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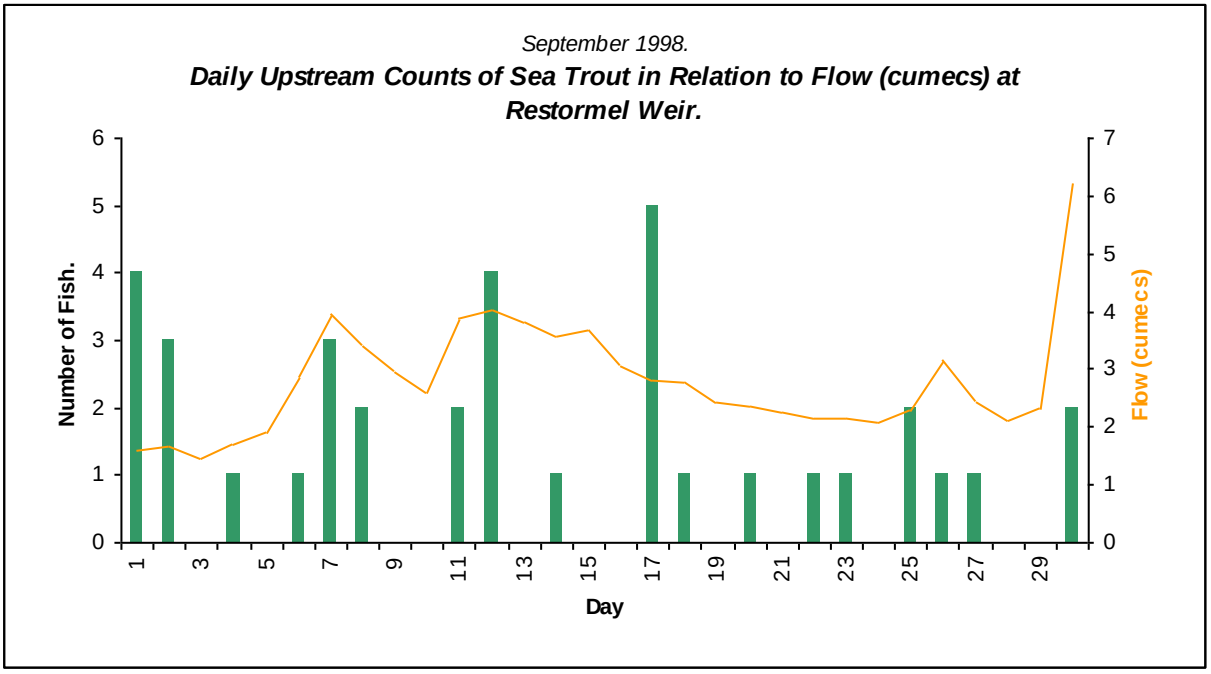

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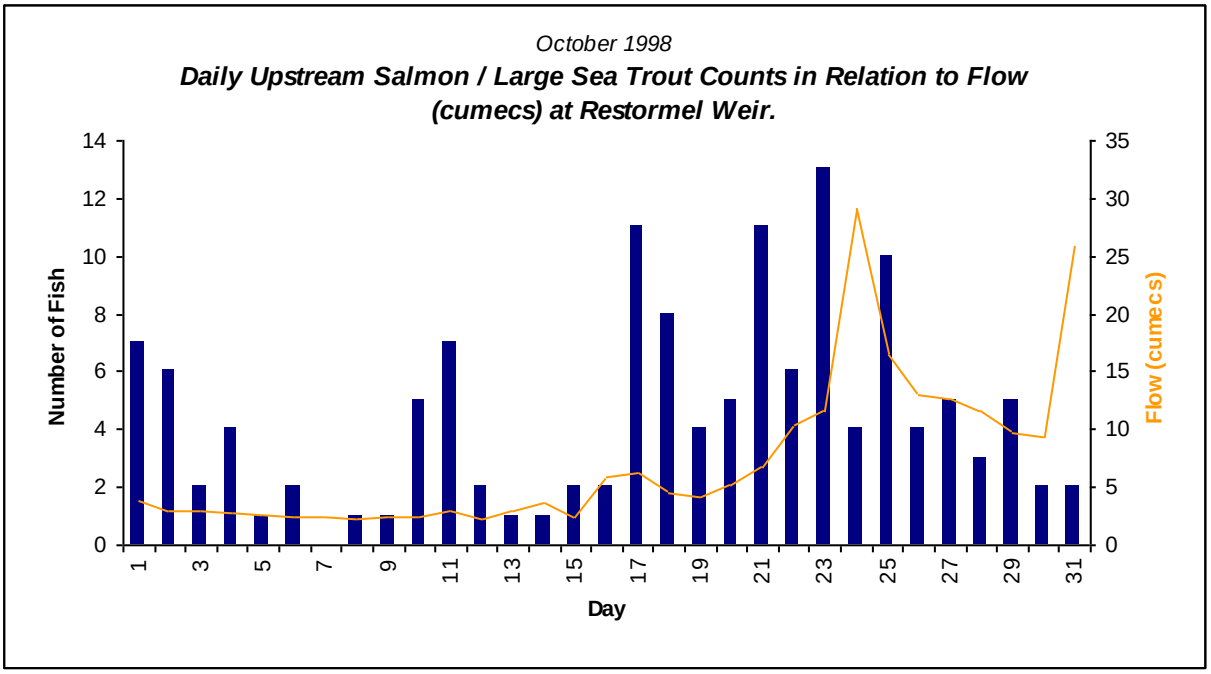

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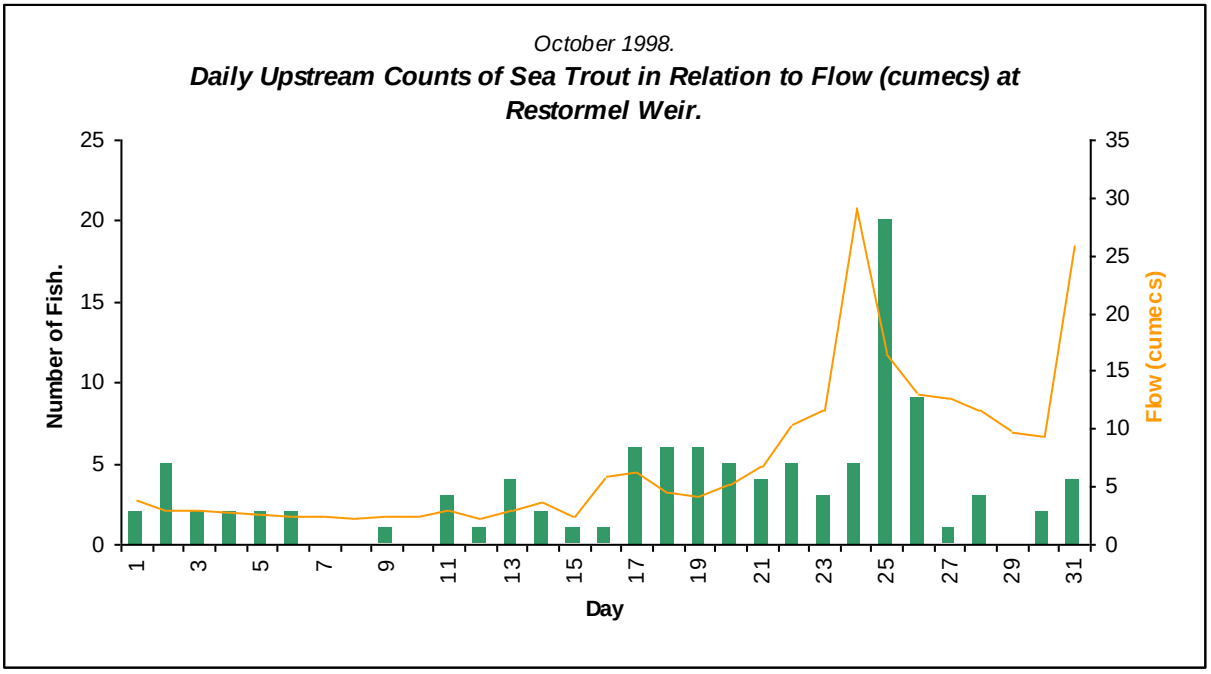
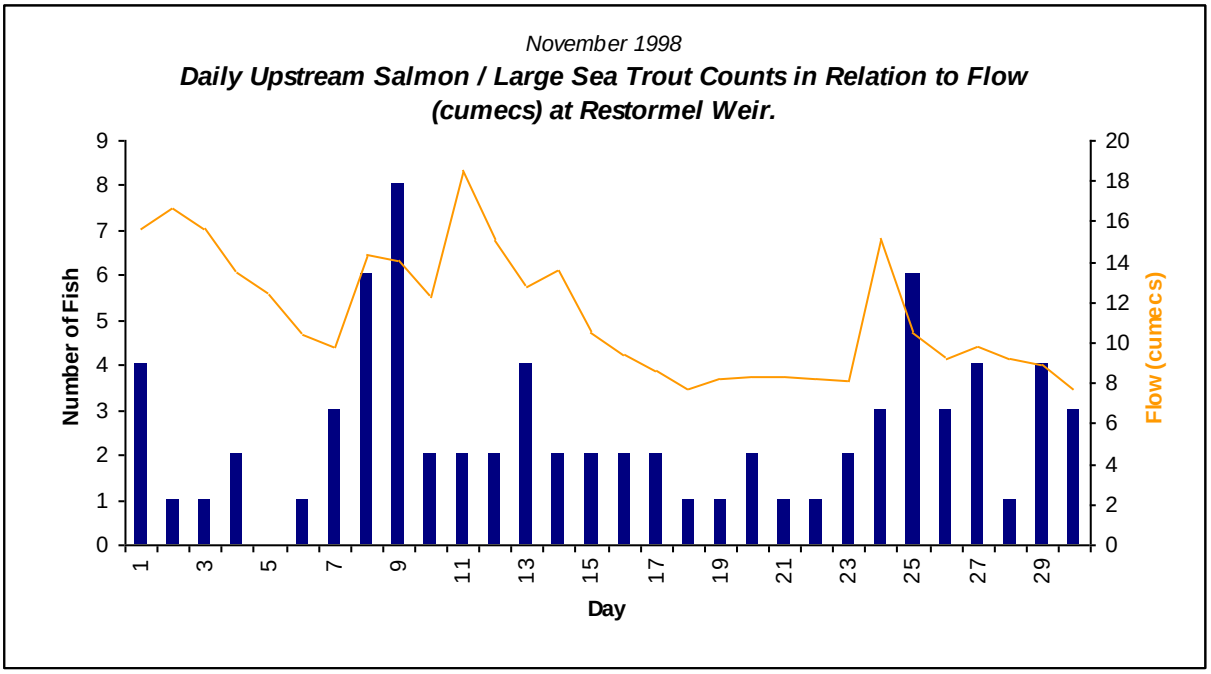


Figure 24.



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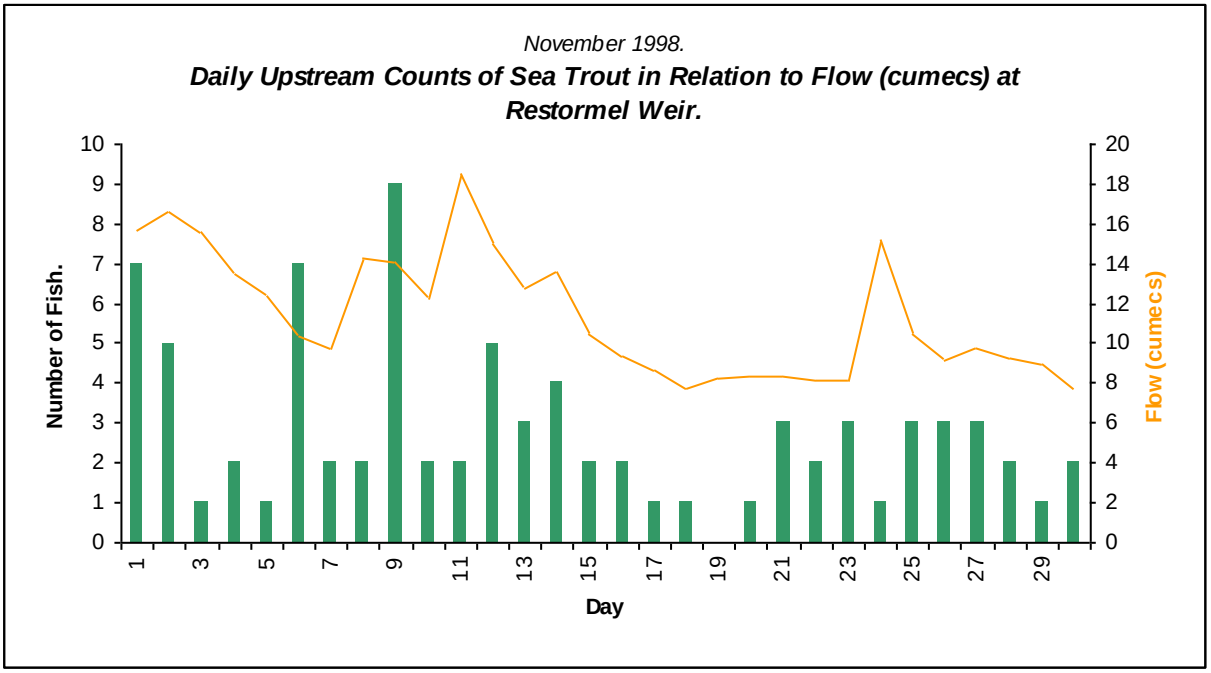


Figure 26.

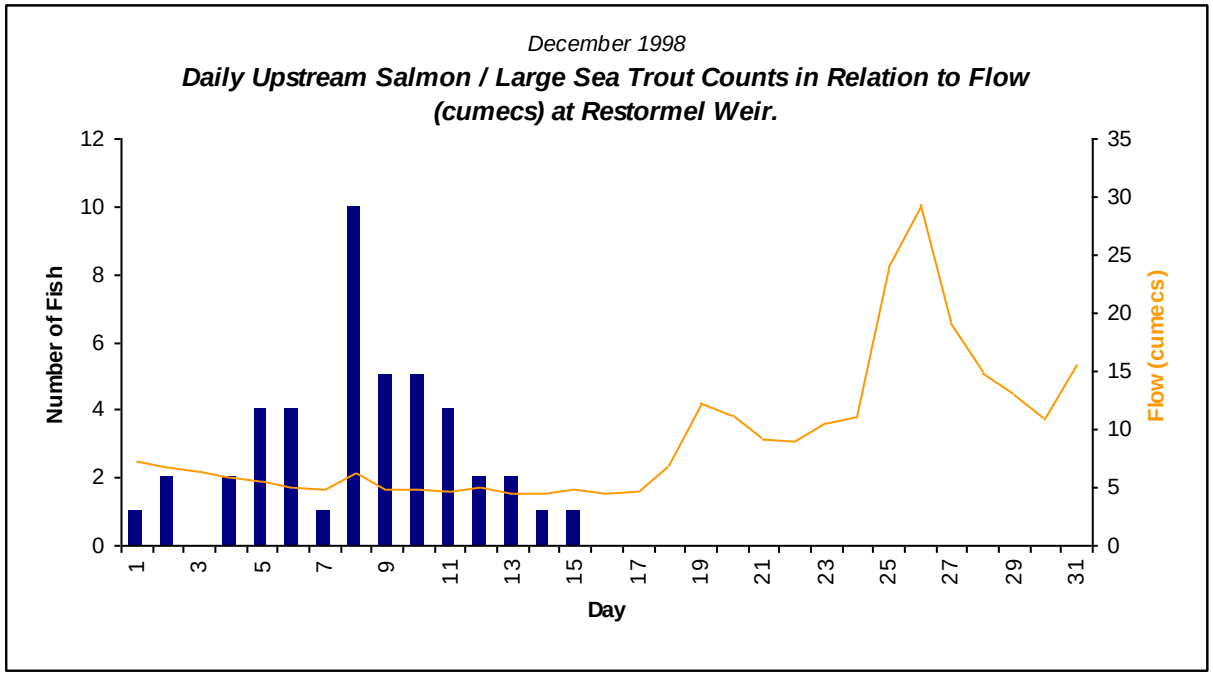
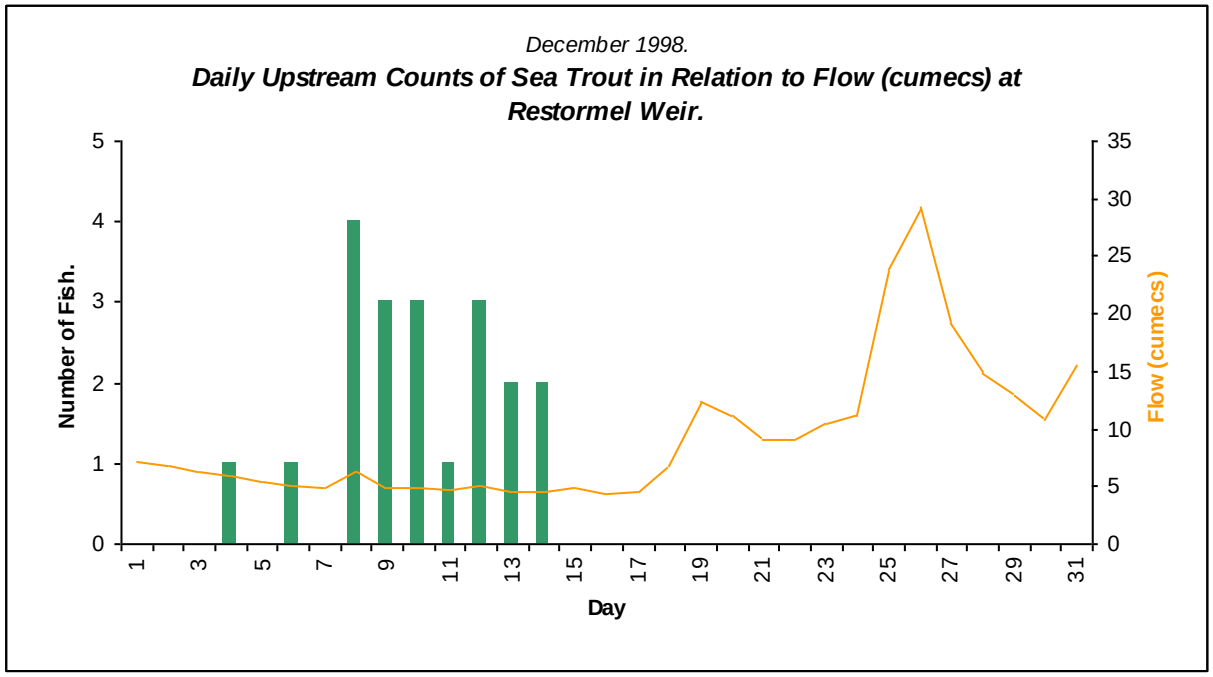


Figure 27.



8.0 APPENDICES

Appendix 1.

Operating protocol for the Logie 2100A resistivity fish counter at Restormel Weir.

To detect fish passing upstream, the Logie 2100A utilises three stainless steel electrodes that are set into the downstream face of the fish pass at Restormel Weir. The construction of the fish pass ensures a smooth laminar flow of water over the electrodes and allows the fish to ascend the weir in close proximity to the electrode array. The electrodes are set into a polythene block to reduce fluctuations in resistivity due to the structure and between the electrodes.

The counter operates by applying a low positive/negative voltage (5 volts) at high frequency to the upper (+5 volts) and lower (-5 volts) electrodes. The net voltage at the central electrode is virtually zero as the two voltages effectively cancel each other out. As a fish passes over the bottom electrode it acts as a weak electrical conductor, causing an increase in the negative voltage at the central electrode. As a fish passes over the central and upper electrode it causes an increased positive voltage at the central electrode. The net result of a fish passing over the electrode array is a typical sine wave, the amplitude of the waveform being governed by the size of the fish.

The counter processes the signal received from the electrodes and uses an algorithm, together with pre-set parameters, to assess whether the object is a fish or not. If the positive and negative parts of the waveform are similar the counter recognises the ‘event’ as a fish and logs it as either an ‘upstream’ or a ‘downstream’ fish. The counter also records information connected to the event such as date, time, direction, water conductivity and signal strength (deflection signal size). If the deflection signal does not conform to that of a ‘typical fish’, it is logged as an event or discarded. In this way the counter can distinguish between fish and inanimate objects such as leaves and twigs.

Appendix 2.

Species Apportionment and Data Analysis

Species apportionment is made on the basis of the deflection signal size that is generated by the counter when a fish passes over the electrodes on the weir. The validation study conducted in 1997 (ref: 01) using video equipment to identify and measure fish traversing the weir found a linear relationship between fish length and deflection signal size. The study concluded that a deflection signal size of 50 could be used to differentiate between the majority of salmon and sea trout between July and February (88% of all fish greater 50 cm attained a deflection size greater than 50).

Data from previous years indicated that larger sea trout run into the river from March –May. In order to eliminate these larger sea trout from the salmon count within this period the deflection signal size to differentiate salmon from sea trout is increased to 70. It must be stressed that this relationship is not 100% accurate and that some large sea trout, those greater than 70 cm, may be counted as salmon.

Appendix 3.

Table 1: Lengths and Age Classes of all Salmon Caught at Restormel Fish Trap 1979 - 1984.

Date	Age Class	Length (cm)
14-Jul-79	2.1+	55.2
10-Aug-79	2.1+	64.1
10-Aug-79	2.1+	67.1
10-Aug-79	2.1+	62.3
10-Aug-79	2.1+	65.3
10-Aug-79	2.1+	62.5
2-Aug-80	2.1+	54
16-Aug-80	2.1+	64.7
16-Aug-80	2.1+	62.8
16-Aug-80	3.1+	65.1
16-Aug-80	2.2+	80.7
29-Aug-80	Rep	67.6
29-Aug-80	2.1+	55.5
29-Aug-80	2.1+	61.8
29-Aug-80	2.1+	66.7
29-Aug-80	2.1+	60.2
30-Aug-80	2.1+	59.7
30-Aug-80	2.2+	80.8
13-Sep-80	Rep	53.9
20-Jun-81	2.2+	75.4
18-Jul-81	2.1+	58.5
18-Jul-81	2.1+	55.8
24-Jul-81	>1.1+	66.5
25-Jul-81	2.1+	59.8
1-Aug-81	3.1+	64.8
1-Aug-81	2+.2+	70
1-Aug-81	2.1+	60.2
18-Sep-81	2.1+	60.6
18-Sep-81	2+.1+	58
18-Sep-81	2.1+	63
18-Sep-81	2.1+	58.5
18-Sep-81	2.1+	49.2

Date	Age Class	Length (cm)
18-Sep-81	2.1+	64.5
18-Sep-81	2.1+	50.4
18-Sep-81	2.1+	60.4
25-Sep-82	*	62.5
25-Sep-82	*	60
25-Sep-82	*	62
26-Sep-82	*	63.6
3-Oct-83	2.1+	63.5
16-Oct-83	*	63
16-Oct-83	*	61.8
17-Oct-83	2.2+	80
17-Oct-83	Rep	64
17-Oct-83	2.1+	65
17-Oct-83	*	65.2
17-Oct-83	*	63.5
17-Oct-83	*	67.5
17-Oct-83	*	62.2
26-Sep-84	-.2+	82.3
26-Sep-84	2.1+	61.7
26-Sep-84	-.1+	64.1
26-Sep-84	2.1+	60.4
26-Sep-84	-.1+	59.9
26-Sep-84	2.1+	63
26-Sep-84	2+.1+	72.3
29-Jun-84	2.1+	61.7
30-Sep-84	2.1+	62.5
30-Sep-84	2.1+	59
30-Sep-84	-.1+	58.8
30-Sep-84	2+.1+	69.2
30-Sep-84	2.1+	63.2
30-Sep-84	2.1+	69.8

Appendix 4.

Mean Lengths of One and Multi Sea-Winter Salmon caught at Restormel Fish Trap 1979 –1984.

Age Category	Mean Length (cm)
One Sea-Winter Fish	61.62
Multi Sea-Winter Fish	78.79

Appendix 5.

Mean Lengths of all Sea Trout caught at Restormel Fish Trap 1979 – 1984.

Year	Maiden Fish			Single Spawners		Multiple Spawners								
	.+	.1+	.2+	.SM+	.1+SM+	.2SM+	.3SM+	.4SM+	.5SM+	6SM+	.1+2+SM+	.1+3SM+	.1+4SM+	.1+5SM+
1979	29.49	40.38	*	37.59	44.2	43.96	*	53.3	*	*	*	57.1	*	61.1
1980	28.61	40.24	*	36.47	45.38	41.31	49.47	50.4	57.8	*	*	*	63.2	64.9
1981	29.91	42.95	*	37.44	51.25	43.28	48.33	52.4	*	*	*	57.5	*	*
1982	29.48	41.95	*	38.09	*	46.4	*	58.2	*	*	49.9	59	*	*
1983	30.03	46.04	*	39.48	44.3	47.3	45.1	55.9	59.3	*	*	*	*	*
1984	29.21	42.58	45.3	37.63	48.58	41.9	50.18	52.1	61.5	62.2	49.9	*	*	*

Appendix 6.

Numbers of Sea Trout from each age class caught at Restormel Fish Trap 1979 – 1984.

Year	Maiden Fish			Single Spawners		Multiple Spawners								
	.+	.1+	.2+	.SM+	.1+SM+	.2SM+	.3SM+	.4SM+	.5SM+	6SM+	.1+2+SM+	.1+3SM+	.1+4SM+	.1+5SM+
1979	298	18	0	59	11	19	0	2	0	0	0	1	0	1
1980	65	53	0	76	13	17	7	1	1	0	0	0	1	1
1981	137	6	0	8	4	16	4	2	0	0	0	1	0	0
1982	17	4	0	7	0	2	0	2	0	0	1	1	0	0
1983	61	5	0	6	1	2	1	2	1	0	0	0	0	0
1984	54	6	1	7	4	4	4	2	1	1	1	0	0	0

Appendix 7

Daily Movements of Salmon and Sea Trout Recorded at Restormel Fish Counter In 1998.

Environment Agency

South West Region.

Restormel Fish Counter.

Annual Report 1998.

Cornwall Area Fisheries Science Team
March 1999.