Monitoring of the River Dee Fishery Season Extension 2009

The River Dee Trust

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Executive Summary

The River Dee was granted a licence in 2008 to extend its rod and line fishing season from 30 September to 15 October for a trial period of three years, from 2008-2010. This extension period operates under the Dee Conservation Code which requires that all caught salmon and sea trout be returned. This is a report of the second year of the three year monitoring programme to assess the potential impact of angling in October on Dee salmon stocks.

After a pilot monitoring study in 2008, full monitoring of the season extension in the Lower Dee (downstream of Banchory) was undertaken in 2009. The four methods used to assess impact of the fishery extension on the salmon population were: rod catch analysis; scale sampling; radio tracking of individual salmon; and redd count surveys.

993 salmon (grilse and Multi Sea Winter (MSW) salmon) were caught in the October 2009 fishing extension period (14% of 2009 rod catch), as well as 66 sea trout. 98.7% of October-caught salmon were released (this return rate was 1% higher than for the rest of the season). Fresh, silver salmon comprised a significantly greater component of the Lower Dee fishery than the Middle Dee fishery in October. There was also a small but significant increase in the proportion of coloured, stale fish in the Middle Dee rod catch between the last two weeks in September and the first two weeks of October. There was no such change in the Lower Dee rod catch between these two periods.

Scale samples showed that MSW salmon dominated the October rod catch in the Lower Dee (72% in 2009), with the remainder of the rod catch being grilse. Approximately three quarters of the Autumn rod catch in the Lower Dee comprised Summer and Autumn runs of fish, with the remaining quarter being Spring salmon. There was no evidence that the proportions of these stock components varied between the last two weeks in September and the first two weeks of October.

60 fish that were caught by anglers in the Lower Dee were radio tagged. Tracking of these fish found no significant difference between the movements of fish that were captured, tagged and released in the last two weeks in September compared to fish caught, tagged and released in the first two weeks of October; 66% of the tagged fish migrated further upstream, 21% showed little directional migration (less than 2 miles up- or down-stream) and 13% migrated downstream. The distribution of fish that were captured and tagged in September and October did not differ significantly; the majority (56%) remained in the Lower Dee for spawning, but 30% entered the Middle Dee (above Banchory) and 14% entered the Upper Dee (above Aboyne). On average, the tagged fish reached their final (spawning) destinations in the second week of November.

Redd count surveys highlighted that spawning occurs earlier in the Western catchment. At sites in the Upper River (Dinnet and further west), spawning started the fourth week of October. In the Middle and Lower Dee, spawning started early-mid November, and there was limited evidence that spawning was earlier in the tributaries in these areas. Spawning was recorded until the end of

December in the Lower River (and may have occurred later, but river conditions prevented further surveys being undertaken).

There was no evidence that, in the Lower Dee, capture and handling of salmon in the October extension period had any significant impact on fish survival or ability to migrate for spawning, compared to the capture of fish in the last two weeks of September. There was no evidence that Spring salmon caught in the Lower Dee fishery were negatively impacted compared to other stock components. Therefore the overall conclusion is that the October fishing extension is sustainable in the Lower Dee (downstream of Banchory).

The third year of the season extension monitoring will be undertaken in Autumn/Winter 2010, with a focus on the Middle Dee (between Aboyne Bridge and Banchory Bridge). The final decision on whether to apply for a permanent extension to the fishing season will be made in early 2011, once all data has been reviewed.

Contents

Introduction

In 2007 the Dee DSFB applied to the Scottish Government to extend the angling season from 30 September until 15 October for a trial period of three years (2008-2010). Following a public consultation, in which more than 109 out of 129 responses were in favour of the trial, the trial extension was granted from 2008. The October fishing extension would allow fishing beats to benefit from the increasing Autumn runs of salmon that the Dee has been experiencing since the 1980s (Fig. 1). In particular, numbers of multi sea winter (MSW) salmon entering the Dee in August and September, and the number of one sea winter salmon (grilse) entering the Dee from June to September, has increased (River Dee Trust 2006).

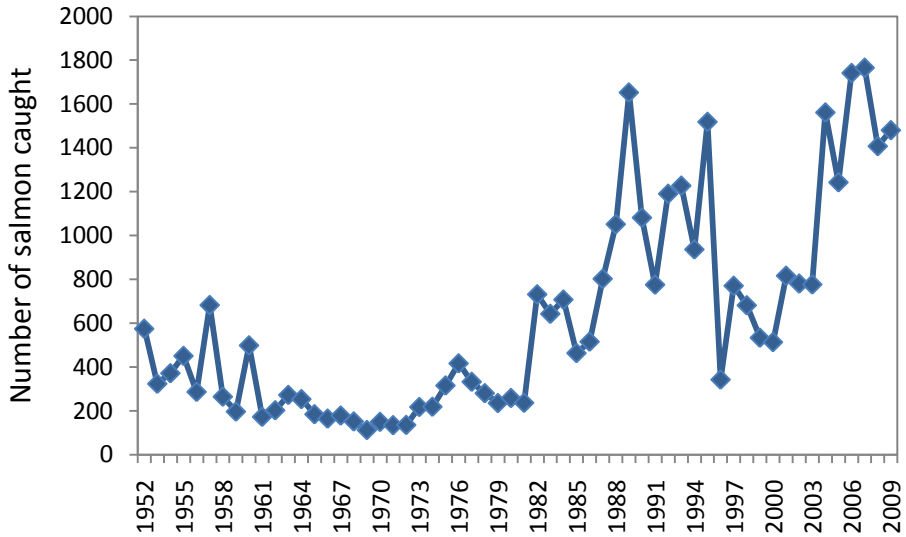


Figure 1. Rod catch of MSW salmon and grilse on the Dee in September, 1952-2009.

The October fishing extension was requested for a trial period only. During the three trial years, monitoring is being undertaken to determine whether fishing in October is sustainable or whether it has any potential to harm the Dee salmon stock. The decision to make the fishing extension permanent will be based on the findings of the monitoring. It is essential that the Dee Conservation Code policy is maintained during the season extension period; in particular that all salmon and sea trout caught must be released. The Dee DSFB are monitoring adherence to the Conservation Code closely during the trial.

The trial extension period encompasses the whole river but is restricted to downstream of Aboyne Bridge (i.e. the Middle and Lower Dee). This restriction was placed because of evidence from redd count surveys that spawning occurs earlier (late October) in the Upper Dee. There is also evidence from radio tracking studies on several rivers that salmon that enter the river earlier tend to penetrate further into the catchment (e.g. Saunders 1967, Laughton & Smith 1992). The upstream limit was thus designed to minimise impact on Spring salmon and early-spawning fish.

The pilot study conducted in 2008 was primarily to test the logistics of running a radio tracking programme (RDT 2008). Of the 20 salmon radio tagged in October 2008, there was no evidence of subsequent mortalities. However, four of the tagged fish showed no further migration upstream

after capture and handling. It was not possible to determine whether these fish were affected by capture and handling late in the season or whether they had already reached their final (spawning) destination. In 2009/10, a comparison of fish tagged in September and fish tagged in October would be able to address this concern.

In 2009 and 2010 the aims of the season extension monitoring are:

1 To assess whether fish caught by rod and line and released in the first two weeks of October have the same chance of successfully surviving to spawn as those caught in the last two weeks of September.

2 To determine if Aboyne Bridge is the correct upstream limit of the season extension.

3 To determine what stocks of salmon are being caught in the first two weeks of October and whether there is an impact on the more vulnerable stocks of spring-running salmon.

The first two elements of the monitoring programme were undertaken through a radio tracking programme and redd count surveys. A salmon scale survey and rod catch analysis addresses the third element of the programme.

In the following sections of this report the four methods of data monitoring (fishing records, scale analysis, radio tracking, redd counts,) and the results obtained are analysed.

Rod catch analysis

Introduction

To allow an assessment to be made on whether there can be a viable October fishery it is necessary to establish what the rod catch is likely to be in the October period. This includes information on the number of salmon and sea trout caught in October (collected by the Dee DSFB for the Scottish Government). It also includes the colour (freshness) of the fish caught in October, as this may have some bearing on the viability of an October fishery. To this end, the RDT conducted a survey to assess autumn rod catches from a business perspective. Note, though, that fish colouration does not indicate time until spawning and such inference cannot be made.

Methods

Numbers of fish caught in October were collated and are provided below. In addition, ghillies and angling club representatives covering 25 fishing beats recorded information on all fish caught between 15 September and 15 October 2009. This allowed a comparison to be made of rod catch in the last two weeks of the traditional season and in the final two weeks of the trial extension. In particular, colour of fish caught was recorded, categorised as either: sea liced; silver; clean; coloured; or very coloured.

Records of 621 salmon caught in the October extension (63% of total October rod catch) and 296 salmon caught in the last two weeks in September (40% of this period's rod catch) were taken by the participating ghillies and angling club representatives.

Results

Statutory catch returns reported a total of 993 salmon caught in the October extension period, of which 593 (60%) were caught in the Lower Dee, 398 in the Middle Dee and two on the Feugh. A total of 66 sea trout were also caught in this period. 98.7% of salmon caught in October were released (0.9% higher release rate than for February - September 2009) and 95.5% of the sea trout caught in October were released (the same rate as occurred between February - September 2009).

A comparison of the rod catch in the Middle Dee (between Aboyne Bridge and Banchory Bridge) and the Lower Dee (downstream of Banchory Bridge) showed a significant difference between these two river sections in the colour of fish caught, for both time periods (shown statistically; chi square; Figs. 2 and 3). In the Middle Dee there were fewer silver (fresh) fish caught in both September (10% of total catch) and October (4% of total catch) compared to the Lower Dee (34% in September, 30% in October). The proportion of coloured fish caught in the Middle Dee was very high in both September (81%) and October (92%) but much lower in the Lower Dee (53% in September, 59% in October.)

There was no significant difference in the colour of fish caught between the periods 15 - 30 Sep and 1 - 15 October in the Lower Dee (shown statistically; chi square). However, there was a small but significant increase in the proportion of coloured fish caught in the Middle Dee between 15 - 30 Sep and 1 - 15 October (shown statistically). This reflected a 10% increase in the proportion of

coloured fish caught in the Middle Dee between these two time periods and a 6% decline in the proportion of silver fish.

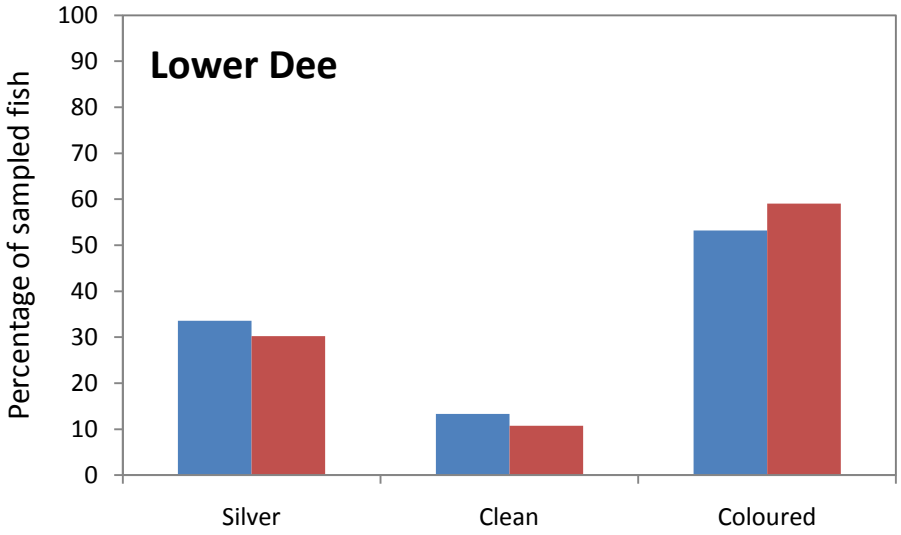


Figure 2. Colour of salmon and grilse (silver, clean or coloured) landed in the Lower Dee between 15 - 30 September (■) and 1 – 15 October (■) 2009.

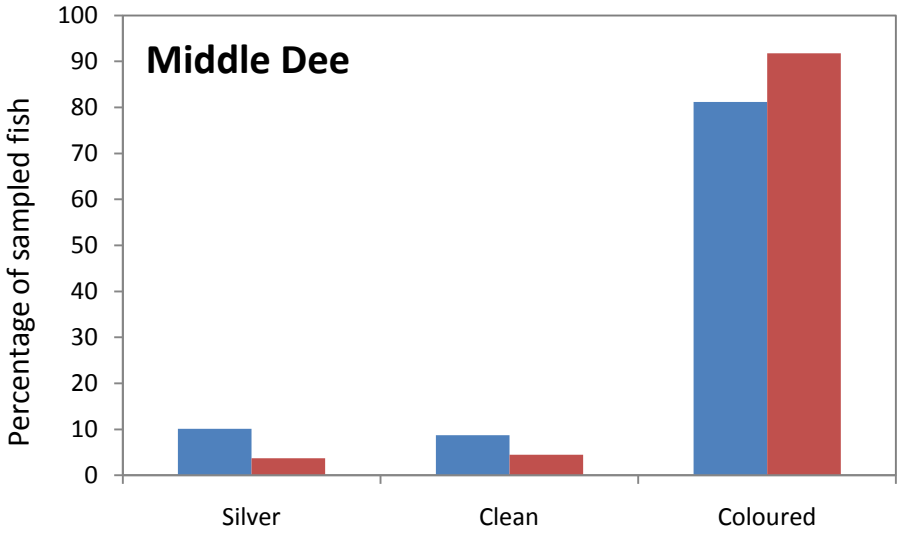


Figure 3. Colour of salmon and grilse (silver, clean or coloured) landed in the Middle Dee between 15 - 30 September (■) and 1 – 15 October (■) 2009.

The colour of sea trout caught by rod and line in the periods 15 - 30 Sep and 1 - 15 October were very similar (total of 44 sea trout sampled; Fig. 4). The majority of sea trout caught in both periods were considered to be coloured (87 and 79%) and only 7 and 14% were considered to be silver.

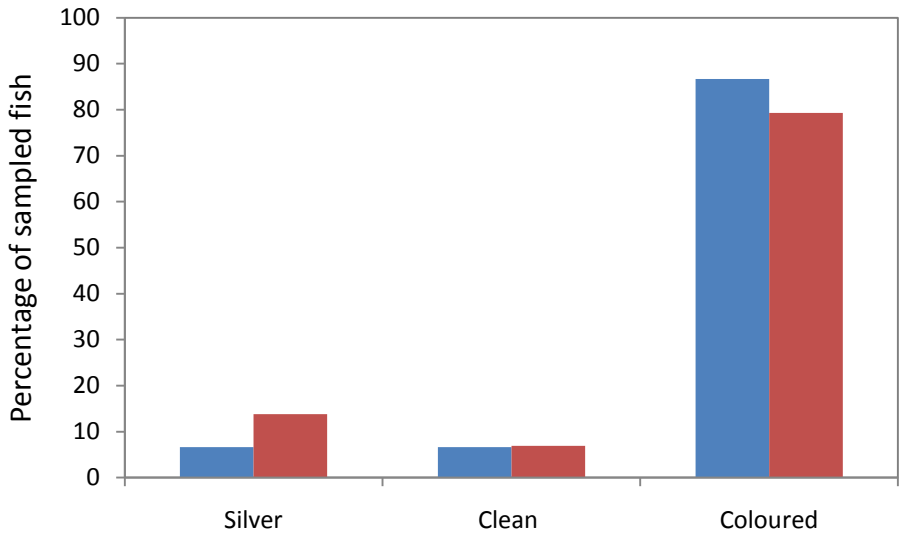


Figure 4. Colour of sea trout (silver, clean or coloured) landed in the Middle and Lower Dee between 15 - 30 September (■) and 1 – 15 October (■) 2009.

Conclusions

The number of salmon caught in the October extension period was high (nearly 14% of the total rod catch for 2009) and there was very little difference in the proportions of coloured to non-coloured fish caught between 15 - 30 September and 1 – 15 October for the Lower Dee. There was, however, a difference between the proportion of coloured fish caught in the Lower Dee (lower) and the Middle Dee (higher), and an increase in the proportion of coloured fish caught in the Middle Dee between 15 - 30 September and 1 – 15 October. This suggests that any affect of fish colouration (staleness) on business viability of the fishery will not be the same along the length of the river.

The numbers and condition of fish caught in October will vary between years and will depend on factors such as river flow levels, temperature and weather conditions prior to and during the fishing period. These factors could explain the lower proportion of silver and clean fish recorded in October 2009 (27%) compared to October 2008 (44%), for the Middle and Lower river sections combined (although note that a larger sample size was also achieved in 2009). It is important to note that the colour of the fish does not reflect the approximate time until spawning, although it tends to reflect the length of time the fish has already spent in the river.

Scale Sampling

Introduction

Scales provide information on the individual fish, including its age at smolting, the number of years it spent at sea, the approximate entry time into the river as an adult and occurrence of previous spawning. A fish scale reading programme was set up on the Dee in 2008. Scale samples are collected strategically at different locations along the main stem and this relies on the support of ghillies and angling club representatives. Analysis of scales from fish caught in October will help determine what stock components comprise the October fishery, for example, grilse (1 SW salmon) versus MSW salmon, or Spring versus Summer runs of salmon. Note that Spring salmon are fish that do not grow after their final winter at sea; scale analyses from the RDT sampling programme show that Spring salmon enter the Dee before late May - mid June.

Methods

26 ghillies, covering 28 fishing beats, collected scales from salmon and sea trout. In total, scales were obtained from 50 fish between 15 and 30 September and from 53 fish between 1 and 15 October. As few scale samples were obtained from fish caught in the Middle Dee, the analysis is restricted to samples from the Lower Dee, for the periods 15 - 30 Sep (N = 33) and 1 - 15 Oct (N = 47).

Results

MSW salmon predominate in the Autumn rod catch, for both September (58%) and October (72%) periods, with the remainder of the catch being grilse. Although there were more grilse and fewer MSW salmon in September compared to October (Fig. 5), this was not a significant difference (statistical test; chi square). A similar trend of more grilse caught in September also occurred in 2008. This trend reflects that grilse are more abundant in August and September (shown in the 2008 and 2009 scale sampling programme) but grilse decline in the rod catch by October.

The proportion of salmon in the Lower Dee rod catch that were Summer- and Autumn-entry fish were very similar between 15 - 30 September and 1 - 15 October (Fig. 6) - approximately three quarters of the rod catch were confirmed as Summer/Autumn salmon in the September (73%) and October (75%) periods. A greater proportion of the Lower Dee rod catch was confirmed as Spring salmon in the September period (21%) than in the October period (4%); however, this is thought to be an artefact of scale erosion (which progresses with time that the fish is in the river) being more severe in Spring salmon caught in October, thus making confirmation of Spring entry time difficult/impossible. As can be seen in Fig. 6, there was a greater proportion of salmon in the October period whose river entry time could only be identified as Spring or early Summer (21%) than in the September period (6%), due to scale erosion. Therefore, overall, approximately one quarter of the Lower Dee rod catch in the Autumn period was probably Spring salmon.

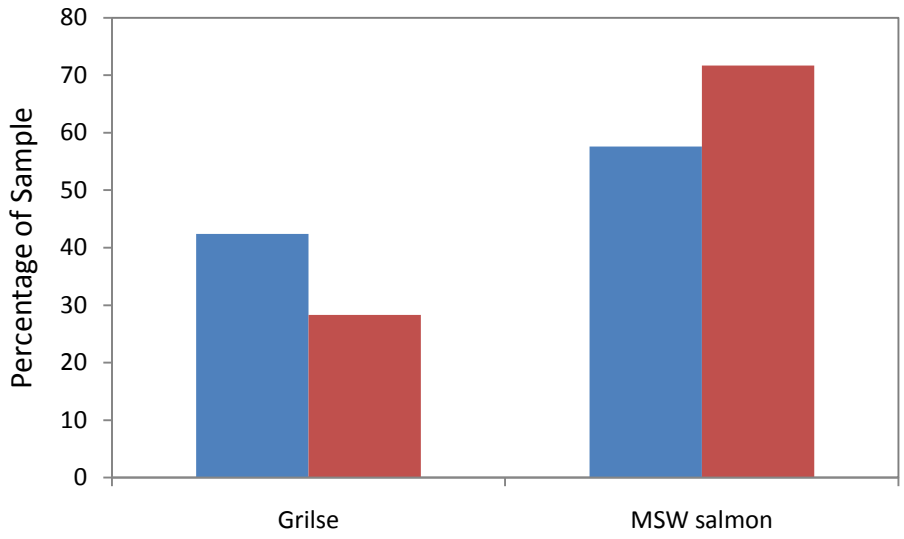


Figure 5. Percentage of grilse and MSW salmon scale sampled in the Lower Dee between 15 - 30 September (■) and 1 – 15 October (■) 2009.

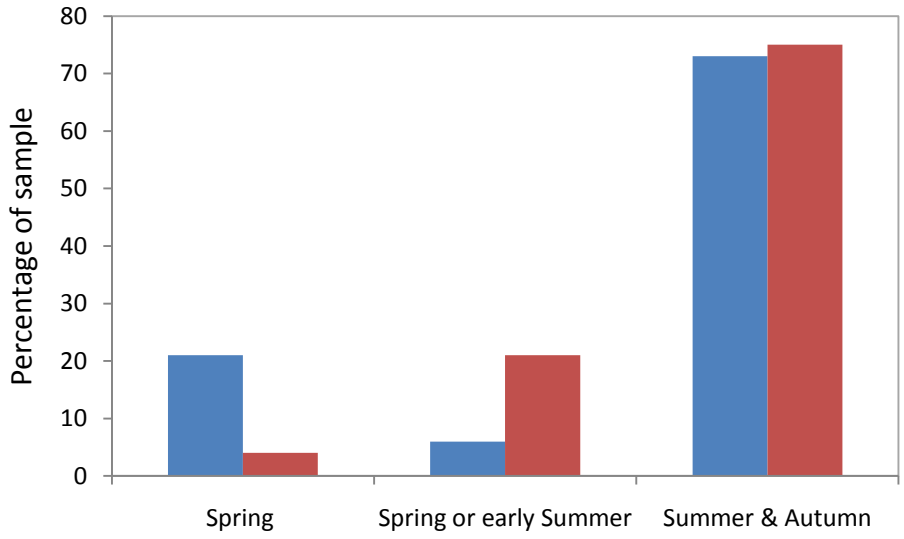


Figure 6. Time of entry into the river of salmon caught in the Lower Dee between 15 - 30 September (■) and 1 – 15 October (■) 2009.

Conclusions

The October fishery in the Lower Dee comprises mostly MSW salmon (72% in 2009). Over the last two years of the study, there has been a tendency for more MSW salmon in the October rod catch than in the September rod catch, although this difference is weak and not statistically significant. It likely reflects the greater influence of the grilse runs in September.

Spring salmon appear to comprise a significant component of the Lower Dee's Autumn fishery - approximately 25% (note, this could be confirmed for fish caught in the period 15 - 30 September but due to scale erosion is presumed for fish caught between 1 - 15 October). The remainder of the stock are Summer- and Autumn-entry salmon.

Too few fish were sampled in the Middle Dee to assess the Spring salmon component in the Autumn fishery. It is considered likely that the Middle Dee has a greater Spring salmon component than the Lower Dee, based on a greater proportion of Spring salmon occurring in the Middle Dee rod catch between June and September (22%) than in the Lower Dee over this period (7%; River Dee Trust 2009). A trend for more Spring salmon in the Middle Dee catch compared to the Lower Dee catch was also found in the scale sampling carried out in October 2008 (RDT 2008).

The existence of a substantial Spring salmon component in the Lower Dee in the Autumn is important additional information, as evidence also shows that Spring salmon predominate in the Upper Dee (based on previous radio tracking studies and fish traps run by Marine Scotland). The current radio tracking project may help determine whether the Spring salmon component in the Lower Dee fishery are still to make a final spawning migration into the upper catchment or if there is a significant breeding stock of Spring fish in the Lower Dee.

Radio Tracking

Introduction

Radio tracking allows movements of individual fish over a period of time to be established. Radio tracking can therefore address whether angling and handling of fish at different times of the year has different impacts on fishes' subsequent behaviour and movements. A previous radio tracking study on the Dee (Smith et al 1998) found no evidence of mortality of fresh salmon that were angled in October. However, the Lower Dee comprises more than just fresh fish, indeed, surveys in 2009 (see previous sections of report) suggests that more than half of the Lower River's October fishery is comprised of non-fresh runs of fish, including Spring salmon. It is unknown what impact angling and handling these fish could have to their subsequent behaviour.

Radio tracking studies in other Scottish rivers (e.g. Saunders 1967, Laughton & Smith 1992) suggest that fresh fish caught in an October fishery will not migrate upstream long distances. This would imply that any fishing in the Lower Dee is likely to target the Lower Dee salmon stock. Smith et al's (1998) radio tracking study on the Dee also found that fresh October fish tend to stay in the Lower Dee and spawn. This was again found in the pilot study in 2008, although 17% (three fish) moved into the Upper Dee. Thus, whilst these late-run salmon did not penetrate the very top of the catchment, the Lower Dee autumn rod catch did comprise Middle and Upper Dee stock. If there was any impact of angling in October on salmon, the impact could therefore be widespread.

The radio tracking study carried out by the RDT and Dee DSFB in Autumn/Winter 2009 had the following aim:

(i) To determine if fish caught in the first two weeks in October show the same ability to migrate and reach spawning grounds as fish caught in the last two weeks in September.

Methods

Equipment

In Autumn 2009 60 fish were tagged with digitally encoded radio transmitters. These radio 'tags' emit distinct numerical codes. All the tags transmitted codes on a single frequency. The tags were 16 mm diameter x 46 mm length, had a weight in water of 6.7 g and an estimated operational life of 641 days. The tag codes are detected by receivers that automatically scan for the transmitter codes with the aid of directional (yagi) antennae. Two types of receivers were used for this project: (1) manual tracking receivers and (2) fixed station data loggers.

(1) Manual tracking receivers automatically scan at the correct frequency and when a transmitter code is detected the corresponding tag number is displayed on the receiver. Tracking was carried out on foot and in vehicles and code numbers and location were recorded by the tracker. Two manual trackers were used in the project.

(2) Fixed station data loggers automatically scan the correct frequency and create a record of the date, time, tag number and relative signal strength when a transmitter code is detected. This data is downloaded to a laptop. Data loggers can detect signals from multiple yagi antennae, allowing it to be determined from where the signal is being sent. In this project we deployed five data loggers, each with one or two antennae.

Tagging

Fish were tagged on fishing beats in the Lower Dee (Crathes Castle, Lower Crathes & West Durris, Park North & South, Upper Drum & Lower Durris, Middle Drum, Altries & Lower Drum), between 15 and 31 km (9 - 19 miles) upstream of the river mouth.

29 fish were tagged between 15 - 30 September 2009 and 31 fish between 1 – 15 October 2009 (Tables 1 and 2; NB, 30 fish were initially tagged in each month, however a tag from a September fish (tag 54) was found in early October and so was re-used in an additional October-caught fish).

Tracking of Fish

Manual tracking was carried out from 18 September - 18 December and from 8 - 29 January. Tracking was carried out by Dee DSFB staff, in a vehicle and on foot, with the antennae fixed to the top of the vehicle. Tracking was undertaken twice a week, with the entire main stem from Aberdeen to Aboyne covered on each track. Additional tracking was carried out in November and early December, in particular, covering tributaries and 'difficult' main stem areas (such as around islands).

The five data loggers were positioned at the following locations:

1. Aberdeen (ADAA bothy, Pots & Fords)
2. Park (Upper Kirks)
3. Lower Feugh (antennae covering the Feugh and the main stem at Banchory Lodge)
4. Beltie burn (antennae covering the Beltie and the main stem at Inchmarlo)
5. Craigendinnie (antennae covering the base of the River Tanar and main stem above Aboyne)

The data loggers ran continuously from 15 September until end of February 2010. However, failure of the data logger on the Feugh (which was eventually returned to the manufacturer for repair) meant that the data logger on the Beltie burn was moved in November to cover the Feugh position. Data loggers at Aberdeen, Park and the Feugh will be maintained until April 2010, to track kelt movements.

Fish

Equal numbers of males and females were tagged in the September and October periods. Sizes of tagged fish ranged from 55 cm /22" to 98 cm/39" length. Information on individual fish is provided in Tables 1 and 2.

The fish comprising the September-tagged group included 11 grilse (39%), 11 2 SW salmon (39%) and five 3 SW salmon (18%). One of the September fish could not be aged due to severe scale erosion (but was a minimum of 2 SW) and for one fish no scales could be removed because of

scale re-absorption. Of the fish tagged in October, there were fewer grilse (6; 19%), more 2 SW salmon (15; 48%) and two (6%) 3 SW salmon. There were also a greater number of fish (8; 26%) that could not be aged due to scale erosion (these fish were a minimum of 2 SW).

Based on scale readings, the approximate entry times of the tagged fish into the river were:

- 21% of September-tagged fish and 19% of October-tagged fish were Autumn entrants
- 46% of September-tagged fish and 48% of October-tagged fish were Summer entrants
- 25% of September-tagged fish and 6% of October-tagged fish were Spring entrants
- 7% of September-tagged fish and 26% of October-tagged fish could not be confirmed (due to scale erosion) but were either Spring or early Summer entrants.

The low number of Spring salmon tagged in October is probably an artefact of scale erosion having progressed on Spring salmon scales to a greater extent by this time in the season, such that confirmation of Spring entry time was not possible. This is supported by the higher proportion of October fish whose entry time could not be ascertained. Overall, the proportion of Spring, Summer and Autumn entrants in the September and October groups of fish are probably very similar.

There were slightly more silver (fresh) fish tagged in September than October (31% versus 23% of the groups) and slightly more 'clean' fish tagged in October than September (39% versus 28%). The proportion of coloured (stale) fish tagged in September and October were very similar (41% versus 39%) but most of the October fish were considered to be 'very' coloured, whereas none of the September fish were.

Examination of fish showed that no females were close to spawning, although five females had (slightly) protruding vents (these five fish were caught on 18 Sep, 23 Sep, 1 Oct and 7 Oct). Note that one of these females was silver and two were clean, demonstrating the lack of relationship between fish colour and propensity to spawn. No males showed evidence of milt production.

Table 1. Information on fish radio tagged 15 - 30 September 2009

Tag no.	Date of tagging	Tagging Location (Pool location)	Length cm (inches)	Sex	Description	FW age*	SW age†	River Entry
30	15 Sep	U. Drum (Kirks)	74 (29.5)	M	Silver, S.L.	2	1+	Autumn
31	15 Sep	L. Durris (Pipeline)	57 (23)	M	Silver	2	1+	Summer
32	15 Sep	Park (House)	89 (35.5)	M	Clean	3	3	Spring
33	16 Sep	Park (Bulwark)	98 (39)	M	Clean	2	3(+)	Spring/ Summer
34	16 Sep	Altries (Hut)	78 (31)	M	Clean	2	2+	Summer
35	16 Sep	M. Drum (Lawson)	83 (33)	M	Clean	2	2+	Summer
36	16 Sep	Park (U Kirk)	85 (34)	M	Coloured	-	-	-
37	17 Sep	Park (Castleton)	80.5 (32)	M	Coloured	3	3	Spring
38	17 Sep	L. Crathes (Mill)	65 (26)	F	Silver	2	1+	Autumn
39	18 Sep	Park (Bridge)	77 (31)	F	Coloured	?	2	Spring
40	18 Sep	L. Crathes (Mill)	85 (34)	F	Coloured; Vent protrusion	3	3	Spring
41	21 Sep	Park (Greenbank)	76.5 (30.6)	F	Clean	2	2+	Summer
42	22 Sep	Park (Bridge)	68.5 (27.5)	M	Coloured	2	2	Spring
43	22 Sep	Park (Long)	84 (33.5)	M	Coloured	?	3	Spring
44	22 Sep	U. Drum (U Fenty)	68.5 (27.5)	F	Clean	2	1+	Summer
45	22 Sep	Park (Durris Stream)	59.5 (24)	F	Silver, S.L.	2	1+	Autumn
46	22 Sep	L. Durris (Pipeline)	56 (22.5)	M	Coloured	2	1+	Summer
47	23 Sep	Park (Long)	81.5 (32.5)	M	Coloured	2	2++	Spring/ Summer
48	23 Sep	Park (Coopers)	62 (25)	M	Coloured	2	1+	Summer
49	23 Sep	L. Crathes (Mill)	77.5 (31)	F	Silver	2	2+	Summer
50	23 Sep	L. Crathes (Mill)	80 (32)	F	Coloured; Vent protrusion	?	2+	Summer
51	23 Sep	Park (Bakebare)	59 (23.5)	F	Silver	2	1+	Autumn
52	23 Sep	L. Crathes (Mill)	82 (33)	F	Clean	2	2+	Summer
53	23 Sep	L. Crathes (Mill)	67 (27)	M	Coloured	2	1+	Summer
55	24 Sep	Park (Greenbank)	61 (24.5)	F	Silver	2	1+	Autumn
56	24 Sep	U. Drum (Kirks)	63 (25)	M	Coloured	3	2	Spring
57	24 Sep	Park (House)	55 (22)	F	Silver	3	1+	Autumn
58	28 Sep	L. Crathes (Kelpie)	73.5 (29.5)	F	Silver	?	2+	Summer
59	28 Sep	U. Drum (Neave's cast)	73 (29)	F	Clean	3	2+	Summer

* FW: years spent in fresh water prior to smolting. ? denotes that FW age could not be determined due to scale regeneration.

† SW: years spent at sea. '+' denotes summer growth at sea occurred after the final Sea Winter (i.e. the fish was a Summer or Autumn river entrant). '2++' means that the fish spent a minimum of 2 winters at sea and the following summer, so is aged minimum of 2+ but possibly 3 or 3+.

Table 2. Information on fish radio tagged 1 - 15 October 2009

Tag no.	Date of tagging	Tagging Location (pool name)	Length cm (inches)	Sex	Description	FW age*	SW age†	River Entry
60	01 Oct	Park (House)	80 (32)	F	Clean; Vent protrusion	?	2+	Summer
61	01 Oct	M Drum (Lawson)	91 (36.5)	M	V coloured	?	2++	Spring/ Summer
62	01 Oct	L Durris (Lodge)	62 (25)	F	Silver; Vent protrusion	2	1+	Summer
63	02 Oct	U Drum (Craiglug)	94 (37.5)	M	V. coloured	?	2+	Summer
64	02 Oct	L Crathes (U Bridge)	70.5 (28)	M	Coloured	2	2++	Spring/ Summer
65	05 Oct	M Drum (Cairnton)	80 (32)	F	Clean	2	2+	Summer
66	05 Oct	L Durris (Boat)	88 (35)	M	V. coloured	3	2++	Spring/ Summer
67	05 Oct	L Durris (Boat)	88 (35)	M	V. coloured	2	2++	Spring/ Summer
68	05 Oct	Park (U kirks)	94 (37.5)	M	V. coloured	2	2++	Spring/ Summer
69	05 Oct	Park (Cellar)	79.5 (32)	F	Clean	2	2+	Summer
70	05 Oct	Altries (Hut)	91 (36.5)	M	V. coloured	2	2++	Spring/ Summer
71	05 Oct	L Durris (Boat)	75 (30)	M	Silver, S.L.	2	2+	Autumn
72	05 Oct	Crathes castle (Floating banks)	82 (33)	F	Coloured	3	2+	Summer
73	05 Oct	Park (House)	86 (34.5)	M	V. coloured	3	3	Spring
74	05 Oct	L Durris (Otter)	77 (31)	F	Clean	1	2+	Summer
75	05 Oct	Altries (Donal Garth)	77.5 (31)	F	Silver	3	2+	Summer
76	06 Oct	Park (Durris stream)	72.5 (29)	M	Clean	2	1+	Autumn
77	06 Oct	L Durris (Boat)	80.5 (32)	F	Silver	?	2+	Autumn
78	06 Oct	Park (U kirks)	79 (31.5)	F	Silver	?	2+	Autumn
79	06 Oct	Park (Bakebare)	64 (25.5)	M	Silver, S.L.	?	1+	Autumn
80	06 Oct	Park (Bakebare)	79 (31.5)	M	V. coloured	2	3	Spring
81	06 Oct	L Durris (L Fenty)	82 (33)	F	Clean	2	2+	Summer
82	06 Oct	L Durris (L Fenty)	79 (31.5)	F	Clean	?	2+	Summer
83	06 Oct	L Durris (U Fenty)	61 (24.5)	F	Silver	?	1+	Autumn
84	06 Oct	Park (Coopers)	80 (32)	F	Clean	3	2+	Summer
85	07 Oct	L Durris (Boat)	68.5 (27.5)	M	Clean	?	1+	Autumn
86	07 Oct	M Drum (Lawson)	63 (25)	M	Clean	2	1+	Summer
87	07 Oct	L Crathes (Bulwarks)	79 (31.5)	F	Coloured	2	2+	Summer
88	07 Oct	L Durris (L Fenty)	80.5 (32)	M	V. coloured	2	2++	Spring/ Summer
89	07 Oct	U Drum (Kirks)	77 (31)	F	Clean; Vent protrusion	3	2++	Spring/ Summer
54	08 Oct	L Durris (U Fenty)	74 (29.5)	F	Pink	3	2+	Summer

*,† See footnotes to Table 1.

Results

Fish behaviours

57 of the 60 tagged salmon (95%) were tracked through their spawning period, although this included two fish that were lost in November after migrating upstream and subsequently dropping downstream and two fish that died in tributaries in November (see Table 3). The remaining three fish that were 'lost' from the study included two fish that were lost in October (though both had moved upstream since tagging) and one fish that was lost in November, after moving only downstream. 45 of the tagged fish (75%) were tracked into January 2010.

There was no significant difference in the number of September- and October-tagged fish that migrated upstream, showed no directional migration or migrated downstream (shown statistically; chi square). In total, 20 of September-tagged fish (69%) showed upstream migration after tagging, as did 20 of the fish tagged in October (65%). Five September-tagged fish (17%) and three October-tagged fish (10%) showed downstream migration after tagging (males and females), although three of these fish subsequently moved upstream again. The remainder (14% of September-tagged fish and 29% of October-tagged fish) showed no significant directional movement, but stayed within 3 km (2 miles) of the tagging site.

Seven fish entered tributaries at spawning time (these included both September- and October-tagged fish): Two males went into the River Tanar, a female and a male went into the Beltie burn, one male went into the River Muick and one female went into the Dinnet burn. The seventh fish entered the Pollagach burn (between Dinnet and Ballater) but left the tributary a week later and continued upstream, to its probable spawning destination. At least three of these fish died in the tributaries.

The movement of each tagged fish (excluding the three lost fish) is shown in Fig. 7. The movements and behaviour shown by these tagged fish could be categorised by the following groups:

1. Long distance upstream migration. This included ten September-tagged fish and 12 October-tagged fish (39% of all tagged fish). These fish reached their upstream location between mid October and late November (average 2nd week in November), and migrated between 11.4 and 62 km (7 - 39 miles), average 30.6 km (19 miles), since tagging. The majority of these fish were males that were Spring or early Summer river entrants.

2. Short distance upstream migration. This included three September-tagged fish and four October-tagged fish (12% of all tagged fish). Fish travelled an average of 7.8 km (5 miles) upstream after tagging and reached their upstream destination by (average) mid November. The fish in this group were both male and female and varied in river entry time. One male fish (tag 35) showed a final upstream movement in mid January but it is thought that its primary spawning period was before this movement.

3. Late upstream migration. This included two Autumn-entry, female fish, tagged in October (4% of all tagged fish). They reached their upstream locations on 21 Jan and 6 Feb, after migrating 13 and 30 km since they were tagged.

4. Little directional migration. This group included six September-tagged fish and eight October-tagged fish (25% of all tagged fish). These fish travelled 3 km (2 miles) or less from the site of capture and tagging (upstream or downstream). This group was predominantly females (11 out of 14 fish). This group had a range of river entry times. Because of the almost total lack of movement of three of the fish (one September- and two October-tagged fish; see Table 3), it is considered possible that these three fish may have regurgitated their tag near the tagging site; hence movements of these fish are uncertain.

5. Early, short distance upstream migration and return. This group included four September-tagged fish and one October-tagged fish (9% of all tagged fish). The upstream migration of these fish ranged from 3 to 17 km (2 – 11 miles) but for all fish, the migration occurred around mid-October, with subsequent downstream migration occurring within 2 days. This group of fish included both sexes and had a range of ages and river entry times. It may be that this early upstream migration was not necessarily part of their final spawning movements but exploratory in nature; however, this could not be confirmed. All of this group were tracked until Dec /Feb.

6. Downstream migration only. This group included two September-tagged fish and two October-tagged fish (7% of all tagged fish). Downstream migration started in October and the group included two Summer-entry females and two Spring/early Summer- entry males. All fish were tracked until the end of January.

7. Downstream migration followed by upstream migration. This group included two September-tagged fish and one October-tagged fish (5% of all tagged fish). The downstream migrations of two of these fish occurred during floods in late October/early November. After dropping between 6 and 16 km (4 – 10 miles), all three fish were recorded close to their original tagging site later in the season.

Fish tagged in both September and October periods showed the complete range of behaviour categories, outlined above. The only exception was that the ‘late upstream migration’ behaviour was seen in two October-tagged fish but no September-tagged fish. Generally, these behavioural groups comprised males and females, both grilse and MSW salmon, which had entered the river throughout the year. In particular, there was no ‘type’ of fish that migrated downstream only after tagging. However, the fish that showed little directional migration were mostly females (11 out of 14 fish), of which ten of these females were 2 SW fish that had entered the river in the Summer. It was also noted that most of the fish that migrated upstream long distances were males (15 out of 22 fish).

Table 3a. Summary of movements of fish radio tagged 15 – 30 September 2009

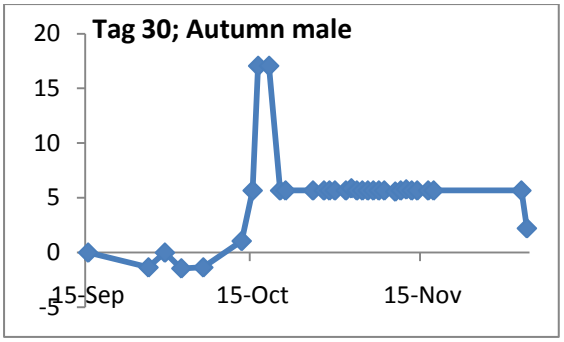
Tag no.	No of days tracked	Furthest location upstream	Upstream distance travelled (km)	Date upstream location reached	Comments
Spring salmon					
32	135	Kirks, Park	1	-	
37	133	Long pool, Monaltrie	55	10-Nov	
39	132	Bulwarks, Park	3.2	21 Sep	Recaptured 16 Feb by angler; kelt
40	132	Embuttments, Sluie	14.9	03-Nov	Vent protrusion
42	128	Bridge pool, Cambus O' May	51.1	24-Nov	Entered Pollagach burn briefly in Nov
43	128	Park (close to tagging site)	0	-	
56	85	Angel, Ballogie	24.9	06-Nov	
Male grilse					
30	80	Mill pool, Inchmarlo	17.1	16-Oct	
31	92	Keith's Pot, U Drum	2	-	Dropped 16 km in Oct but moved up 15 km again in Dec
46	29	U Kirks, Park	5.4	-	Lost from study after 21 Oct
48	68	Fir tree, Woodend	16	30-Oct	
53	127	Ice house, Inchmarlo	8.2	16-Oct	Decomposed carcass found at Park, 17 March
Male MSW salmon					
33	89	Garden run, M Blackhall	11.8	27-Oct	Dead early-mid Dec – floy tag retrieved at Kingcaussie
34	135	Lemming's corner, Craigendinnie	43.9	24-Nov	
35	121	Green bank, Banchory Lodge	16.1	12-Jan	Probably spawned at L Crathes in late Nov; final upstream movement in mid Jan
36	134	River Muick	62.1	04-Nov	Dropped 21 km in Oct before going upstream
47	127	Park (close to tagging site)	0	-	
Female grilse					
38	69	Dinnet burn	45.6	>23 oct, <25 nov	Dead in tributary; tag retreived 25 Nov
44	128	Jetties, Invery	11.4	24-Nov	

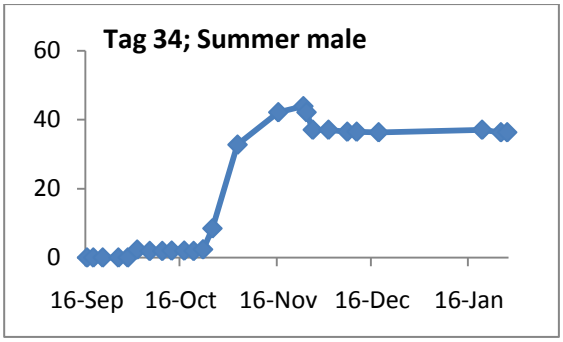
45	128	Beltie burn	20.7	16-Nov	
51	55	Park (close to tagging site)	0	-	Lost from study after 17 Nov
55	126	Jetties, Invery	7.6	24-Nov	At coast by 28 Jan
57	126	Park (close to tagging site)	0	-	
Female MSW salmon					
41	129	Park (close to tagging site)	0	-	
49	127	L Crathes (close to tagging site)	0	-	Query tag regurgitated
50	127	Island, Crathes Castle	2	30-Oct	Very slight vent protrusion
52	127	Sawmill, Invery	3.3	20-Nov	
58	69	Boat pool, Crathes Castle	2.7	24-Nov	
59	122	U Kirks, Park	2.7	19-Oct	

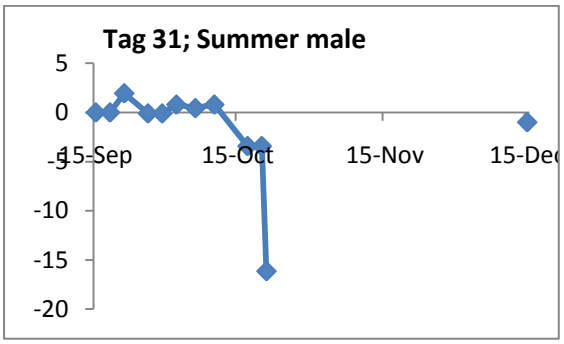
Table 3b. Summary of movements of fish radio tagged 1 – 15 October 2009

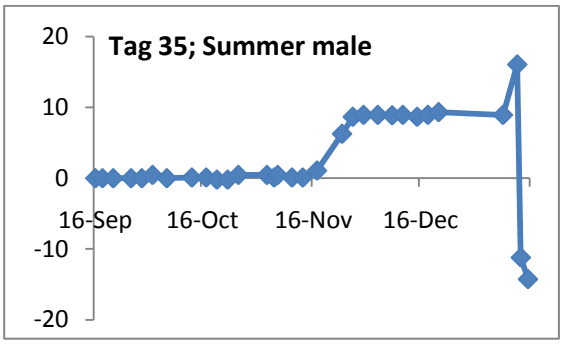
Tag no.	No of days tracked	Furthest position upstream	Upstream distance travelled (km)	Date upstream location reached	Comments
Spring salmon					
73	60	Slips, Ballogie	21.7	13-Nov	
80	114	Park (close to tagging site)	-	-	
Male grilse					
76	122	Dinnet bridge, Deecastle	44	05-Nov	
85	111	L Durris (close to tagging site)	-	-	Query tag regurgitated
86	23	U Bridge, L Crathes	9.5	13-Oct	Lost from study after 30 Oct
79	114	Park Inn, Park	3	17-Oct	
Male MSW salmon					
88	55	Tanarmouth, Aboyne Castle	39	16-Nov	Reached Aboyne but dropped down and entered Beltie burn

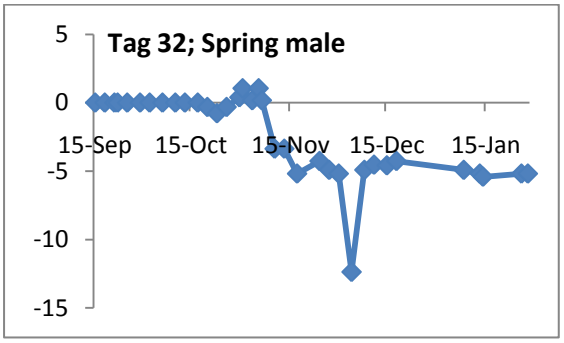
61	119	Jetties, Invery	14.1	17-Nov	
63	116	Jock adams, Banchory Lodge	14.3	17-Oct	
64	54	Top of River Tanar	54.4	> 21 Oct	Dead in tributary by 25 Nov
66	113	Bulwarks, Ballogie	22.2	27-Nov	
67	113	L Durris (close to tagging site)	-	-	Query tag regurgitated
68	113	Island, Commonty	16.9	26-Oct	
70	113	Keith's pot, U Drum	5.1	04-Dec	
71	46	River Tanar (Kildhu)	41.2	16-Nov	Lost after 22 Nov, after leaving tributary
Female grilse					
62	117	Lower Bridge pool, L Crathes	6.9	30-Oct	Vent protruding slightly; out to sea 26 Jan
83	125	Green bank, Banchory Lodge	12.6	06-Feb	
Female MSW salmon					
69	113	Park (close to tagging site)	-	-	
65	113	Kirks, U Drum	1	-	
72	111	Old Fawn, Little Blackhall	5.9	20-Nov	
74	105	L Durris (close to tagging site)	-	-	
75	100	Mill stream, L Crathes	11.8	24-Nov	
77	125	Long haugh, Dess	29.8	21-Jan	
78	129	Park (close to tagging site)	-	-	
60	119	U Kirks, Park	1	14-Oct	Vent protruding
81	114	Jetties, Park	2.8	13-Nov	
82	112	U Kirks, Park	4.8	18-Nov	
84	59	Kelpy, L Crathes	1.9	20-Nov	
87	113	Warren, Birse	26.7	30-Oct	
89	111	Long pool, Woodend	21.7	13-Nov	Vent protruding
54	112	L Durris (close to tagging site)	-	-	

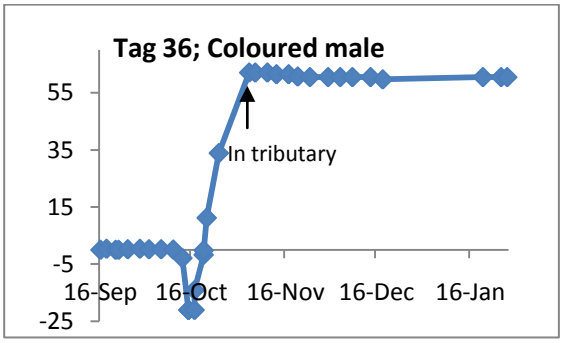


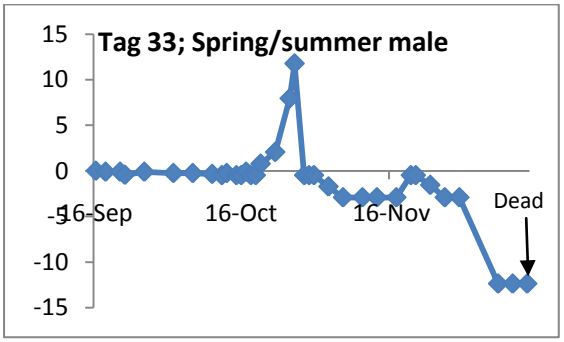












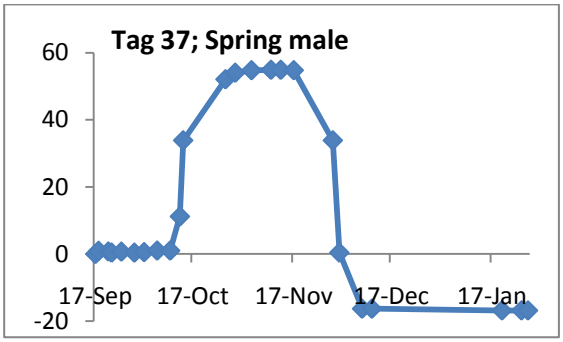
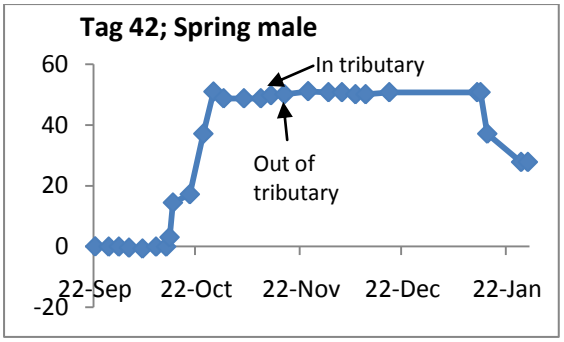
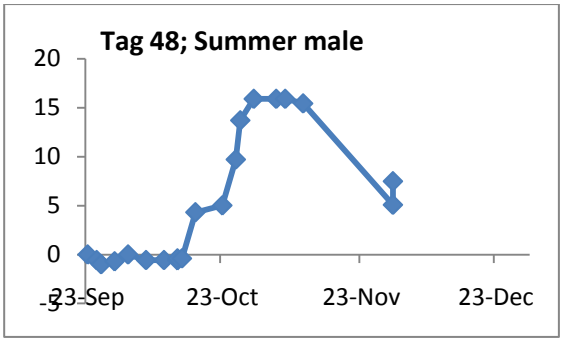
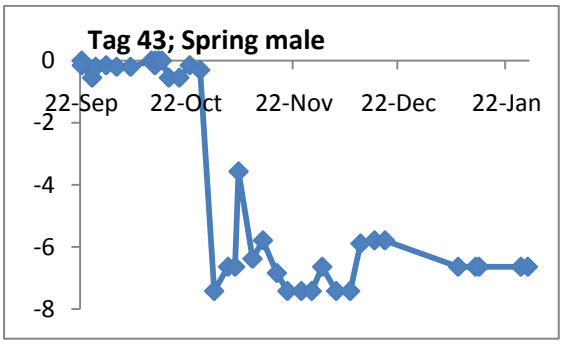
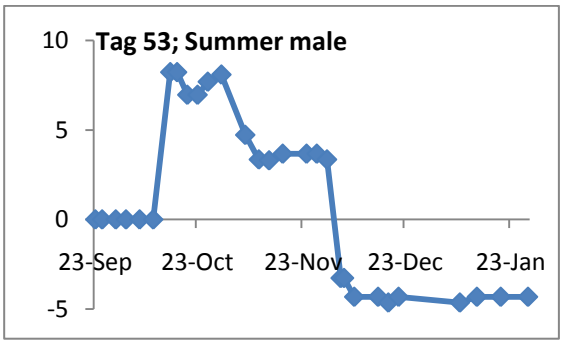


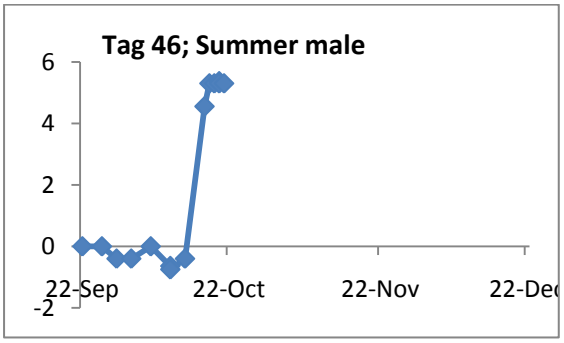
Figure 7a. Plots of migration of male salmon tagged in September 2009. Distance moved from tagging site (in km) shown on vertical axis (distances greater than 0 represent upstream migration). Positions of fish as determined by tracking marked ♦. Note different scales on axes for different fish.

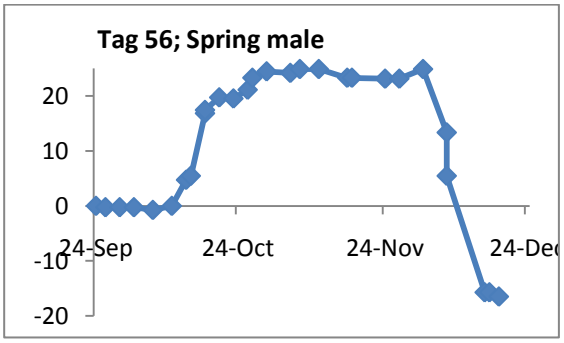












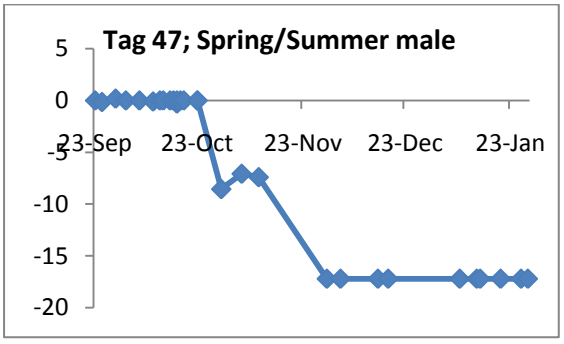
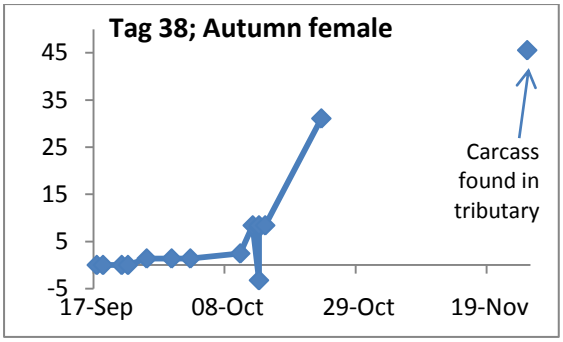
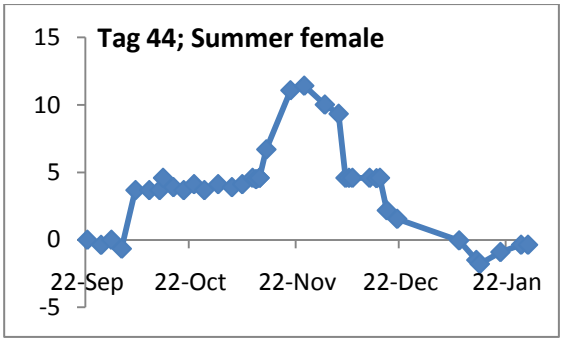
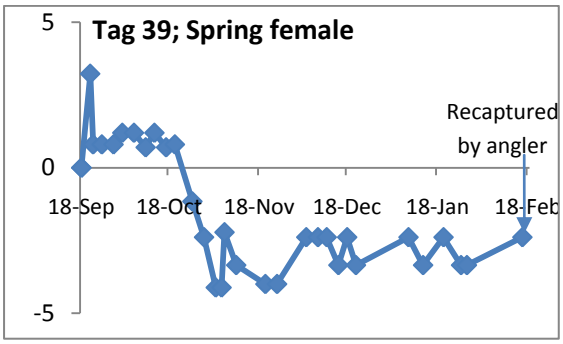
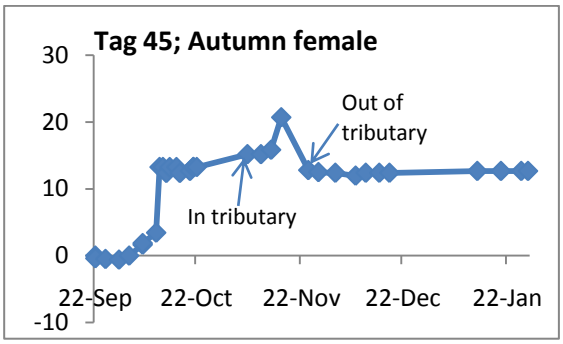


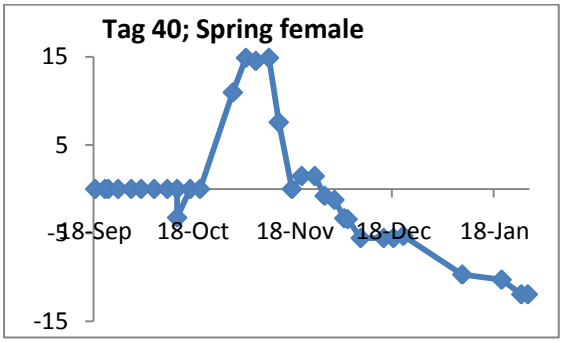
Figure 7a continued. Plots of migration of male salmon tagged in September 2009. Distance moved from tagging site (in km) shown on vertical axis (distances greater than 0 represent upstream migration). Positions of fish as determined by tracking marked ♦. Note different scales on axes for different fish.

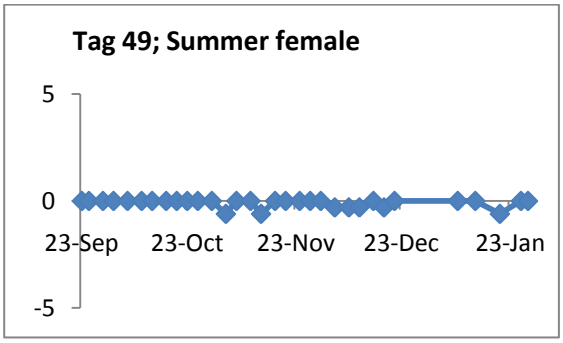


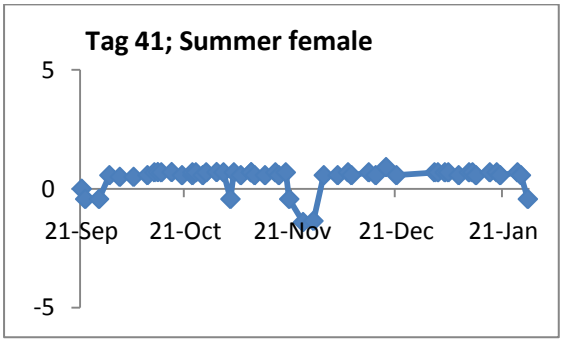












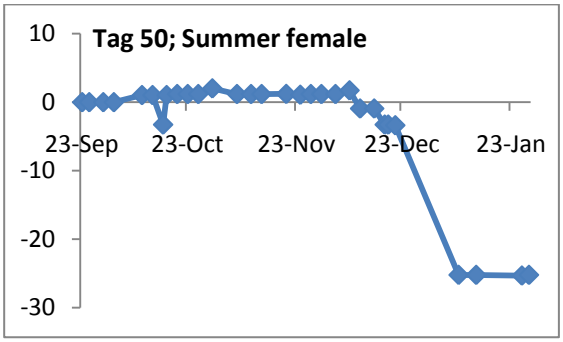
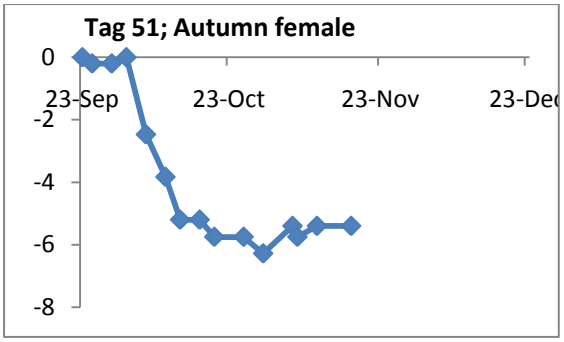
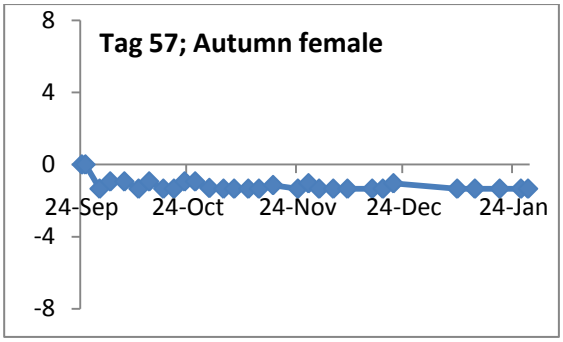
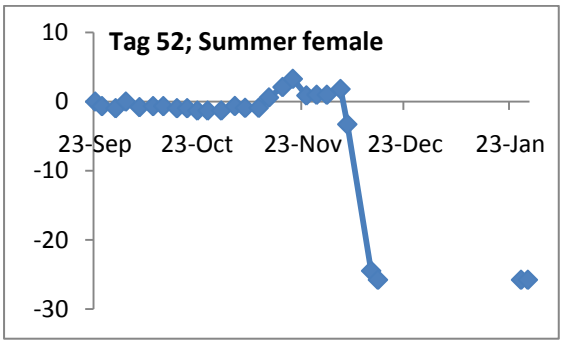
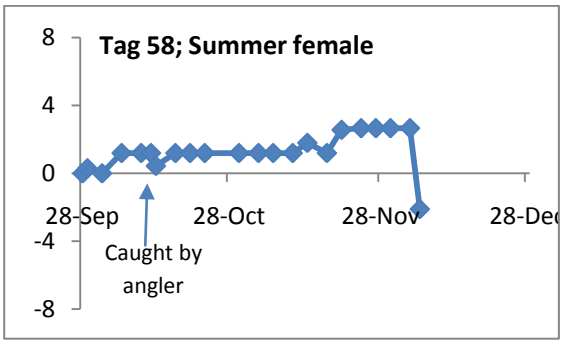


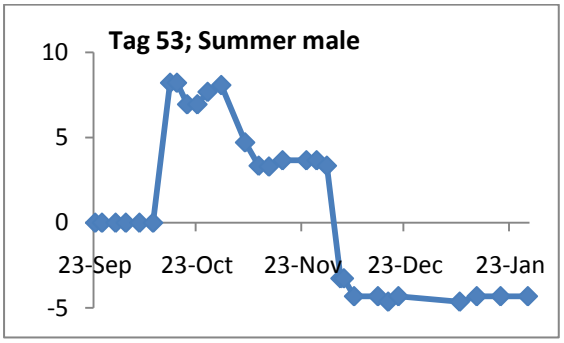
Figure 7b. Plots of migration of female salmon tagged in September 2009. Distance moved from tagging site (in km) shown on vertical axis (distances greater than 0 represent upstream migration). Positions of fish as determined by tracking marked ♦. Note different scales on axes for different fish.

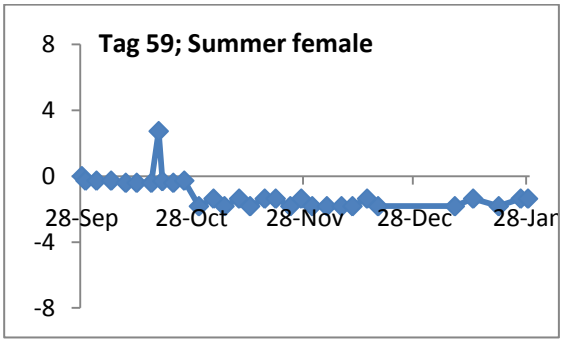












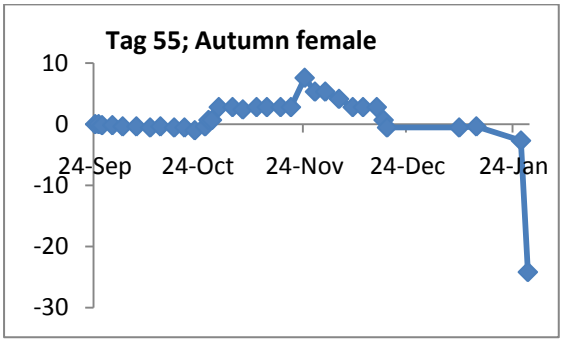
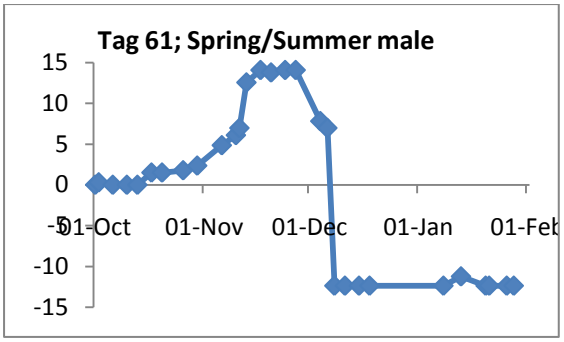
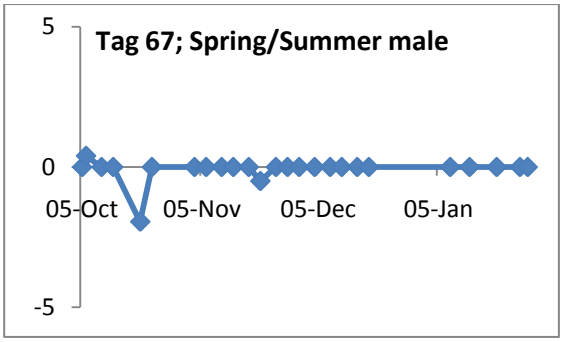
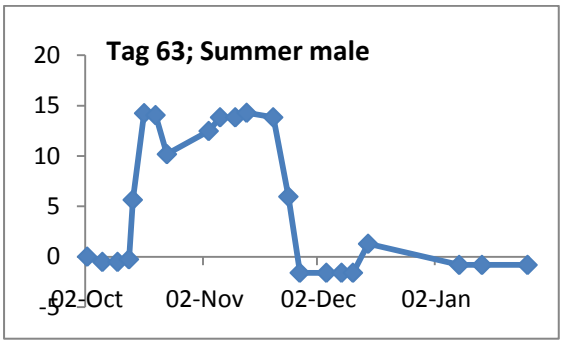
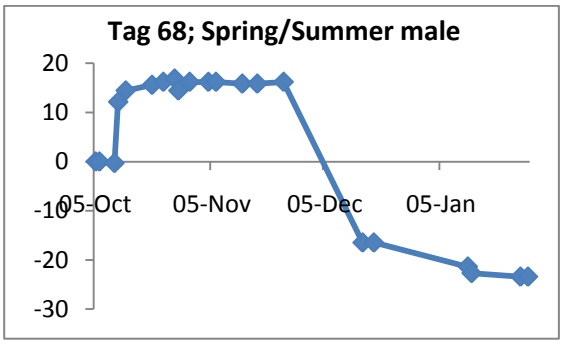


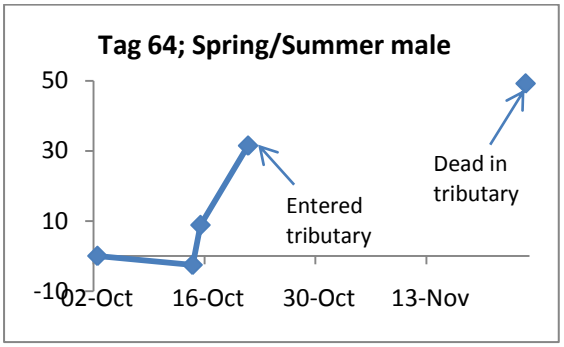
Figure 7b continued. Plots of migration of female salmon tagged in September 2009. Distance moved from tagging site (in km) shown on vertical axis (distances greater than 0 represent upstream migration). Positions of fish as determined by tracking marked ♦. Note different scales on axes for different fish.

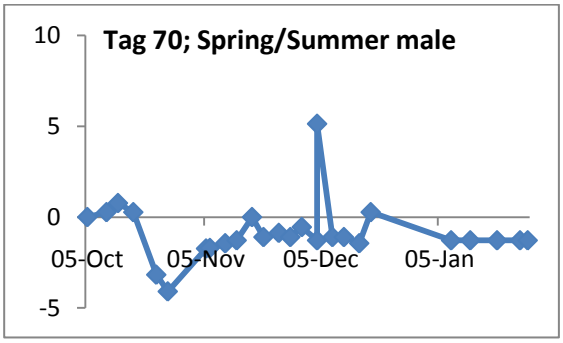


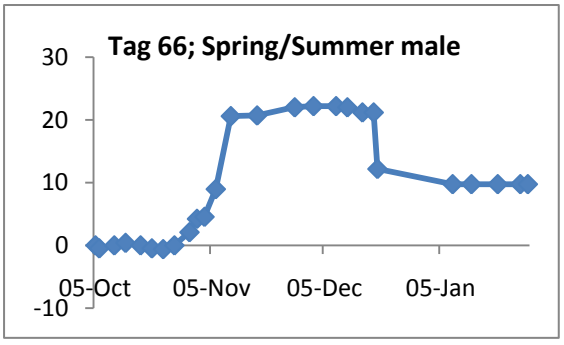












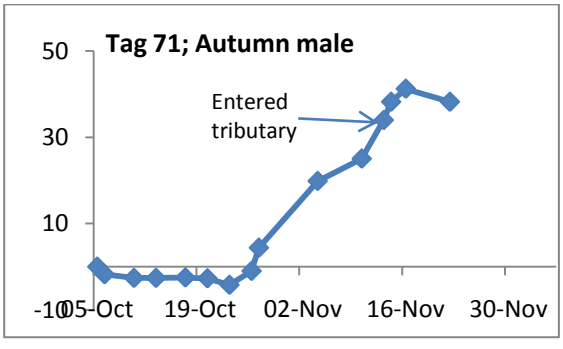
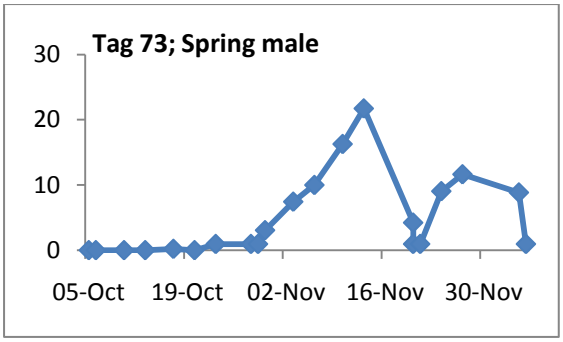
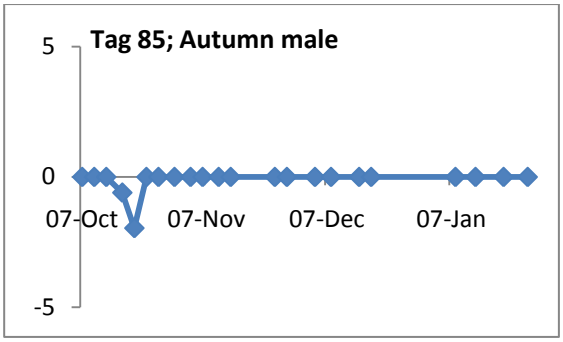
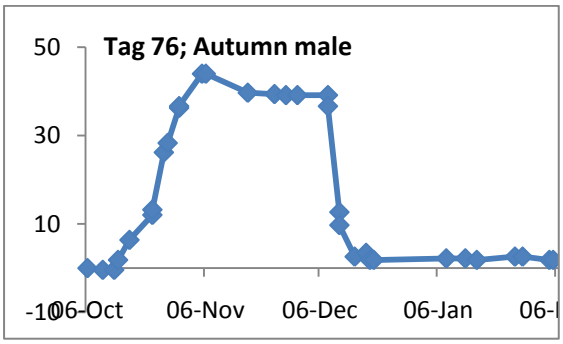
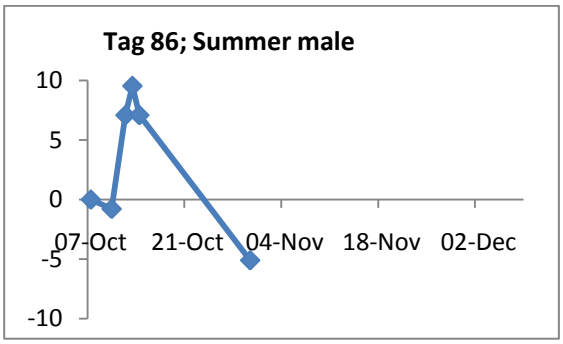


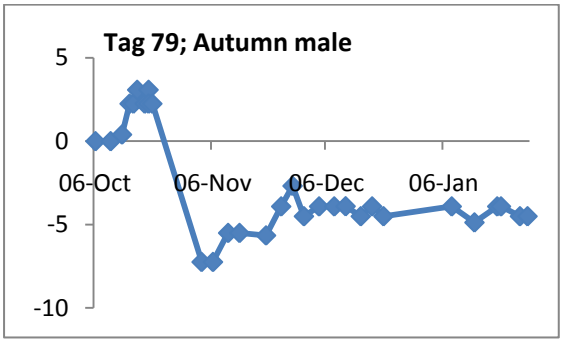
Figure 7c. Plots of migration of male salmon tagged in October 2009. Distance moved from tagging site (in km) shown on vertical axis (distances greater than 0 represent upstream migration). Positions of fish as determined by tracking marked ♦. Note different scales on axes for different fish.

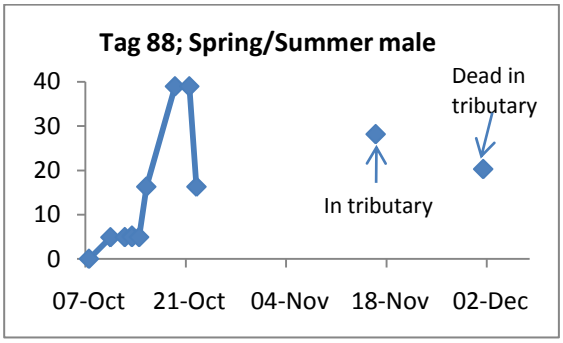












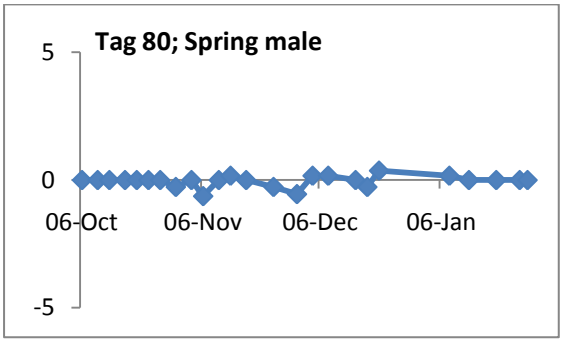
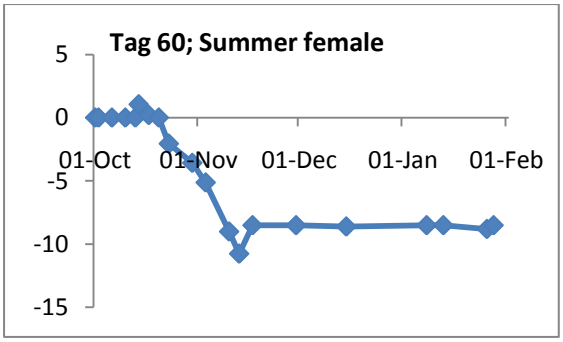
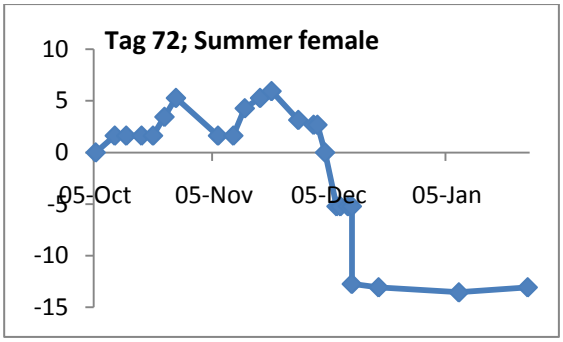
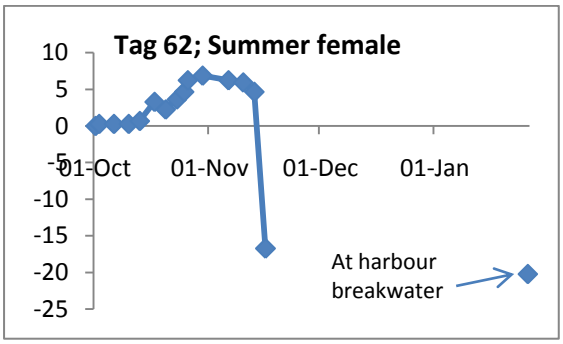
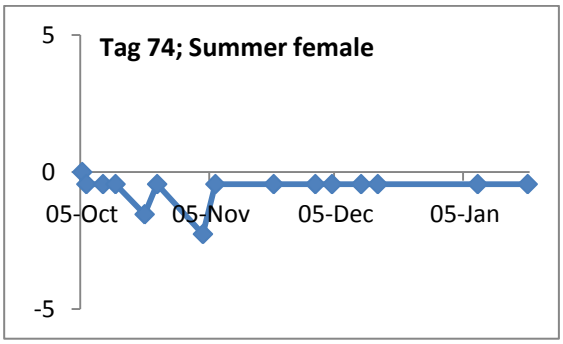


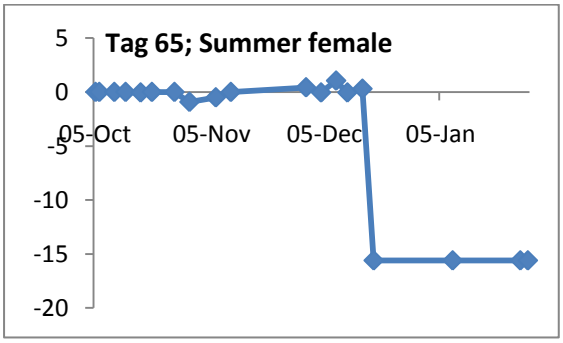
Figure 7c continued. Plots of migration of male salmon tagged in October 2009. Distance moved from tagging site (in km) shown on vertical axis (distances greater than 0 represent upstream migration). Positions of fish as determined by tracking marked ♦. Note different scales on axes for different fish.

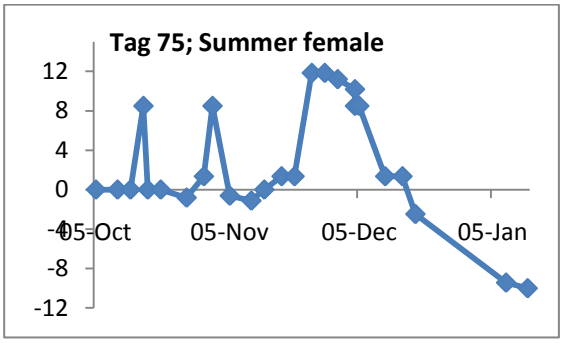


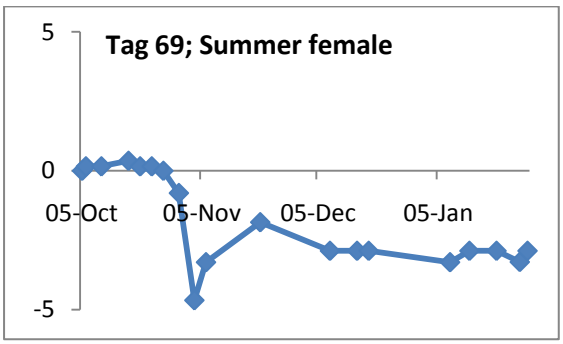












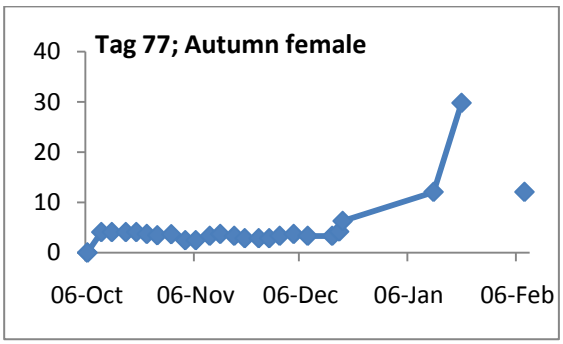
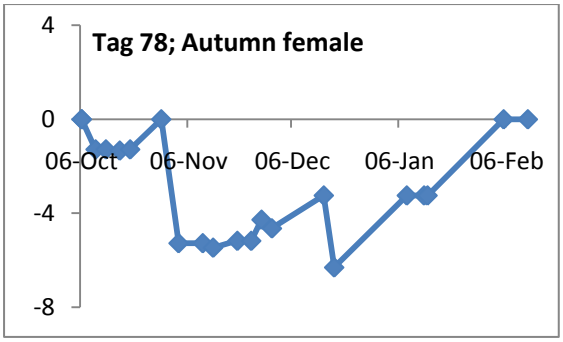
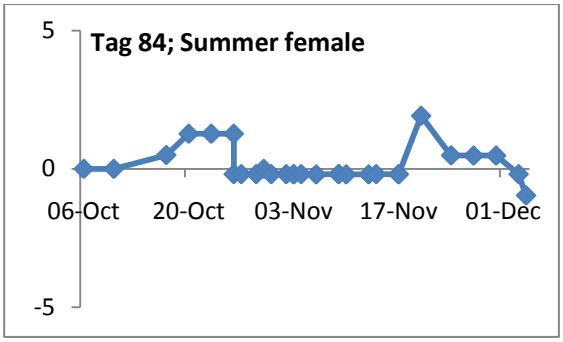
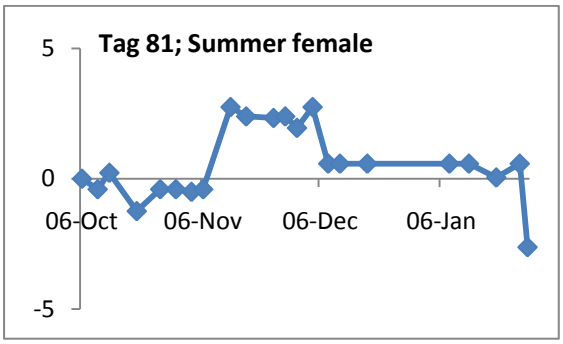
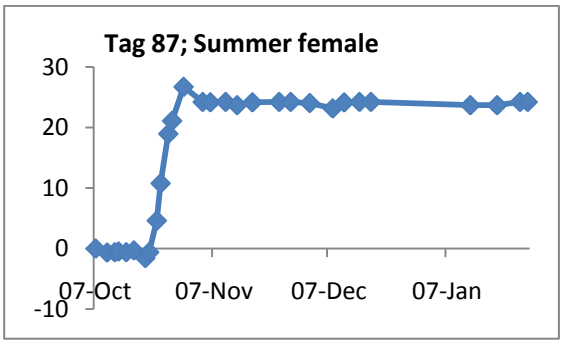


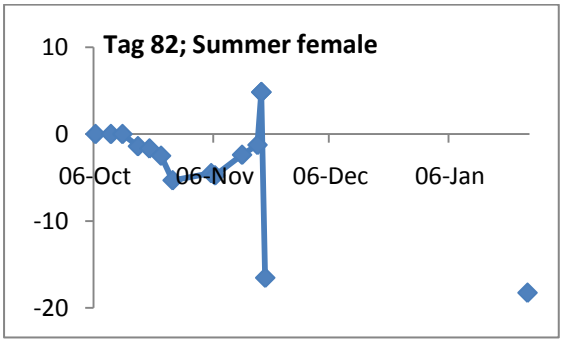
Figure 7d. Plots of migration of female salmon tagged in October 2009. Distance moved from tagging site (in km) shown on vertical axis (distances greater than 0 represent upstream migration). Positions of fish as determined by tracking marked ♦. Note different scales on axes for different fish.

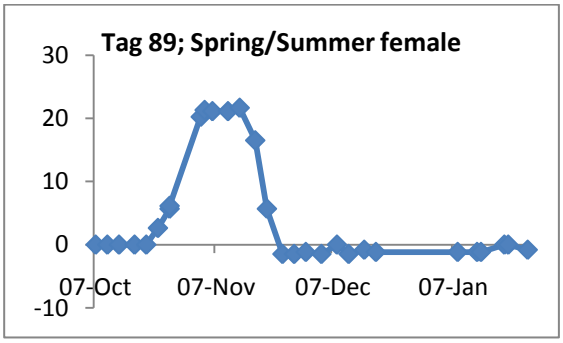


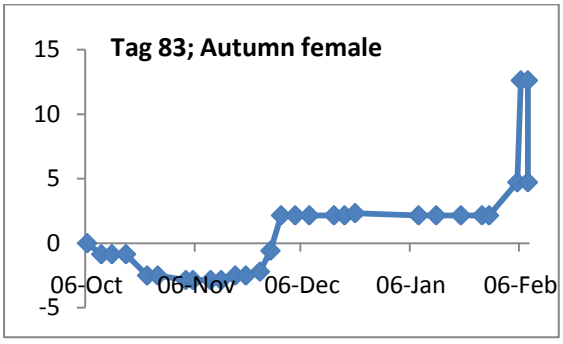












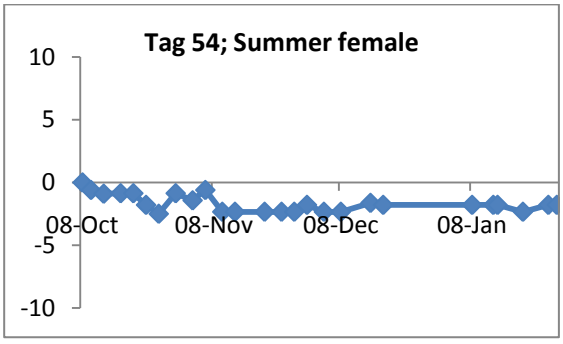


Figure 7d continued. Plots of migration of female salmon tagged in October 2009. Distance moved from tagging site (in km) shown on vertical axis (distances greater than 0 represent upstream migration). Positions of fish as determined by tracking marked ♦. Note different scales on axes for different fish.

Upstream Limits

Eight fish (14%) migrated more than 40 km (25 miles) after being tagged and a further eight fish migrated between 20 and 40 km. There was no significant difference in the numbers of September- and October-tagged fish that reached the Upper, Middle and Lower river sections (shown statistically; chi square):

- 14 September-tagged fish (52%) and 18 October-tagged fish (60%) remained in the Lower Dee.
- 8 September-tagged fish (30%) and 9 October-tagged fish (30%) reached in the Middle Dee.
- 5 September-tagged fish (18%) and 3 October-tagged fish (10%) reached in the Upper Dee.

Of the Spring salmon and Spring / early Summer salmon that were tagged, four reached the Upper Dee, eight reached the Middle Dee and eight remained in the Lower Dee for spawning (Fig. 8). This final distribution of Spring (and/or early Summer) salmon throughout the three sections of the river was not significantly different from the distributions of Autumn-entry tagged fish (shown statistically; chi square; Fig. 9). However, Summer-entry salmon showed significantly less upstream migration than Spring or Autumn entrants (showed statistically; ANOVA), such that significantly more Summer salmon remained in the Lower Dee, compared to Spring or Autumn salmon (shown statistically; ANOVA; Fig. 9).

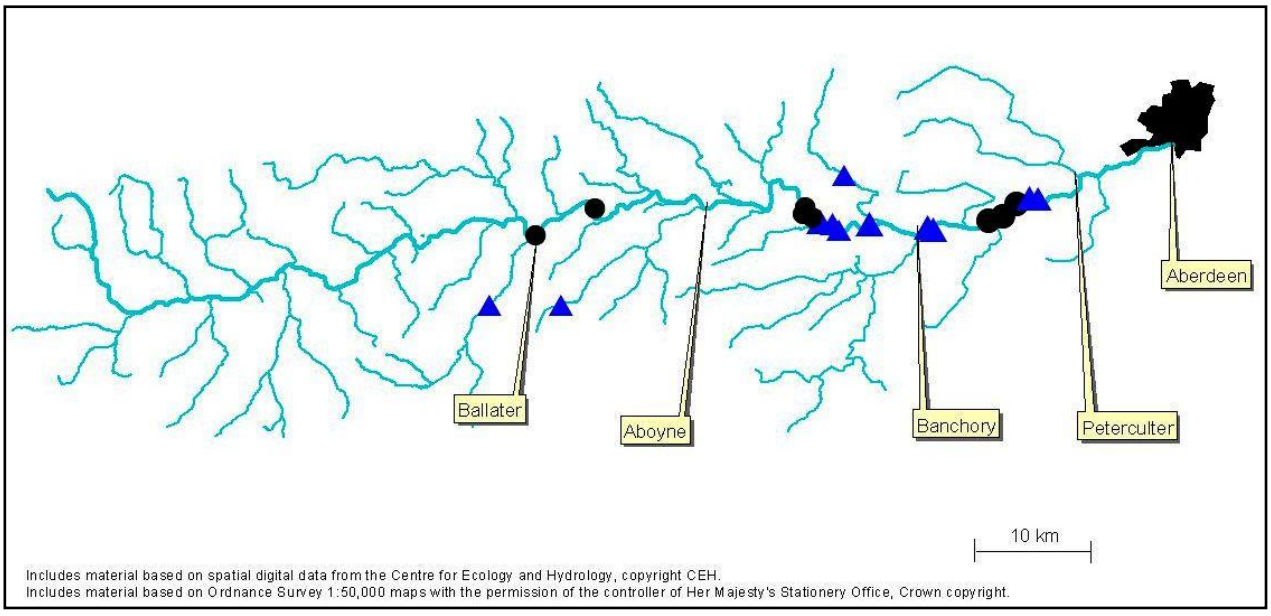


Figure 8. Maximum upstream locations of fish tagged in September and October 2009 that had entered the river in Spring (●) or Spring/early Summer (▲); determined by scale readings.

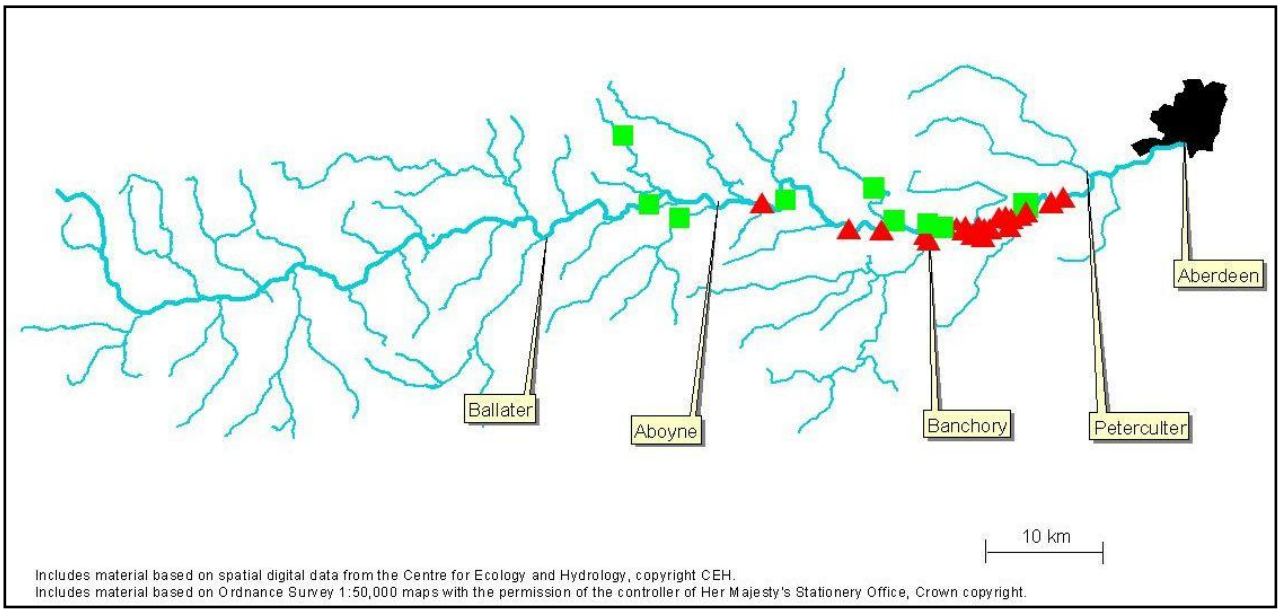


Figure 9. Maximum upstream locations of fish tagged in September and October 2009 that had entered the river in Summer (▲) or Autumn (■); determined by scale readings.

Male salmon showed significantly greater upstream migration distances (average 21 km /13 miles) than females (average 8 km /5 miles; shown statistically; ANOVA), thus significantly more females remained in the Lower Dee for spawning (shown statistically; ANOVA). Only a single female (a September-tagged fish) entered the Upper Dee for spawning, whereas seven males reached the Upper Dee.

Timing of Fish Movements

The dates at which the upstream migrants reached their furthest location upstream ranged between 13 Oct and 6 Feb, with the majority of fish reaching their final position around the second week of November. The dates at which September-tagged fish that migrated upstream reached their final destination was not significantly different to the dates at which October-tagged fish reached their final destination (shown statistically; t-test), and averaged 11 Nov and 15 Nov for the two tagging groups, respectively. There was also no statistical difference in the time that September- and October-tagged fish started on their downstream migration (averaging 15 Nov and 27 Nov, respectively).

The date at which upstream migrants reached their final destination did not differ between males and females (shown statistically; t-test). The time at which the fish entered the river (Spring or early Summer, Summer, Autumn) did not significantly affect the time that upstream migrants reached their final destination either (shown statistically; ANOVA), although there was a weak trend that Autumn entrants reached their spawning destination later in the season, in early December (Fig. 10). This was also seen in the 2008 pilot study. There was no relationship between the final (spawning) position of the radio tagged fish (distance from the harbour) and the time that

they reached this final location (shown statistically; Pearson correlation). The timing of initial downstream migration was not related to sex or entry time of the fish (shown statistically; ANOVA).

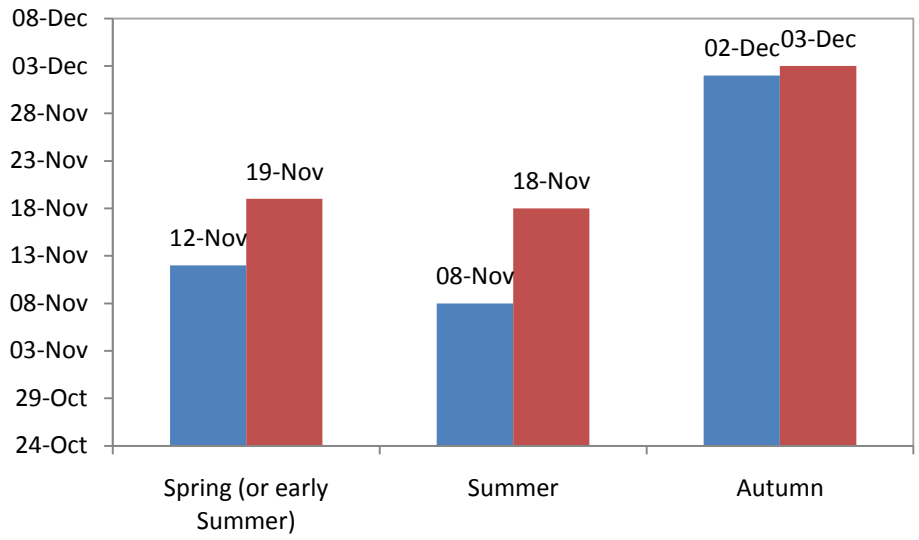


Figure 10. Average date of reaching maximum upstream location (■) and for initiation of downstream migration (■), for fish that entered the river in Spring (or early Summer), Summer and Autumn.

Relationships with river flows

There was no clear association between fish movements and river flows. This may be, in part, due to the frequency of tracking (twice a week), meaning that exact dates of fish movements were often not known. However, there were three floods on the Dee in Autumn 2009 (22 Oct - 1 Nov, 2 - 6 Nov, 22 - 26 Nov) and downstream movements of several fish were associated with these floods. In particular, nine tagged fish moved downstream with the first flood whilst a tenth fish (radio tag 46) was lost after this flood. It is possible that one additional fish (radio tag 78) dropped downstream in the second flood and two further fish dropped downstream in the third flood (radio tags 63, 45). Overall, 22% of the tagged fish showed downstream movements during these floods.

Diurnal Movements

The fixed position data loggers registered the time that tagged fish moved into range and it could be determined from subsequent movements whether these fish were migrating upstream, downstream, or simply 'milling around'. The data loggers recorded 47 movements from 30 fish that were migrating upstream. There was no evidence from this data that upstream migration occurred more during periods of daylight (22 of the recorded movements) or darkness (22 of the recorded movements), or during twilight (the periods 0.5 hr before sunrise and 0.5 hr after sunset;

three of the recorded movements). However, examination of the data did show that there were few movements recorded between 10 pm and 7 am.

There were also 34 movements recorded from 25 fish that were migrating downstream. Of these records, 14 occurred during daylight and 20 occurred during darkness (none occurred during twilight). None of these movements occurred during late afternoon but, this withstanding, movements occurred throughout the 24 hour period.

Discussion

The majority of fish (60%) caught and tagged in the Lower Dee in October remained in the Lower Dee through the spawning period. However, 30% migrated into the Middle Dee and 10% into the Upper Dee. This spawning distribution was similar (i.e. not significantly different) to the final distribution of the fish captured and tagged in September, suggesting that both the September and October fisheries on the Lower Dee primarily target Lower Dee, but also include Middle and Upper Dee stocks.

There was no evidence that salmon captured, handled and tagged in October were differently impacted than salmon tagged in September, as both groups of fish showed the same propensity to continue upstream migration. Some tagged fish (12%) did show downstream migration after tagging but this was unrelated to whether the fish were captured in September or October.

Spring salmon are believed to predominate in the upper Dee catchment (e.g. Girnock and Baddoch burn studies by Marine Scotland) yet one third of the fish caught and tagged in the Lower Dee in the Autumn were Spring or early Summer entrants (this is a comparable proportion to that found in the scale sampling and therefore is considered to be representative of the Autumn fishery). Some of these Spring fish (20%) did migrate upstream into the Upper Dee, however, the majority were limited to the Middle (40%) and Lower (40%) Dee through the spawning period. There was no difference in the timing of arrival at spawning grounds between Spring fish and Summer or Autumn fish.

There is evidence that spawning occurs earlier in the Upper catchment. However, there was no relationship between the location of a fish's final (spawning) site and the time that the fish reached this location, nor was the timing influenced by the initial entry time of fish into the river (Spring, Summer, Autumn). This suggests that, for the Autumn fishery at least, the time of arrival at spawning grounds does not reflect readiness to spawn. In particular, it appeared that females that had entered the river in the Summer had reached their spawning grounds by the end of September, whereas males that had entered in Spring/early Summer often had large distances to migrate in October and November. It is therefore expected that there will be little impact from the Lower Dee fishery on females that spawn in the Upper Dee (only a single female migrated into the Upper Dee after being caught and tagged in the Lower Dee).

Four fish (7%) showed downstream migration after capture and tagging and did not return as far upstream again. This included both males and females, tagged in September and October. All four

fish dropped downstream during the autumn floods, but then showed some upstream migration again in early-mid November. Similar behaviour was also reported by Smith & Johnstone (1996) and it is considered that these fish were unlikely to have been affected by capture and tagging.

Radio tracking does not allow confirmation of a spawning event, as fish are not (or rarely) observed. This year, a single fish (tag 39) was recaptured (at Lower Durris in February 2010) and was identified as a kelt (i.e. it had spawned). It is interesting to note that fish 39 was a female who dropped downstream during the October floods, further supporting that downstream migration does not necessarily indicate disruption to spawning. Although two radio tags were retrieved from carcasses (tags 38 and 53), the carcasses were too decomposed to assess.

Of the three fish lost before any spawning migrations were complete (tags 46, 51, 86), two of these did migrate upstream but were lost after flood events. The third (tag 51, female), was lost in November after migrating downstream. There is also a query over three fish (5%) that were tracked throughout the season but showed (almost) no movement. It is possible that they may have regurgitated their tags. Regurgitation of radio tags has been found in other studies and, for comparison, a study on the River Tweed found that 13 - 17% of salmon regurgitated their radio tags (SOAEFD 1997).

Redd Count Surveys

Introduction

Repeated redd count surveys demonstrate when spawning starts and when peak spawning occurs at a given location. In 2008, redd count surveys (for salmon and sea trout) were undertaken on four tributaries of the Upper and Lower Dee and this provided evidence that spawning occurs earlier in the Western catchment. However, observations also suggest that spawning may occur earlier in tributaries than in the main stem. As tributaries support only a portion of the Dee salmon stock, in 2009 the programme was extended to survey additional main stem sites.

Methods

Repeat redd counts were carried out during the spawning season on four tributaries and at three sites on the main stem. Survey sites in the Upper Dee were on the Clunie and Feardar tributaries and on the main stem at Dinnet. Sites in the Middle Dee were on the Beltie tributary and the main stem at Lower Woodend. Sites in the Lower Dee were on the Sheeoch tributary and the main stem at Middle Drum.

Redd counts were carried out once per week at each site between 12 October and 21 January (15 weeks). However, because of flow conditions and water clarity, it was not possible to conduct surveys after 28 December (four counts missed). Two weekly counts in mid November were also impossible at most sites, due to high flows (Fig. 11). For each count, only fresh redds (i.e. redds that were not present at the previous survey) were counted.

Results

In all three upper Dee sites (Fig. 11), spawning had started by the fourth week in October (26-27th). On the Clunie tributary (the most westerly site), spawning peaked in the first week in November and no further spawning was recorded after that time. On the Feardar tributary, the maximum redd count was recorded on 30 October, but the first week in November also had a high count. A fresh redd was also found here in the first week in December. For the Upper Dee main stem site (Dinnet), no peak for spawning could be determined, but spawning occurred over an extended period between end of October and the first week in December.

In the Middle Dee (Fig. 11), spawning in the Beltie burn started in the first week of November and peaked in the fourth week of November. No spawning was observed in December. On the main stem (Lower Woodend) site, the start of spawning could not be determined (due to high flow conditions) but was not before 12 November. Spawning occurred until the third week in December.

In the Lower Dee (Fig. 11), spawning in the Sheeoch burn started in the first week in November and peaked between the second and fourth week of November (peak unknown due to high flow conditions). Spawning continued into the first week in December. On the main stem (Middle Drum) site, the start of spawning was between first and second week in November (unknown due to high flow conditions). Spawning occurred until at least the fourth week of December, after which, no more surveys were possible.

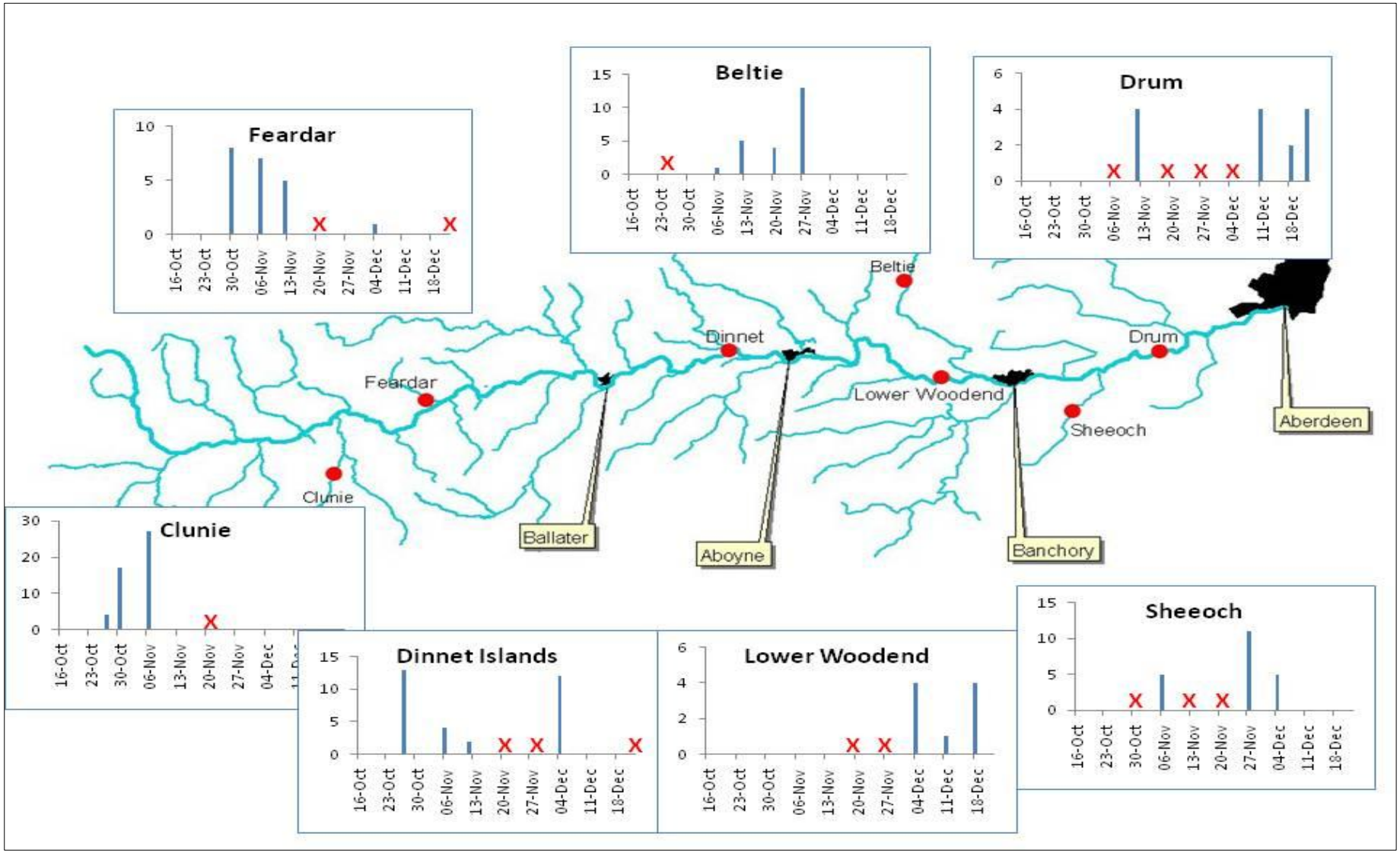


Figure 11. Locations of repeat redd count surveys overlaid with results of redd count surveys at each site. Graphs show number of redds counted at each site each week. **X** denotes that a weekly redd count could not be carried out due to high flows.

Conclusions

The redd count surveys in 2009 (and in 2008) show a trend for spawning occurring earlier in the Upper Dee. Spawning starts in the Upper Dee in the fourth week of October and continues into the first week of December. Earlier spawning in the Upper Dee may be a result of lower water temperatures, which affects the development rate of spawned eggs and newly-hatched fish (Taranger et al 2003, Taranger & Hansen 2008).

In the Middle and Lower Dee, spawning in the tributaries (Beltie and Sheeoch) started by the first week in November in 2009 and finished by the first week of December. The start of spawning in the Middle and Lower main stem sites could not be ascertained because of high flows that prevented redd counts being carried out. However, there was no spawning at these sites before November, and spawning continued there until at least the third and fourth week in December.

There was some evidence that spawning occurred earlier in tributaries than on the main stem, as spawning started on the Beltie burn (Middle Dee) in the first week of November but did not start at the corresponding main stem site (Lower Woodend) until at least after the second week of November. However, for the Upper Dee sites, there was no evidence that spawning started earlier in the tributaries than the main stem. There was evidence that spawning finished earlier in tributaries than in the main stem in the Upper, Middle and Lower Dee sites.

There is some annual variability in the onset and peak of spawning, due to conditions such as weather, flows and temperatures. This is particularly likely to influence spawning in tributaries, as flows can affect access into tributaries and smaller water bodies are more rapidly influenced by changing temperatures. For example, spawning on the Beltie burn in 2009 started two weeks earlier and finished at least one week earlier than in 2008. However, spawning has never been recorded earlier in the Upper Dee tributaries than the fourth week (23rd) of October.

Conclusions

The monitoring of the fishing season extension period was carried out in 2009 with a focus on the Lower Dee fishery (downstream of Banchory). Three objectives for monitoring were outlined and these are addressed below.

Objective 1. To assess whether fish caught by rod and line and released in the first two weeks of October have the same chance of successfully surviving to spawn as those caught in the last two weeks of September.

The radio tracking project found no significant difference in the movements and final destinations of salmon caught and tagged in the Lower Dee in the last two weeks of September compared to the first two weeks of October. There was also no significant difference between fish caught and tagged in the last two weeks of September and in the first two weeks of October in the time that they reached their final (spawning) destination, providing no evidence that these two groups of fish had different spawning periods. This provides strong indication that, for the Lower Dee, extending the fishing season to 15 October will have no additional impact on the survival of salmon after capture and handling - and therefore on the sustainability of the salmon stock - than closing the fishing season after 30 September. In support of this conclusion, a study by Booth et al (1995) looked at the impact of catch and release of Atlantic salmon just prior to spawning. The study found that, after salmon were fly fished and played to exhaustion, physiological recovery occurred within 12 hours and the stress response was minimal (which may have been due to low water temperatures in the Autumn). They also found that egg survival from females was not affected by capture and handling close to spawning time.

Objective 2. To determine if Aboyne Bridge is the correct upstream limit of the season extension.

Redd count surveys indicate that commencement of spawning in both the Middle and Lower Dee is no earlier than November. The radio tracking conducted in 2009 provides evidence that fishing until 15 October is sustainable below Banchory. The radio tracking to be carried out in 2010 will determine whether this fishing period is also sustainable between Banchory and Aboyne Bridge (the 'Middle' Dee). If there is found to be no impact on fish in the Middle Dee, then assessment of whether fishing in October can be carried out above Aboyne Bridge (the 'Upper' Dee) will be given consideration.

There was no difference found between the Middle and Lower Dee in terms of the start of spawning, although spawning continued for longer in the Lower Dee than the Middle Dee (for both tributary and main stem sites). However, the Upper Dee does have an earlier spawning period, commencing the fourth week of October. Thus, an upstream extension limit may need to reflect this difference in spawning times. To do so, it is intended to carry out additional redd count surveys in the area of Aboyne and Ballater in 2010, to refine knowledge on spawning times in this critical area.

There was evidence that females reach their spawning grounds earlier than males. There was also only a single female caught and tagged in the Lower Dee that migrated into the Upper Dee (compared to seven males). This indicates that fishing in the Lower Dee will cause very little exploitation of Upper Dee females, which are due to spawn early (end of October onwards). In contrast, fishing in the Upper Dee could exploit these early-spawning females. The male component of the Upper Dee salmon stock may be exploitable in the Lower Dee October fishery; there was no evidence of any negative impact of exploitation on these fish. However, these males were limited to the Upper Dee downstream of Ballater (both 2008 and 2009 studies), suggesting that the most westerly stock have carried out much of their spawning migration prior to the autumn period. This does suggest that the operation of the Lower Dee fishery is far removed (in terms of the stock components exploited) from an Upper Dee fishery.

Objective 3. To determine what stocks of salmon are being caught in the first two weeks of October and whether there is an impact on the more vulnerable stocks of Spring-running salmon.

The radio tracking suggested that the October fishery in the Lower Dee is targeting primarily Lower Dee stock (60% of tagged fish); however, it also included Middle (30%) and Upper (10%) Dee stock. Scale samples showed that the majority of salmon caught in October in the Lower Dee were Multi Sea Winter (MSW) salmon, with the remainder being grilse. Scales also showed that three quarters of the sampled October rod catch in the Lower Dee comprised Summer- and Autumn-entry salmon. The remainder of the rod catch was presumed to be Spring salmon, although the exact proportion of Spring salmon could not be confirmed for the October period (due to scale erosion). However, one quarter of the rod catch in the last two weeks of September was Spring salmon and there was generally very similar stock components in the September and October periods.

The radio tracking project tagged Spring salmon in the Lower Dee, captured in both the September and October periods. These tagged Spring salmon showed final (spawning) locations in the Upper, Middle and Lower River. These fish did not show any impact from capture and tagging and their final (spawning) distribution was not significantly different to the distribution of the tagged Autumn-run salmon. It is therefore concluded that the October fishing extension in the Lower Dee has negligible impact on Spring salmon.

In 2010 a similar monitoring programme will be undertaken in the Middle Dee, with results to be reported by March 2011. The Dee DSFB will make a decision on whether to apply for a permanent licence to extend the season based on the findings of the monitoring programme over all three years in March 2011.

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Appendix

Table 4. Radio tagged fish

Tag no.	Date of tagging	Tagging Location	Angler	Tag no.	Date of tagging	Tagging Location	Angler
30	15-Sep	U. Drum (Kirks)	Mrs J Bentinck	60	01-Oct	Park (House)	Mr G Thomson
31	15-Sep	L. Durris (Pipeline)		61	01-Oct	M Drum (Lawson)	Mr J Rodgers
32	15-Sep	Park (House)	Mr A Denson	62	01-Oct	L Durris (Lodge)	Mr J Gray
33	16-Sep	Park (Bulwark)	Mr K Bitmead	63	02-Oct	U Drum (Craiglug)	
34	16-Sep	Altries (Hut)	Mr K Fleming	64	02-Oct	L Crathes (U Bridge)	
35	16-Sep	M. Drum (Lawson)		65	05-Oct	M Drum (Cairnton)	Mr A Cross
36	16-Sep	Park (U Kirk)	Mr J Waggot	66	05-Oct	L Durris (boat)	Mr G West
37	17-Sep	Park (Castleton)		67	05-Oct	L Durris (boat)	Mr G West
38	17-Sep	L. Crathes (Mill)		68	05-Oct	Park (U kirks)	Mr N Baird
39	18-Sep	Park (Bridge)	Mr J Waggot	69	05-Oct	Park (Cellar)	Mr P London
40	18-Sep	L. Crathes (Mill)		70	05-Oct	Altries (Hut)	Mr R Mason
41	21-Sep	Park (Greenbank)	Mr J Merry	71	05-Oct	L Durris (boat)	Mr J Paton
42	22-Sep	Park (Bridge)	Mr N. Helyhutcheson	72	05-Oct	Crathes castle (Floating banks)	Mr J Axtiles
43	22-Sep	Park (Long)	Mr S Maspoli	73	05-Oct	Park (House)	Mr P Nix
44	22-Sep	U. Drum (U Fenty)	Mr L Bedy-Grey	74	05-Oct	L Durris (Otter)	
45	22-Sep	Park (Durris Stream)	Mr D Ramsey	75	05-Oct	Altries (Donal Garth)	Mr J Branch
46	22-Sep	L. Durris (Pipeline)	Mr P Brown	76	06-Oct	Park (Durris stream)	Mr N Baird
47	23-Sep	Park (Long)	Mr K Reid	77	06-Oct	L Durris (boat)	Mr J Paton
48	23-Sep	Park (Coopers)	Lord Donahue	78	06-Oct	Park (U kirks)	Mr P London
49	23-Sep	L. Crathes (Mill)	Mr G Fisher	79	06-Oct	Park (Bakebare)	Mr P Nix
50	23-Sep	L. Crathes (Mill)	Mr G Fisher	80	06-Oct	Park (Bakebare)	Mr P Nix
51	23-Sep	Park (Bakebare)	Mr E Allan	81	06-Oct	L Durris (L Fenty)	Mr A Fisher
52	23-Sep	L. Crathes (Mill)	Mr G Fisher	82	06-Oct	L Durris (L Fenty)	Mr A Daniel
53	23-Sep	L. Crathes (Mill)	Mr G Fisher	83	06-Oct	L Durris (U Fenty)	Mr E Whyte
55	24-Sep	Park (Greenbank)		84	06-Oct	Park (Coopers)	Mr N Baird
56	24-Sep	U. Drum (Kirks)		85	07-Oct	L Durris (boat)	Mr G West
57	24-Sep	Park (House)	Mrs A Alston	86	07-Oct	M Drum (Lawson)	Mr S Birth
58	28-Sep	L. Crathes (Kelpie)		87	07-Oct	L Crathes (Bulwarks)	Mr G Fisher
59	28-Sep	U. Drum (Neave's cast)	Mr D MacDonald	88	07-Oct	L Durris (L Fenty)	Mr J Paton
				89	07-Oct	U Drum, kirks	Mr A Fisher
				54	08-Oct	U Drum, U Fenty	Mr A Daniel