TAY DISTRICT SALMON FISHERIES BOARD

FREQUENTLY ASKED QUESTIONS

No. 1. (February 2011)

Why have there been so many baggots and rawners in the Tay in the first few weeks of the 2011 season?

The first three weeks of the 2011 Tay salmon season saw unprecedented catches of "baggots" and "rawners". Double figure daily catches were common. Such fish were also a big feature of the first week of the Tweed season, but not the Dee apparently. We have received numerous queries as to why there have been so many of these fish in the Tay this year. This note tries to explain what baggots and rawners are and why they may have been so common this season.

What is a baggot?

A "baggot" is a female salmon caught in the spring which is still full of mature eggs. There are, however, two possible reasons why females may be carrying eggs that late.

1) They are fish which for some reason have failed to spawn at the appropriate time. In such cases the eggs may be degenerating and no longer viable.

2) They may just be very late spawners which have still to spawn. True "baggots" have, in the past, normally been thought of in terms of the first type.

As there has been no systematic attempt to look at the reproductive status of the "baggots" caught this year (this would involve killing fish) we cannot definitely say which of these types predominates. However, the circumstances indicate they are most likely to have just been very late spawners, as will become apparent later.

What is a rawner?

A rawner is a name for a mature male salmon caught in the spring which has not spawned or may possibly be part spent. If these fish are cut open they would still have mature testes, hence the name rawn. However, in 1910, P D Malloch (see photographs below) referred to unspent female fish as "baggots" or "rawners" implying that, in the past, the term rawner may have applied to both males and females.

The "baggots" and "rawners" of 2011

Most of the baggots and rawners caught at the start of the season were relatively clean looking fish, some were very fresh, even carrying sea lice. In terms of size, the range is very similar to that of fresh fish in the late autumn, i.e. large grilse of 7 – 12 pounds and 2SW fish in the high teens of pounds and bigger. Thus the colouration and size of the fish suggests

many entered the Tay very late in the year, even after the end of the angling season on 15 October

As an interesting aside, it may be the case that a silver colour alone might not be absolute proof that baggots have only been in the river for a short time. In his *Life history and habits of the salmon sea-trout and other freshwater fish* P D Malloch (1910) believed that "if a fish exceeds the time for spawning it becomes bright in colour in the same way as kelts do." Photographs were presented of a silver baggot from the River Don which was described as having "turned bright, like a spring fish". However, while such a change may be expected to occur with true baggots, it might not be expected with fish which still have to spawn, as we are probably dealing with.

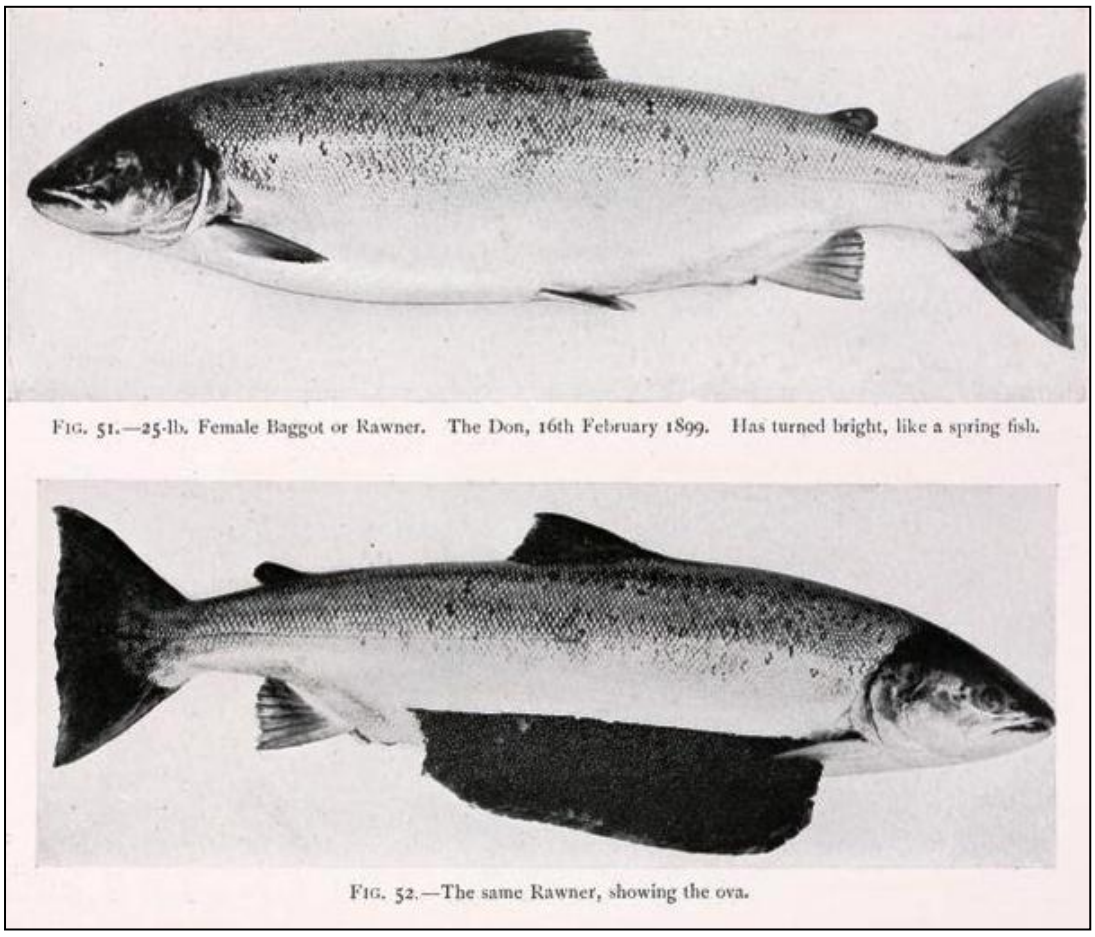


FIG. 51.—25-lb. Female Baggot or Rawner. The Don, 16th February 1899. Has turned bright, like a spring fish.

FIG. 52.—The same Rawner, showing the ova.

Photograph of a female "baggot" or "rawner" from the River Don from P D Malloch's Life history and habits of the salmon sea-trout and other freshwater fish (1910)

Putting 2011 into context

Unspent fish have always been a feature of the early Tay season to some extent. However, many lower Tay ghillies in particular think their numbers have been increasing for over a decade. If that is so, then the bigger numbers seen in the early spring of 2010 and even more in 2011 may partly represent an acceleration of a longer term process.

However, there are some ghillies, and this may be related to their location, who express less certainty about the long term increase in numbers of such unspent fish. But even if they are correct, what cannot be in doubt is that, relative to the number of fish which enter the river in the latter part of the fishing season (i.e. September and early October), the number of unspent fish at the start of the season has been increasing for some time. If these fish are considered to be part of the "autumn" run, they now represent a bigger proportion of it than they did in the 1970s or 1980s. The significance of this is discussed later.

Causes of the increase in baggots and rawners

A major cause of the big increase in the number of these fish in 2011 is likely to have been the weather.

The winter of 2010/11 was exceptionally cold. According to provisional Met Office statistics, the average temperature in eastern Scotland in December 2010 (-2.8 C) was the coldest of the entire period 1910 – 2010 and November 2010 was the 10th coldest. January 2011 was not as cold, it was only the 49th coldest. In December and early January water temperatures dropped down to zero or near zero and the Tay was ice bound for some time.

It has long been known that when water temperatures drop to freezing salmon cease to spawn. They are, presumably, just physically unable to do so. The fertilisation of eggs is also impeded. This is just what appears to have happened.

In 2010/11 it was the Board's experience that autumn run fish taken into the hatchery in December 2010 did not begin to yield eggs until temperatures rose in late January and early February and some have not even stripped by mid February. When the weather was particularly cold the fish appeared almost comatose in the tanks. Even in the Marine Scotland's spring salmon kelt reconditioning scheme at Almondbank, where the fish are typically stripped in late November or early December, those fish which had not been stripped by the time temperatures fell to zero were also delayed beyond anything previously experienced.

Direct evidence that spawning was delayed in the wild was provided by the fact that ghillies reported a lot of spawning activity in the main stem of the Tay in late January. We even received a report on 1 February that the only spawning fish of the year observed in a tributary of the Isla had only just been seen. Ghillies also reported that the number of baggots being caught and the ratio of baggots to kelts decreased between January and February showing that the "baggots" were in fact spawning.

Interestingly, this is not new. Even back in 1910 P.D. Malloch noted that in the Tay "most of the spawning is over by the end of December, although after a severe winter I have seen salmon spawning in March."

However, while the harsh winter of 2010/11 will have delayed spawning, it does not explain why the numbers of late spawning fish have been increasing for some time. To begin to understand this it is necessary to understand what controls the time of year at which salmon spawn.

Controls on salmon spawning times

1) Local adaptation to temperature

In different parts of the Tay district salmon spawn at slightly different times. Spring salmon and early summer grilse spawn in the upper tributaries and do so the earliest. They commence spawning in early November and may be completely finished by the middle of that month. Indeed, it was the case in 2010, that in tributaries like the River Tilt and upper Lyon the salmon spawned at their usual time.

However, the later in the year fish come in from the sea, the lower in the river they spawn and the later in the winter they spawn. In recent years it has been clear from both hatchery broodstock collection and direct observation of spawning salmon in the middle and lower Tay that the great majority of fish which spawn in that area do not do so before mid December at the earliest and that those fish enter the river in autumn or even during the winter itself.

Differences in spawning times are not only found within the Tay, but between different rivers. For example, in the chalkstreams of southern England spring salmon spawn much later than spring salmon do in Scotland. In Scotland, brown and sea trout tend to spawn early (October / November) but in chalkstreams true wild brown trout spawn very late. Very late spawning salmon are also associated with some of the Cornish rivers where the angling season extends to mid December. It has long been appreciated that sea-liced unspent fish can occasionally be caught in those rivers even after the start of the new season.

The main factor which is thought to explain these differences is winter temperature. Rivers with early spawning fish tend to be the coldest and those with the latest spawning fish, like Cornwall, are the warmest. The most widely accepted explanation is that spawning times are adaptations by local genetically distinct sub populations to allow fry to emerge at the most opportune time in spring for starting to feed. As the incubation time of eggs is dependent on temperature, it makes sense that salmon in warm rivers do not spawn in early November otherwise the fry might be seeking food before the winter is actually over. However, such a spawning time makes good sense in the Scottish highlands.

Over the long term, temperature may have another selective effect. It has been found that salmon spawning generally takes place when water temperatures are between about 2 and 6 degrees centigrade. As previously mentioned, when temperatures get close to freezing adult salmon, being cold-blooded, will not or cannot spawn and indeed would not be able to migrate through strong flows to spawning areas. Thus, in rivers where freezing conditions are likely, it is necessary for salmon to spawn before hard weather sets in. This would certainly have been the case in the upper tributaries of the Tay in 2010 and possibly in other years in the past when colder winters were the norm. Late running / late spawning fish may traditionally have been restricted to the lower reaches of rivers because of water temperatures.

2) *Direct effects of temperature*

It is often said that falling temperatures help encourage salmon to spawn. This may be true, but only within the limits set by genetics. If temperatures fall into the preferred range for spawning after fish have become ready to spawn then presumably that might trigger spawning. However, if temperatures drop into the preferred spawning range before fish have fully matured, they will still not spawn until they are physiologically ready to do so. However, as explained above, if temperatures drop down to zero before fish are ready to spawn then spawning may be delayed until temperatures rise enough to allow them to spawn.

Possible effects of previous mild winters

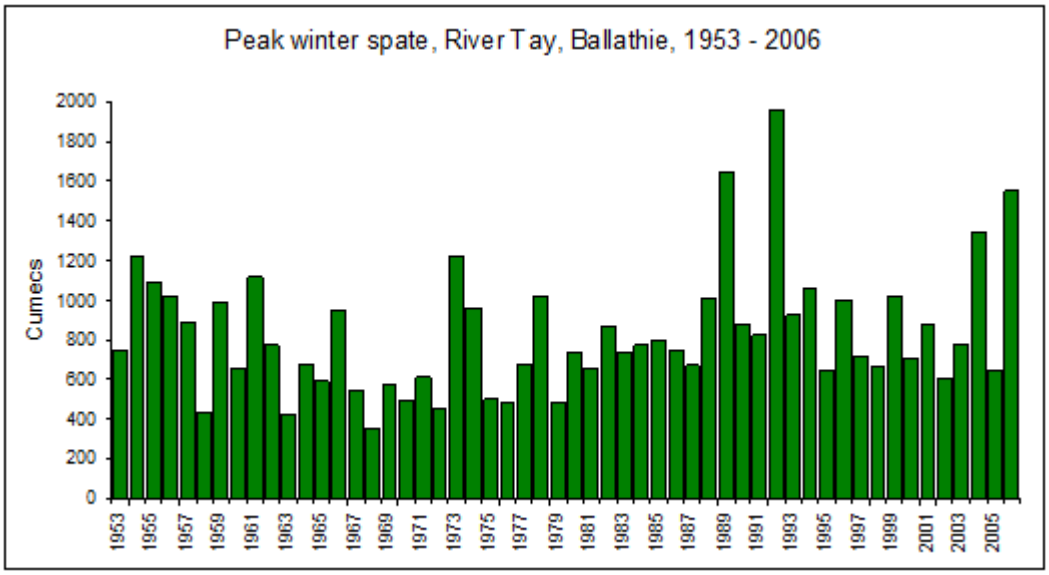
While the winters of 2009/10 and 2010/11 were cold, they have in fact followed a 20 year period when winters have generally been warm[1]. The longer term increase in numbers of unspent fish at the start of the season has coincided with this period. There are a number of reasons why the two may be connected.

1) For reasons just explained, a long period of mild winters might be expected to encourage late spawning fish and that might be the reason, or at least part of the reason, for why late spawning fish have been increasing. It may be, that on emergence from the gravel after a mild winter, the progeny of earlier spawning fish do not have the same advantage over those of late spawned fish as they might do in colder years.

2) Milder winters allow late spawning fish more opportunity to push further upstream to spawn and therefore this type of fish may gain "territory" at the expense of earlier spawning fish.

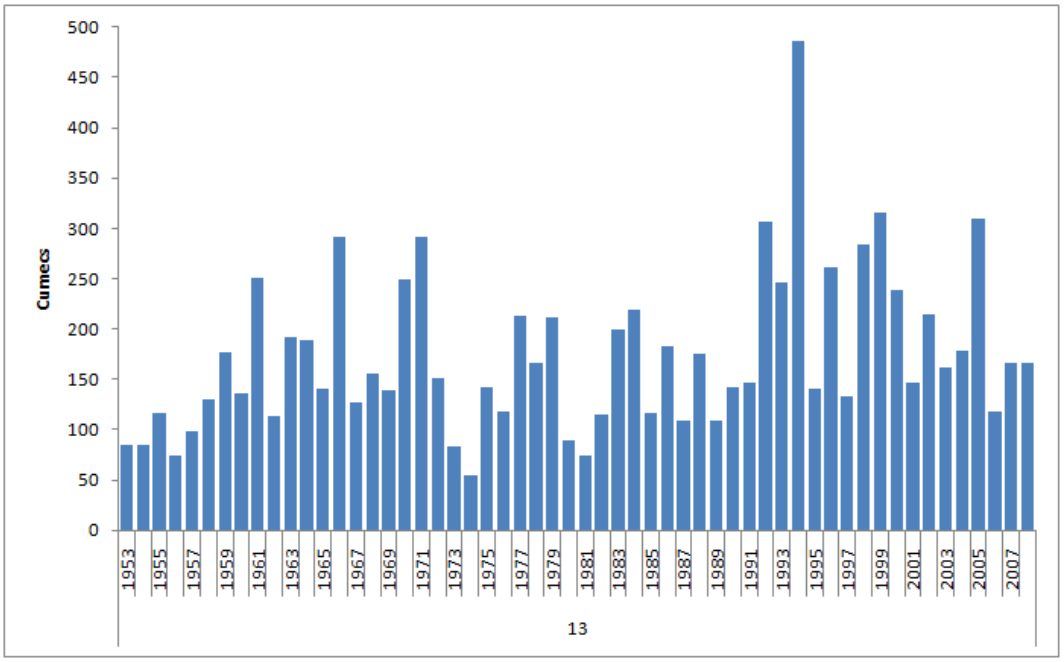
3) Another factor which may be indirectly linked to milder winters is the increased frequency of large winter spates (see figure below). This may be important if such spates result in redd washout. As the eggs of late spawning fish are in the gravel for a shorter period they will be less exposed to this danger. Indeed, the predominant component of the 2010/11 baggots and rawners would have been spawned in the winter of 2006/07, when a mid December spate was the largest recorded on the upper Tay by SEPA. The parents of this year's baggots and rawners would themselves have spawned some weeks after that spate had passed, but any earlier spawning fish might not have been so lucky.

[1] According to Met Office statistics for eastern Scotland, between 1988/89 and 2008/09 16 out of the 21 Novembers, 12 of the 21 Decembers and 17 of the 21 Januarys were warmer than the 1910 – 2010 averages.



Data courtesy of SEPA.

4) While there is no direct evidence to show it has had any effect, there have also been changes in flows at times of year that may be important for salmon fry establishing themselves in the river. For example in the 1990s peak flows in the Tay in the last week of April were generally higher than they were in the 1970s and 1980 and that week may be important for the offspring of any November spawned fish in the mainstem of the Tay but too soon to concern the offspring of late spawned fish. Such are the subtle effects which may be important in tipping the balance.



Maximum flows recorded at SEPA's Ballathie gauging station in the last week of April, 1953 – 2008. Data courtesy of SEPA.

Whatever the exact reason, if it has been the case that mild winters have helped late spawning fish, then the sudden switch to the coldest winter in 100 years would have caught these fish off guard. It may therefore be that the large numbers of unspent fish in 2011 were not just a product of the cold winter in itself but the fact it followed a long run of mild winters.

The reason why the Tay, in particular, has been affected by this issue in 2011 and not the Dee, for example, may be due to the fact that the Dee's autumn run fish probably spawn earlier than they now do on the Tay. This again may be due to the fact that the temperature regimes of the two rivers are different. Because of the presence of large lochs, the Tay is more buffered against sudden falls in temperature in the early winter compared to other rivers or indeed the Tay's own upper tributaries. It has to be very cold for a long time before the Tay freezes. This effect is even more pronounced because of hydro power. During dry weather the flow in the River Tummel is higher than it would be naturally. Furthermore, the amount of water which flows into, and hence out of, Loch Tay over a year is higher because of the diversion of extra water from the neighbouring Lyon and Orchy catchments.

Implications

Does it matter that spawning was delayed in 2011? Will the delayed spawning result in reduced survival of the eggs or other stages?

Unfortunately, with the limited information available, it is not possible to do much more than speculate on this issue. For example, if incubating alevins are exposed to relatively high temperatures in early summer they might be in poorer condition at the time they start to feed (this is because the higher the temperature during incubation the more of their yolk they metabolise). It is also known from fish farming that if spawning is delayed significantly after the fish have "ovulated" (i.e. when the eggs are released into the body cavity) the fertility of the eggs will be reduced. However, as no fish have been autopsied it is not known whether the cold weather just delayed ovulation or whether it delayed fish which had already ovulated (this is something we intend to investigate, however).

But whatever the impact, given that many of the late spawning fish make little or no contribution to the fishery (they come into the Tay very late in the season or even during the close season), would it actually matter to the fishery if delayed spawning did impact on their reproductive success?

The answer to this question depends on which of the following two points of view is correct:

1) All salmon within a river are essentially the same and differences in run timing / time of spawning etc arise because of differences in the environmental conditions they experience in the river and in the sea. Proponents of this scenario would be concerned at any reduction in the spawning success of late spawning fish because they could in future give rise to fish which enter freshwater and spawn at other times of the year.

2) In the second scenario, features like the sea age, adult run timing, smolt run timing, spawning time and other factors are, in part at least, inherited traits which may be loose adaptations to certain environmental conditions. Environmental changes may result in changes in the proportions of the various types within the total population through the gradual effects of natural selection.

While many people imagine the first scenario to be correct, the weight of evidence now being accumulated indicates the truth is likely to be somewhere between the two, but possibly nearer the second than the first.

There is in fact little doubt that run timing and similar traits have a large inherited component.[2] However, the latening of the summer grilse run which occurred between 2005 and 2009 proved that the timing of that run of fish can vary by several weeks, presumably as a result of the direct effect of environmental conditions at sea. Thus, genes appear to set broad differences in run timing between different sub-stocks but direct environmental effects produce fine tuning on a shorter timescale. If 1) had been the whole case then the climatic changes of the last twenty years would have caused fish to spawn later across all parts of the catchment, but that has not happened. Spring salmon still spawn in early November in the upper tributaries as they have always done.

The increase in late spawners in the main stem of the river may therefore, to some extent, be a result of selection for late spawning fish, which under recent conditions must have had advantages over earlier spawning fish. Some of these have been alluded to earlier. Another could be the fact that late spawning fish are not fished for, while earlier spawning fish are. But if late spawning fish have had a reproductive advantage over earlier spawning fish it would not matter if they are now being selected against, particularly if this means that earlier spawning / earlier running fish do better as a result. From a fishery point of view it would be an advantage if environmental factors favoured earlier spawning fish every year.

But, irrespective of whatever the cause has been, the fact that late running fish now make up a greater proportion of the total autumn/winter run than they did in the 1970s and 1980s is of course one of the reasons why autumn angling catches on the Tay have been lower in recent years.

[2] As a practical example of this, back in the 1990s researchers from the Freshwater Laboratory at Pitlochry stocked one tributary of the River Braan near Dunkeld with salmon fry from the River Almond and another with fry from the River Tilt. Before the fish smolted two years later they were tagged. On recapture as adults it was found that those of Tilt parentage returned as spring salmon or early grilse while the fish of Almond origin returned in late summer, as fish normally do in those tributaries. Thus it was conclusively proved that run timing has a genetic basis rather than being directly dictated by the environment in which the fish grew up. More details can be found by clicking here.