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Coarse fishing close season on English rivers

Appendix 3e – Literature review - smolt migration and potential impacts of relaxing the coarse fish close season on English rivers

Background

The conservation status of Atlantic salmon (Salmo salar) in most principal salmon rivers in England has been classified as being “at risk” or “probably at risk” for the past few years, prompting a programme of work to aid recover - the Salmon five point approach. Some concerns have been raised about the potential impacts of coarse anglers accidently catching smolts on mixed game and coarse fish waters if the close season was shortened or removed. Thus, in our risk appraisals of any change options to the current close season for coarse fish on rivers, we must look at the potential impacts of such reforms on salmon, and in particular on smolts.

Smolt physiology

Prior to seaward migration, juvenile salmon which have typically spent one or two years in freshwater undergo a preparatory smolting process. This involves morphological, biochemical, physiological and behavioural changes that pre-adapt them to life at sea (Hoar, 1988; Høgasen, 1998; Thorpe et al., 1998; Finstad & Jonsson, 2001). These ocean-ready adapted juvenile salmon are termed smolts. Their survival is affected by a limited period of readiness (a physiological “smolt window”) and the timing of seawater entry with environmental conditions (an ecological “smolt window”), such as temperature, food, and predators (McCormick et al., 1998).

In migratory salmonids, the outer layers of the fish is important during the transition from fresh to saltwater. Damage to the skin, scale and mucous complex can directly impair osmoregulation in Salmo salar smolts (Zydlewski et al., 2010). Smolts are delicate when they are in this transition stage and are prone to scale loss, so it is possible that if caught, they could be more susceptible to catch and release handling mortality, compared to pre-smolts. However, Moore et al., (2018) has recently shown in laboratory investigations on the de-scaling of smolts that removal of 1%, 5% and 10% of scales had no significant effect on saltwater survival or other measured physiological parameters.

Smolt mortality rates

Documentation of natural mortality of smolts is rare, indeed research is generally conducted in relation to anthropogenic factors (Norman, 2016). Smolts during their migration are preyed upon by both avian and mammalian species as well as other fish predators. For example, goosanders consumed up to 16% of the total smolt run in the North Esk River, UK (Feltham 1995, Feltham and MacLean 1996).

Thorstad et al., (2012) has shown that smolts and post-smolts swim actively and fast during migration and has estimated their mortality as 0.3–7.0% (median 2.3) per km during downriver migration, 0.6–36% (median 6.0) per km in estuaries and 0.3–3.4% (median 1.4) per km in coastal areas. Thus, estuaries and river mouths are the sites of the highest mortalities, with predation being a common cause. Kennedy et al., (2018) has shown the passage of Salmo salar smolts through a large natural lake resulted heavy mortality rates at the river-to-lake confluences (mean 31.2% per km), but smolt mortality rates were lower in the main body of the lake (mean 2.4% per km). Predation was a significant pressure on emigrating smolts as tagged pike (Esox lucius) aggregated at river-to-lake confluences during the peak of the smolt run. In this study, it was also shown that tagged smolts mainly emigrated from the river into the lake in the late evening after dusk, possibly as a predator-avoidance behaviour.

Smolt migration behaviour

The migration of Atlantic salmon smolts is a critical transition phase from one life history stage to another. This downstream migration is heavily influenced by water temperature; photoperiod; discharge volume; and it can also be impeded to various magnitudes by barriers and obstacles within the river catchment (Newton, 2016). The natural smolt migration window is often reported to be at water temperatures of about 10°C (McCormick et al., 1998). Ibbotson et al., (2006) reported that the migration patterns of salmon smolts on the River Frome (UK) were related to water temperature, such that when daily mean river temperatures were below 12°C migration rates during the day were significantly lower than those at night. When the mean daily river temperature exceeded 12°C, however, there was no significant difference between the hourly rates of migration during the day and night. The timing of the smolt migration is important in determining marine survival. The timing varies among rivers, most likely as a consequence of local adaptations, to ensure sea entry during optimal periods (Thorstad et al., 2012).

The downstream movement of wild Atlantic salmon from established feeding territories in the River Itchen (UK) has been studied by Riley et al., (2002). The time of these movements was related to a number of monitored and calculated environmental parameters. Initial downstream movement of smolts in April was correlated with the onset of darkness, at which time salmon moved from their established feeding territories alone. River Itchen spring run smolts migrations were significantly correlated with sunset. In contrast, the timing of downstream movement of parr (July to mid-March) was random with regard to sunset, suggesting parr movement are motivated by ecological drivers that are different from the environmental cues initiating smolt migration (Riley, 2007). These result support the first stage of a two-stage theory for salmon smolt migration, solitary movement from natal streams followed presumably by ‘schooling’ further downstream.

Schooling behaviour was further investigated on the River Itchen by Riley et al., (2014), these studies showed a significant shift in behaviour between individual smolts observed migrating during the day and at night as they approach the lower reaches of the chalk stream catchment. The patterns observed suggest that smolts detected migrating during the day are schooling but those detected migrating during the night are not. Riley (2007) has shown on the River Itchen that the peak movement (42%) of smolts occurred in April, during the main spring “run”, but note that more than half of these fish migrated after April 15th (see annex Figure 1 and 2). However, significant numbers also left in the autumn (28%), September–November inclusive, and at the time around adult spawning in January (12%). Many other UK rivers have peak smolt runs later in the spring, at the end of April and well into the month of May (e.g. river Tyne, see Annex Figures 2 &3). The early smolt run on the River Frome probably relates to elevated water temperature at that time of year compare to more northerly rivers, as the River Frome is one of the most southerly salmon waters in the UK.

Smolt feeding

Salmon fry and parr feed primarily upon invertebrates, particularly aquatic insect larvae such as mayfly, stonefly and caddis. Terrestrial insects caught on the surface of the water may also be taken, although this food source is more often utilised by trout (Mills 1964, Maitland 1965). Several parameters associated with the increased mortality rate have been investigated, but little information exists on the possible importance of active feeding of smolts and their nutritional status during seaward migration (Larson et al., 2001). However the limited studies examining feeding of salmon smolts all agree that some level of feeding occurs during migration, although these studies show considerable variation in the proportion of empty stomachs among the migrating population. Garnås and Hvidsten (1985), Andreassen et al., (2001) and Larson et al., (2011) found similar high frequency of feeding during smolt migration runs, but in contrast Johnson et al., (1996) found a considerably higher proportion of empty stomachs among wild smolts (50%) in the Merrimack River (USA). A possible explanation for the an apparent reduction in feeding in the presence of an abundant food supply could be related to an increased risk of predation on the journey downstream towards the sea, where the risks and benefits of feedings need to be balanced (Jepsen et al., 1998; Koed et al., 2006; Serrano et al., 2009b).

Conclusions

Recent evidence suggests that smolts are more robust from scale loss related mortalities than previously thought, although they will be still susceptible to some risk of angling related mortalities if caught e.g. excess bleeding from being deep hooked or via poor handling techniques during catch and release. It is possible maggot and castor baits used by coarse fishermen could tempt some smolts, but trout fishermen using nymphs, buzzers or dry fly in early spring usually do not catch many smolts, and such fly patterns are more akin to the natural diet of smolts compare to most coarse fish baits.

If the coarse fish close season window was amended to the 15 April to 30 June (option 3 of the consultation) it would still protect the vast majority (circa >80%) of migrating smolts from exposure to potential angling pressures by coarse fishermen as most smolts migrate after mid-April. For those smolts that are exposed to angling by coarse fisherman, the fishing pressure would likely be low for several reasons: firstly they will not be actively targeted by these fishermen; secondly smolts are more passive than active feeding whilst migrating in early spring, reducing the likelihood of capture; thirdly they will most likely migrate swiftly and at night, thus avoiding most coarse fishermen; and finally if caught, subject to being handled well during catch and release, they should survive. In contrast the complete revocation of the coarse fish close season would expose the full smolt run to coarse fish angling pressures and fish running later when water temperature are higher (end of April to end of June) are more likely to migrate during the day and possible feed more actively with an intrinsically higher risk of capture compared to the early spring run smolts.

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Annex: Smolt run timings in UK Rivers

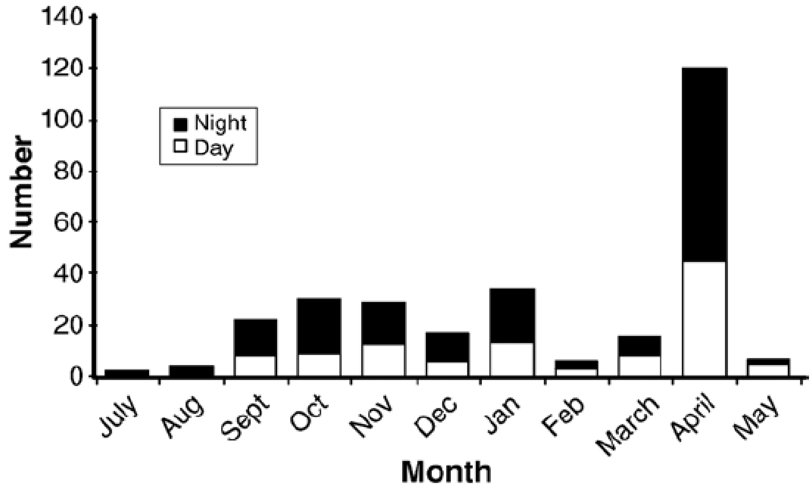

Figure 1 Total number of individual juvenile Atlantic salmon leaving the Brandy Stream, a tributary of the River Itchen (by all exits), by month, pooled for 1999 to 2005. (Figure taken from Riley, 2007)

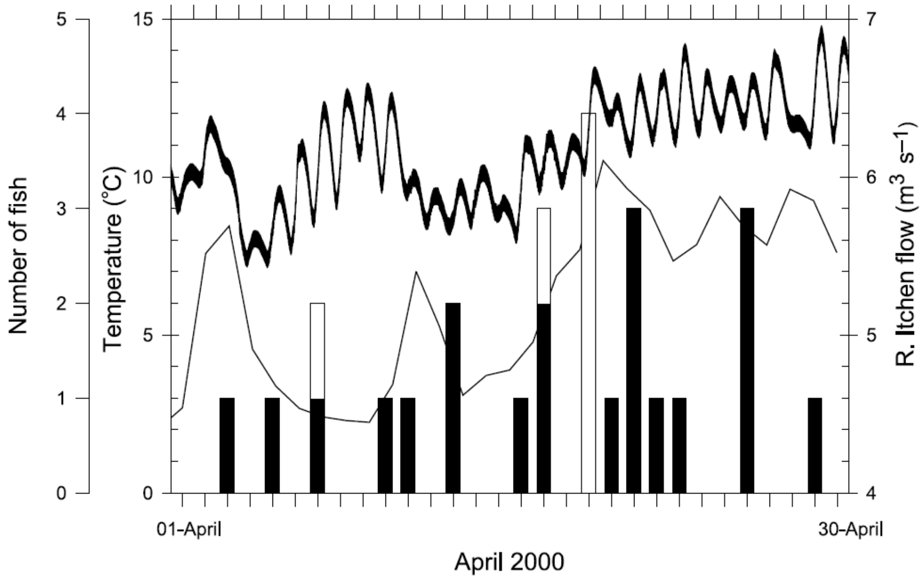

Figure 2 Number of salmon smolts leaving the Brandy Stream (tributary of River Itchen) during April 2000 in relation to environmental pressures (Figure taken from River et al., 2002). ■ Night migration; ☐ Day Migration; ~ Temperature; ~ River flow.

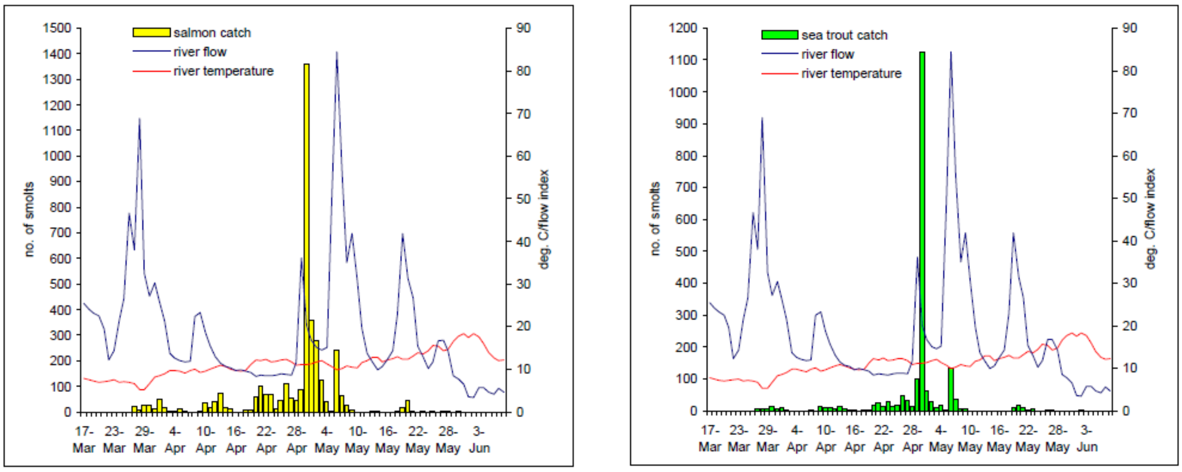

Figure 3 River Tyne smolt catches (salmon and sea trout). In total, 5,559 smolts, comprising 3,652 salmon and 1,907 sea trout, were caught in the rotary screw trap during the 2009 trapping season, most of which were captured in early May. Data source - Second Tyne Tunnel Fisheries Monitoring Smolt trapping report for 2009 season, report No. 11. Environment Agency Internal Report

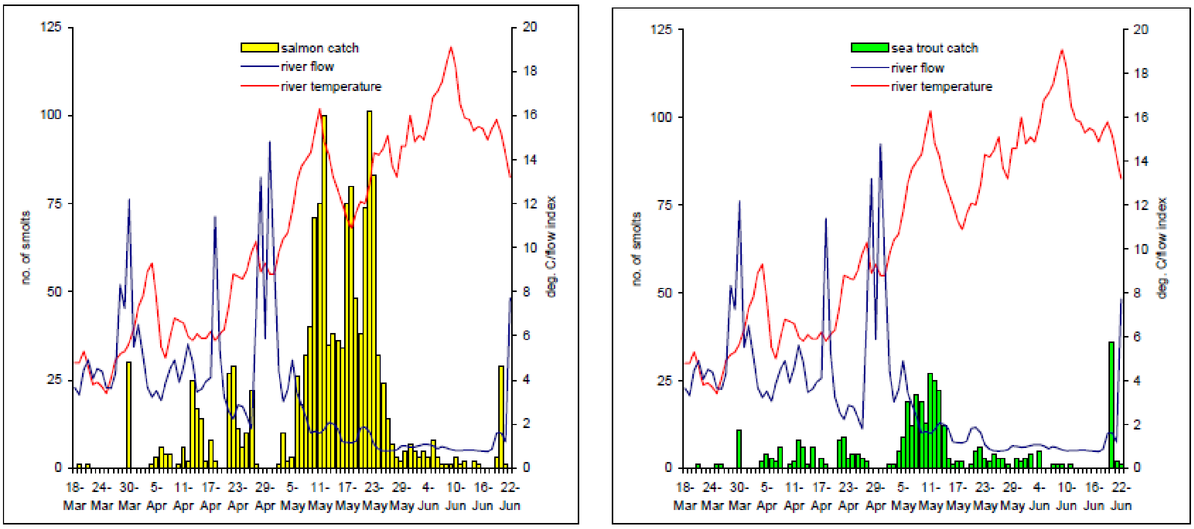

Figure 4 River Tyne smolt catches (salmon and sea trout). A total of 1,793 smolts, comprising 1,419 salmon and 374 sea trout, were caught in the rotary screw trap during the season, with the peak catches recorded during the second and third weeks in May. Data source - Second Tyne Tunnel Fisheries Monitoring Smolt trapping report for 2008 season, report No. 10. Environment Agency Internal Report