Annex 5

Coastal netting impacts on salmon and sea trout: a review of available evidence

1.0 Background

Devon and Severn IFCA is in the process of developing a new byelaw to manage netting within the District. Having recently completed a pre-consultation, comment has been received from all sectors relating to whether current netting measures should be maintained or extended. The nature of these extensions has been detailed elsewhere, but they consider whether an extension of the current 3m headline measures should be extended to the whole District, or whether the current 3m headline restriction should be extended to 5 metres

Additionally, there as has been a dialogue between the EA, IFCAs, the MMO and Defra regarding the legal responsibilities of IFCAs relating to the conservation of migratory fish (primarily salmon and sea trout) stocks. Devon and Severn IFCA is committed to seeking to balance the social and economic benefits of exploiting the sea fisheries resources of the District with the need to protect the marine environment from, or promote its recovery from, the effects of such exploitation as per its obligations under the Marine and Coastal Access Act (MaCAA 2009). This paper primarily focuses on the need to protect the marine environment, in this case the migratory fish component of that environment. This Annex should be considered alongside the other reports compiled as part of this pre-consultation package so that the level of conservation benefit achieved by extending coastal netting measures can be considered in relation to the socio-economic costs. It should also be highlighted that this document is focused only on netting ***outside of estuaries*** (as currently defined) in coastal waters.

2.0 Coastal netting in the context of salmon conservation

2.1 Direct and indirect mortality through direct contact with gillnets

A recent review by the Environment Agency (Sumner 2015) provides a useful background to the potential direct and indirect effects of gillnetting on salmon and sea trout. An initial survival rate of 95% in some fisheries undoubtedly underestimates the overall effects on salmon caught in nets either by delayed mortality or failure to breed. As highlighted by Sumner (2015), existing evidence on the scale of delayed mortality is conflicting, with some studies reporting high mortality rates in experimental gill-netting trials for Pacific Salmon (Thomson et al. 1971 as reported in Chopin and Arimoto 1995) and others reporting low mortality rates in inshore drift net fisheries for Atlantic salmon (Potter and Pawson 1991). Ultimately however, the concern relating to direct and indirect effects of entangling should be proportional to the rate of capture in coastal nets.

2.2 Salmon and sea trout bycatch rates and at sea mortality

Whilst there is an overlap in mesh sizes of nets which are preferentially used to target salmon and those fished for marine species. Sumner (2015) refers to a report by Pawson (2008) which considers bycatch of sea trout in fisheries where bass, grey mullet, herring, mackerel and flatfish are being targeted in East Anglia, resulting in a high potential bycatch of sea trout. However, although the size ranges of mesh for both species will still overlap, in contrast to the situation in East Anglia, netting byelaws already exist in Devon which aim to spatially manage nets which may intercept Salmon.

Details of this byelaw exist elsewhere, but it is clear that the Devon and Severn IFCA already has some of the most stringent measures in place to protect stocks of migratory salmonids, developed in conjunction with the Environment Agency. These areas currently cover a large proportion of the district.

The EA submission to the netting byelaw review suggests that coastal netting may be having a large impact on salmon populations. However D&S IFCA officers have found limited evidence to support the supposition that inshore coastal netting activities for seafish (which may result in a bycatch salmon and sea trout depending on the location, gear type and time of year) are a serious factor in the observed declines in Atlantic salmon or sea trout. Issues relating to the marine phase of salmon must also be viewed in the light of the issues it faces in the freshwater phase of its life-history. In 2014 a coalition of the Angling Trust, Angling Cymru, Afonydd Cymru, Atlantic Salmon Trust, Fish Legal, The Rivers Trust, and Salmon & Trout Association urged the Government to take the five remedial actions to restore stocks of salmon in English and Welsh rivers and protect them for future generations. These steps were generally focused on the freshwater phase of the life-cycle, with fish passage, abstraction, agricultural pollution, physical habitat and exploitation in the North-East coast *targeted* salmon fishery being seen as the crucial steps towards improving salmon stocks. The netting of salmon in estuaries and coastal waters was not highlighted as one of the major factors in the decline of salmon stocks (Angling Trust 2014).

There appears to be a significant evidence gap relating to actual bycatch rates of salmon and sea trout in coastal marine fisheries, how these vary geographically and whether current regulations are sufficient. Sumner (2015) cites a report by the EA and Cefas (Cefas and Environment Agency 2007) as stating that ICES assessments of unreported catches of Atlantic salmon in England and Wales recognises that bycatch of salmon occurs in net fisheries targeting bass. However, no quantative data is provided by either Sumner (2015) or Cefas and the Environment Agency (2007).

Most research investigating the impacts of marine fisheries on salmon has focused on offshore pelagic trawling targeting species such as mackerel and herring, which may intercept juvenile salmon. In a report by the Environment Agency and Cefas (2007) it was found that there was insufficient evidence to allow an assessment of the effect of non-targeted fisheries in salmon abundance, but that they probably had a 'low impact' on salmon pre-fishery abundance:

"*Limited new information was made available to the Working Group in 2007, as a result of research cruises and observer programmes on commercial vessels. A Norwegian research vessel recorded a catch of 46 post-smolts in a single haul, and 7 adult salmon were also recorded as bycatch from three other Norwegian research cruises. However, Norwegian bycatch observers on commercial vessels reported no salmon. Russian observers reported a total of 9 fish from commercial catch screening operations in the Norwegian Sea. Five post smolts, including 4 from one 40 t mackerel catch and 1 from another catch of 35 t, and one adult salmon were recorded during the screening of mackerel, blue whiting and herring catches on one vessel between 19 June and 16 September. Three other fish (2 post smolts and 1 adult) were reported by other commercial vessels. The Working Group concluded that there was insufficient information to allow any assessment of the effect of non-targeted fisheries on salmon abundance. It remains the view that salmon bycatches appear to have a low impact on salmon Pre-Fishery Abundance (PFA) and returns to homewaters*."

In a more recent assessment by the EA a similar conclusion was made that:

"*The ICES Working Group previously concluded that there was insufficient information to allow any assessment of the effect of non-targeted fisheries on salmon abundance. This remains the case. The latest available data remain consistent with the view that salmon bycatches appear to have a relatively low impact on salmon PFA and returns to homewaters. However, the Working Group recognises that these estimates remain highly un-certain and considers it would be informative to increase efforts to obtain reliable estimates of the bycatch of salmon*" (Environment Agency, Natural Resources Wales and Cefas, 2015).

In a summary of the 2012 'Salmon Summit' convened by the North Atlantic Salmon Conservation Organisation (NASCO) and the International Council for the Exploration of the Sea (ICES) it was acknowledged that "whilst the short-term response to a stock failing to achieve its conservation limit may be to reduce or eliminate fishing, overharvesting may not be the cause of the decline" (Windsor et al. 2012). In fact, results of scientific studies presented at the Salmon Summit suggested that the reducing marine survival of salmon is thought to be primarily related to a changing climate resulting in the widespread nature of the decline salmon abundance. In particular, a growing body of scientific evidence indicates that changes in sea surface temperature are affecting the growth, survival and maturation of salmon in the marine environment. This may be either through direct physiological and behavioural responses, or through indirect effects of changing temperature on their ecosystem and food (Beaugrand and Reid 2012, Chaput 2012).

Even less scientific evidence is available to deduce the potential impacts of coastal netting on sea trout populations. Sumner (2015) highlights the existence of sea trout in coastal waters year round, and therefore suggests the need to restrict coastal netting more closely. However, again this is an extremely data-poor area, with no evidence that coastal netting is having a negative impact on sea trout stocks. In a detailed review Harris (2004) suggests that the development of a long-term strategy for the conservation and management of sea trout fisheries will need to address the unknowns and uncertainties that limit our ability to manage sea trout stocks effectively and efficiently. He calls for more evidence on a number of issues before a step-wise approach to management can be implemented, including :

"*The nature and extent to which sea trout are subject to illegal or inadvertent capture in other fisheries for marine fish species. We have no information other than a passing reference to the illegal landing of sea trout at seven locations by Pawson & Benson (1983)*"(Harris 2004).

Therefore, given the paucity of evidence on rates of bycatch of salmon and sea trout in coastal netting and the potentially small role played by mortality caused bycatch (or even directed catch) of salmon in the marine environment in relation to other issues in the salmon's marine phase (above) and freshwater phase (below) there does not appear to be a strong evidence base to suggest that further restrictions on coastal netting will have any conservation benefit for the species. Whilst Devon and Severn IFCA is committed to supporting the protection to migratory fish stocks from marine fisheries bycatch, it appears that at the present time there is little evidence that coastal bycatch is playing a large role in the decline of either of these species. Future research (see below) planned by D&S IFCA will attempt to collect some data to help further our knowledge in this area, but clearly an ultimate answer would require large-scale observer programmes and a multi-agency approach. Through the implementation of a permitting byelaw, netting restrictions can be updated based on any new evidence that comes to light.

2.3 Headline depth

The evidence presented by Sumner (2015) does not appear to strongly support an increase to a 5m depth restriction for the headline for nets. Many of the studies cited report salmon spending 'x' proportion of time at 0-5m, however, rather than an explicit test of whether 5m is an ecologically important threshold, in fact this is generally a result of arbitrary binning into depth bands for temporal analysis. A re-analysis of data storage tag data which explicitly tests the amount of time spent in the 0-3m and 3-5m would provide more useful evidence for a management measure which may have large socio-economic consequences. Those studies which have included a finer break-down of time spent at depths shallower than 5m once again fail to present a clear argument for increasing the minimum headline depth. In a study of 56 adult Atlantic salmon in the Alta Fjord in northern Norway mean swimming depth was shallow (2.5–0.5 m), but with dives down to 30 m depth (Davidsen et al. 2013). However it should be noted that the applicability of a study in a Norwegian fjord may have little relevance to behaviour in coastal salmonids in the south west of England. Whilst Godfrey (2014) reports that in 34 salmon 72-86% of their time was spent at 0-5m, and it is clear that a significant proportion of this is also likely to be in the shallower portion of this depth bin (Figure 1).

Table 1. Mean depths and ranges reported for 56 salmon in a fjord in Norway taken from (Davidsen et al 2013) Godfrey 2014

ALS Array	*n*	Mean (m)	S.D. individual mean (range) (m)	Deepest individual recording (m)	Mean depth females (m)	Mean depth males (m)	*p*-value (between sexes)
2	23	2.4	3.7 (0.0–16.1)	29.7	2.6	1.8	0.57
3	24	1.1	1.5 (0.0–6.4)	18.9	0.9	1.4	0.36
4	18	1.5	1.9 (0.0–6.7)	10.9	1.4	1.7	0.75
5	21	0.5	0.7 (0.0–1.8)	14.6	0.4	0.9	0.18

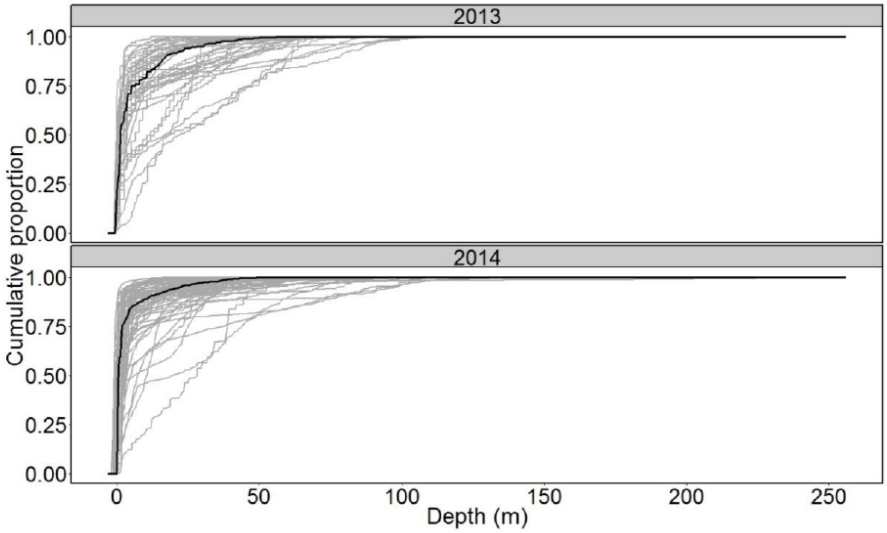

Figure 1 Cumulative frequency of swimming depths for Atlantic salmon in Scottish coastal waters in summer 2013 (upper panel, n=43) and 2014 (lower panel, n=74). Thick line indicates median, thin lines represent individuals.

Again, Holm 2006 reports on the percentage of time spent above an arbitrary depth bin of 5m (60%), but does also report that from a total 5574 observations of 60 min data which were available for the analyse of the diel distribution, 28.5% were above 2 m depth.

Finally, in a fine-scale analysis of a very small number of salmon, Sturlagsson (2009) shows that one male salmon spends the majority of its time significant shallower than 5m and one female spends the majority of its time deeper than 5m (Figure 2).

Currently, there is no reliable data for depth use by salmon from comparable geographic areas. The more recent data does not appear to provide enough evidence to suggest that increasing the minimum headline depth to 5m will have a discernible and beneficial effect on the stocks. The results of the recent studies are variable and still emphasise and indicate that salmon use depths shallower than 3m.

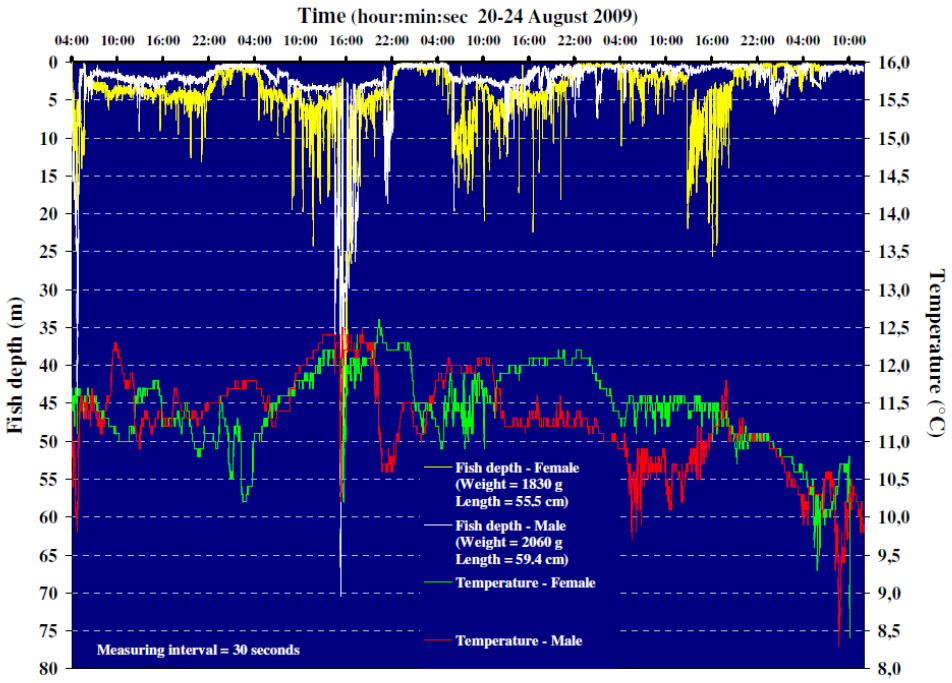

Fig. 2. Depth distribution of 2 homing salmon in coastal waters in the area SW off Iceland and corresponding temperature. The profiles range over area in South from off Reykjanes peninsula near Reykjanes ridge, into Bay of Faxafloi and finally in North into Borgarfjord and the estuary of River Hafnara. Size of the salmon and their sex are given.

2.4 Evidence gaps

In reviewing the evidence provided, Devon and Severn IFCA officers believe there are several large evidence gaps, these are:

1. Little scientific or observational evidence for the level of bycatch salmon and sea trout in coastal net fisheries being significant
2. Little scientific evidence for coastal bycatch in net fisheries being a major component in salmon and sea trout decline and thus there being any measurable conservation benefit to imposing further coastal netting restrictions
3. Weak scientific evidence that that increasing the minimum headline depth from 3m to 5m will have any major conservation benefit, especially given evidence gaps 1 & 2.

2.5 IFCA research

Devon and Severn IFCA are currently developing a PhD focussed primarily on European sea bass. As part of the workplan, a netting study is being developed to look at spatial and depth variations in the catches of bass. Very early stage discussions have taken place to outline whether a partnership approach to this work could be developed to incorporate salmon and sea trout bycatch questions, possibly including genetic testing of any migratory species caught to trace them back to rivers of origin. An outline for the planned bass work is provided elsewhere.

2.6 References

Angling Trust (2014) Wild Salmon Stocks Crash – Angling and Fisheries Organisations Call for Urgent Government Action. Accessed [online] February 2015: http://www.anglingtrust.net/news.asp?section=29&itemid=2247

Arimoto, T., 1995. The condition of fish escaping from fishing gears—a review. Fish. Res. 21, 315–327.

CEFAS & Environment Agency (2007). Annual Assessment of Salmon Stocks and Fisheries in England and Wales 2006.

CEFAS & Environment Agency (2014) Salmon Stocks and Fisheries in England and Wales in 2014.

Davidsen, J. G., Rikardsen, A. H., Thorstad, E. B., Halttunen, E., Mitamura, H., Præbel, K., Skardhamar, J. & Næsje, T. F. (2013). Homing behaviour of Atlantic salmon (*Salmo salar*) during final phase of marine migration and river entry. *Canadian Journal of Fisheries and Aquatic Sciences*, 70(5), 794-802.

Godfrey, J. D., Stewart, D. C., Middlemas, S. J., & Armstrong, J. D. (2014). Depth use and migratory behaviour of homing Atlantic salmon (Salmo salar) in Scottish coastal waters. *ICES Journal of Marine Science:* Journal du Conseil.

Harris (2004) A Review of the Statutory Regulations to Conserve Sea Trout Stocks in England and Wales, Sea Trout: Biology, Conservation, and Management : Proceedings of First International Sea Trout Symposium, Cardiff, July 2004/editors, Graeme Harris and Nigel Milner. Blackwell Publishing.

Holm, M., Jacobsen, J. A., Sturlaugsson, J., & Holst, J. C. (2006). Behaviour of Atlantic salmon (*Salmo salar* L.) recorded by data storage tags in the NE Atlantic–implications for interception by pelagic trawls. ICES.

Potter, E. C. E., & Pawson, M. G. (1991). Gill netting. Ministry of Agriculture, Fisheries and Food, Directorate of Fisheries Research.

Sturlaugsson, J., Gudbjornsson, S., & Stockhausen, H. (2009). Orientation of homing Atlantic salmon (*Salmo Salar* L.) mapped in relation to geomagnetic fields. *International Council for the Exploration of the Sea,* CM.

Sumner K. (2015) Review of protection measures for Atlantic salmon and sea trout in inshore waters, Appendix 3, ENVIRONMENT AGENCY RESPONSE TO THE DEVON AND SEVERN IFCA NETTING CONSULTATION.