



Post-smolt covered in sea lice.

A race for relevance

By Edward Fahy

Significant difference in emphasis in recent studies on sea lice and the marine survival of salmon

WHEN problems with sea lice first appeared in the vicinity of salmon sea cages, the parasite made its debut on sea-trout. The smaller salmonid species undertakes considerably shorter feeding migrations in the sea than Atlantic salmon and the youngest sea-trout may have a sojourn in brackish and salt water of no more than a couple of months before making a first return to fresh water. Sea lice is an inshore parasite, thriving in sea loughs, typical habitat for sea-trout, in which the majority may well spend their entire first marine migration.

The association of salmonids and sea lice has been reported in every account of salmonid biology I can recollect consulting so it was nothing new. The chief inspector of salmon fisheries in Scotland, W.J.M. Menzies, in his book *Sea trout and*

trout, observed that it was not unusual for finnock (sea-trout in their first sea migration) to be covered in dozens of sea lice, the phenomenon recorded in the late 1980s when emaciated, heavily infested post-smolt sea-trout made a premature reappearance in fresh water. Menzies had published his book in 1936, a half century before intensive cage rearing of salmon got underway, so that when the problem came to notice later there was a ready-made explanation for it.

The fate of sea trout absorbed public concern for a number of years and intensive salmon rearing became more implicated as an exacerbating, if not a causal factor

in their decline. The question of whether and how salmon might be affected was alluded to but in a more speculative way. Salmon smolts went to sea, through the lice envelope, on to feeding grounds off the Faroes, whence they returned as grilse after a year, or further, to Greenland, from which smaller numbers of larger spring fish reappeared in their natal rivers after two or more marine winters. The seas were known to be warming; the survival of mature fish might be altered by a variety of interacting environmental, biological and behavioural factors among which the influence of that aspect of intensive aquaculture was indecipherable.

In such complex circumstances, the only way to ascertain the likely effect of a single factor is to selectively eliminate it and critically compare appropriately "treated" batches of salmon paired with untreated "controls." The chemical emamectin benzoate is a pesticide which is widely used to eliminate insect pests in agriculture and sea lice in salmon rearing. Smolts treated with the substance are afforded protection from the salmon louse for up to nine weeks, more than enough time to move through and clear the coastal waters in which the parasites concentrate, in the course of their seaward quest for food. Because the chemical is

effective against sea lice, any survival differences between salmon in the treated and control groups could be attributed to mortality caused by the parasite.

Experiments which attempted to quantify the impact of sea lice infestation, undertaken over the last seventeen years, were published by two teams during the past six months. They provide disturbing data on the status of Atlantic salmon and, additionally, for various reasons, they are eloquent testimony to the state of marine science in Ireland today. The papers, each based on some material already in the public domain, set out to quantify the consequences of sea lice for the marine survival prospects of Atlantic salmon.

The account in the Proceedings of the Royal Society was prepared by collaborators in New Zealand, Canada, Ireland, Norway and the UK, for which reason I will refer to it in abbreviated form as the international study. Its findings are based on 283,000 smolts released between 1996 and 2008 at ten sites in Ireland and Norway.

The other study was published in the *Journal of Fish Diseases*¹ in 2013. I will refer to it as the Irish study because it was prepared by an Irish investigative team. Its findings are based on 352,000 smolts released between 2001 and 2009 at eight locations on Ireland's west and south coasts.

Experimental procedure was similar in both studies: salmon smolts were hatchery reared, imprinted at their point of release, to ensure they would home back to that river catchment, they were micro-tagged and each sample was divided into two batches one of which was treated with emamectin benzoate, the other left untreated as a control. The relative success of the treatment was evaluated from the rate of return of salmon one year later.

HOLD THE FRONT PAGE!

One of the many intriguing aspects of this story is the apparent competition to get the results into the public domain. The international study was received by the Royal Society on 4th October 2012 and accepted for publication on the 15th – eleven

days later. The *Journal of Fish Diseases* received the Irish study some months earlier but, coincidentally (?), received a revised version on the 5th October, one day later than the Royal Society, which it accepted on the 17th, a fortnight later and two days after the international study.

The two investigative teams processed their results using different statistical approaches to calculate the difference in survival rates between lice-proofed and untreated salmon. The international team concluded that treatment had significant benefits; as many as 39% of untreated fish failed to recruit to the adult population. Put another way, sea lice might be held culpable for the mortality of two out of five migrating salmon, a not inconsiderable quantity.

The Irish team decided that, while lice-inflicted mortality on descending salmon smolts could be significant, it was a relatively minor and irregular variable in marine survival which was unlikely to influence the conservation status of salmon stocks. That said, a higher percentage of smolts which had been treated with the pesticide almost invariably out-performed those which had not been dosed while all of the statistically significant better results characterised treated rather than untreated migrating salmon.

A particularly disturbing aspect of the investigation, set out graphically by the Irish team, was the decline in marine survival of salmon, whether treated against sea lice or not. In 2001 it averaged at some 12% of smolts going to sea; three years later it had more or less levelled off at less than 5%.

Obviously, sea lice is not the only factor exacerbating marine mortality and there is much to be learned. A major question is whether in the near future we will have any salmon to teach us?

The extent to which we have been de-sensitised to the decline and disappearance of fish stocks and species is alarming. Whitefish

species have been reduced to commercial extinction in marine areas. Now our most valuable migratory fresh water species, eel and salmon, seem inexorably committed to decline. If the status of Atlantic salmon has deteriorated to the point where closure of commercial fisheries for it has been considered appropriate, should efforts not be made to alleviate any and every source of mortality, however small, and ensure the survival of some broodstock to see us through to better times?

CUI BONO?

The precautionary principle was introduced into European Community policy formulation on marine capture fisheries quite recently and it is honoured more in the breach than the observance. The principle advises prudence

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when dealing with living natural resources: if you do not have sound evidence that a fish stock is in good health, do not assume it is, and proceed accordingly. I have yet to encounter a scientist who disagrees with its sound sense; except

where there is some reason for doing so.

The apparent race to get two studies of the same topic into print might just be coincidence. The drama is however played out against the backdrop of a proposed expansion of fish farming. Welcoming the Irish study Donal Maguire, Director of Aquaculture Development Services in BIM, claimed it confirmed “the validity of the approach BIM had taken ... to the development of the aquaculture industry.” He stated that “stories in relation to sea lice being a threat to wild salmon had no basis in scientific fact,” which goes further than the Irish team's conclusion. It contradicts the findings of the International investigation which is, conveniently, not alluded to in the press release.

As is customary for BIM spokespersons, Maguire's

comments concluded by reminding his audience of the opportunities for employment and income presented by aquaculture to coastal communities around Ireland.

This year is the 61st since BIM was founded. The 1952 legislation establishing the agency conferred responsibility for developing the fishing industry in the widest sense. Aquaculture was not specifically alluded to but was subsequently absorbed into the agency's remit; the amount of effort invested in developing it expanded as wild capture fisheries declined.

Unfortunately, a similar pattern has been repeated in both: the promise of riches in the future directed subsidies from the exchequer and the European Union into the creation of infrastructure but the fate of fish stocks on which such developments depended was either incorrectly assumed to be safe or, more likely, not considered at all. The wild capture fisheries have been greatly depleted and their stocks are committed to further decline. The fishing fleet is disproportionately large and hungry. The experience with aquaculture has not been impressive either. Whatever is permitted to take place in the future must not be allowed to further jeopardise the fish stocks on which all such projected wealth and employment are dependent; the benefit of any doubt in this case must be directed towards safeguarding salmonid stocks rather than promising future enrichment by farming the species.

i M. Krkošek, C.W. Revie, P.G. Gargan, O.T. Skilbrei, B. Finstad and C.D. Todd. *Impact of parasites on salmon recruitment in the Northeast Atlantic Ocean. Proceedings of the Royal Society B.*
<http://dx.doi.org/10.1098/rspb.2012.2359>

ii D. Jackson, D. Cotter, J. Newell, S. McEvoy, P. O'Donoghue, F. Kane, T. McDermott, S. Kelly and A. Drumm. *Impact of Lepeophtheirus salmonis infestations on migrating Atlantic salmon, Salmo salar L., smolts at eight locations in Ireland with an analysis of lice-induced marine mortality. Journal of Fish Diseases, Blackwell Publications, 2013.*