

PE1598/G

Scottish Oceans Institute Letter of 29 August 2016

I write in response to your request for a written response to Petition PE1598 Protecting wild salmonids from sea lice from Scottish salmon farms. Over many years I have been involved in a range of research projects and publications relating to sea lice (*Lepeophtheirus salmonis* and *Caligus elongatus*) and their parasitic association with salmonid fish hosts. The two louse species both are natural parasites of marine fish, but they differ in their host specificity. *L. salmonis* in Scotland is associated only with Atlantic salmon (*Salmo salar*; farmed and wild), sea trout (*Salmo trutta*) and sea-cage cultured rainbow trout (*Oncorhynchus mykiss*), whereas *C. elongatus* has been recorded from more than 80 species of marine fish species. When “sea lice” are referred to in relation to impacts on wild salmonids, the species of concern typically is *L. salmonis*, although *C. elongatus* does also comprise an identifiable pest to the salmon farming industry and also infests wild salmon and sea trout.

Sea lice are unusually effective parasites in many regards. For most parasite-host associations, many (or even most) potential hosts are not infected, or carry a very low abundance of parasites. Typically, many (or most) hosts are uninfected because by chance they fail to encounter the infective stage of the parasite; but a very few host individuals within a given population can carry very high burdens of the parasite. The technical term for this is “over-dispersion” of the parasite amongst host individuals in a population. It also is relatively unusual for a parasite species to exert a lethal influence on the host individual. In the case of *L. salmonis*, this parasite is especially unusual in showing 100% prevalence on wild Atlantic salmon, and despite the fact that adult female louse fecundity is relatively low. Every wild salmon returning to Scotland carries this parasite. Typically, an adult female salmon louse might produce a few hundred or few thousand eggs and larvae in its lifetime. The fact that all wild salmon are infected therefore indicates that the colonising larval stage of the parasite is extraordinarily efficient at locating the host fish. We also have shown, from monitoring data of wild salmon returning to Scotland, that infection continues whilst the salmon are resident in the open North Atlantic Ocean. Again, that the fish and infective parasite larval stage actually encounter one another in the open ocean is remarkable. Finally, it should be noted that the feeding activity of sea lice on the skin of the host fish can cause lesions that compromise the ability of the host fish to maintain body fluids, and these wounds also can lead to secondary infection. Both of these effects can be lethal to the host fish.

Over many years there have been reports from NW Europe and North America of *L. salmonis* negatively impacting wild salmonid populations. Heavily infested fish can show visibly obvious lesions and damage and can be killed as a result. Obtaining direct experimental and observational evidence of detrimental impacts of sea lice infestation on wild salmonid populations is fraught with difficulty. Moreover, identifying the source, or sources, of any such infestations also is challenging.

We have published several papers regarding Irish and Norwegian data derived from large-scale experimental releases of hatchery Atlantic salmon smolts that had been treated to protect them against sea lice infection (e.g. Krkošek *et al.* 2012 *Proceedings of the Royal Society B*, Vol. 2012 2359 doi: 10.1098/rspb.2012.2359; Krkošek *et al.* 2013 *Journal of Fish Diseases*, Volume 37, pp 415-417. doi:10.1111/jfd.12157; in each experiment an additional (control) group of untreated fish also was released. The analytical outcome of these substantive data was a clear positive effect of treatment on survivorship of fish to successfully return from the ocean and to their river of release. The conclusion from these analyses is that salmon lice can and do exert an identifiable negative effect on survivorship of free-ranging host fish and on population viability and maintenance. No comparable data are available from Scotland.

In the petition, a lengthy quote is offered from our recent published review (*Marine Biology*, Volume 163: pp 1-13 doi: 10.1007/s00227-016-2820-3) which focused specifically on sea trout. In that review (and other reviews and an extensive report I co-authored for the WWF Salmon Aquaculture Dialogue) we have consistently made qualified statements about the need to apply the precautionary principle in managing wild salmonid populations in relation to sea lice impacts. For example, in our 2009 Working Group Report on Sea Lice to the WWF Salmon Aquaculture Dialogue (authors L. Dill, B. Finstad, C. Revie, C. Todd) we stated “Nevertheless, given all the foregoing evidence, and in light of sea trout declines having been coincident with observations of sea lice

epizootics and the proximity of intensive salmon aquaculture, the logical conclusion should lead to the invocation of the precautionary principle.” In our recent review of the published literature pertaining to sea trout (Thorstad, E. *et al.* 2016 “Effects of salmon lice *Lepeophtheirus salmonis* on wild sea trout *Salmo trutta* – a literature review”. *Aquaculture Environment Interactions*, Vol. 7: pp 91-113 doi: 10.1007/s00227-016-2820-3) we drew the following conclusion. *“The studies reviewed demonstrate that salmon farming increases the abundance of salmon lice in the marine habitat and there is extensive published evidence that salmon lice in intensively farmed areas have negatively impacted wild sea trout populations. The effects of salmon lice on sea trout include increased marine mortality, changes in migratory behaviour, reduction of marine growth of individual fish, and reduced population sizes.”*

It is clear that it is in the specific interest of the salmon aquaculture industry to minimise the commercial impact of salmon lice on their operations. Control of parasites must be achieved by the industry in a manner that is economically and environmentally acceptable. There is no doubt that the larvae released by gravid female lice on farmed salmon will be dispersed to the wider environment and, in this specific regard, I therefore would continue to encourage an intensely precautionary approach to managing populations of wild salmonids.

Yours sincerely,

C.D. Todd
Professor of Marine Ecology