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Does the use of salmon frames as bait for lobster/crab creel fishing significantly increase the risk of disease in farmed salmon in Scotland?

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ABSTRACT

Salmon farming is an important economic activity, and employer, particularly for remoter areas of Scotland; crustacean fisheries are also significant small businesses in these areas. Salmon frames (the head and spine that remain after evisceration and filleting) are sometimes used to bait the creel pots used to catch lobsters and crabs. These frames may contain pathogens that could potentially be spread to salmon farms in the vicinity of creel fisheries. Therefore, an analysis has been carried out for key pathogens of farmed salmon to assess the risks associated with this process. Infection of farms via creel bait requires that: (1) pathogens are present in salmon at harvest; (2) they are not removed from the salmon that used for bait during processing; (3) they transmit from creel pot baits to salmon farms. This last step is critical and leads to most of the uncertainty in results. Risk were assessed for 7 viruses, 3 bacteria, and 3 eukaryotic parasites of importance to salmon farming. A potentially significant risk was identified in association with disease control programmes if fish were filleted at a secondary processor; such a situation should arise only rarely. A very low risk, per event, was identified from imports, however, because of large numbers of Norwegian imports processed in the UK this risk is always present. Risks were at worst of low (disease control) or very low (imports) probability and are significant only because of the magnitude of consequences.

1. Introduction

Creel fishing is a commonly used method to catch lobster, crab and *Nephrops* in Scottish waters (Scottish Government, 2012, 2013). The creel fishery for lobsters (*Homarus gammarus*) was worth £10.5 M in 2013, while edible crabs (*Cancer pagurus*) and velvet crabs (*Necora puber*) totalled £15.6 M and *Nephrops* (*Nephrops norvegica*) £13.2 M, with a much larger *Nephrops* catch by trawl (£51.3 M). Total creel fishing in Scottish water is thus worth nearly £40 M.

Creel fishing uses creels deployed on the sea bed and baited to entice the crustaceans to enter and become trapped. One source of this bait has been the frames derived from salmon processing. Frames are the head and bones of fish left once fillets have been removed for human consumption and viscera disposed of as waste. Economically beneficial uses for these frames increase the financial sustainability of producers and also minimise waste that might otherwise go to landfill.

A potential risk has been identified in that salmon frames might contain pathogens that place other salmon farms at risk. Atlantic salmon (*Salmo salar*) production was 162,000 ton in 2013 (Munro et al., 2014) and worth over £500 M. Infection is widespread, and infectious diseases account for about 31% of all the losses that occur on salmon farms (Soares et al., 2011); individual disease outbreaks can costs tens of millions of pounds (Hastings et al., 1999). If infected salmon are processed then it is possible that pathogens might be retained in the frames and subsequently be released from a creel deployed in the vicinity of a salmon farm, thus spreading infection to this salmon farm. Although the baits placed in individual creels constitute a small quantity of fish, they do involve the placement of salmon carcass products directly into the marine environment and this can include locations that are close salmon farms with their large populations of potential hosts.

The process of transmission via the frames involves several steps that must all occur for infection to result, but give the large size of potential consequences, even an unlikely route may prove significant enough to require a control intervention. An analysis of the use of imported fish material as bait used in lobster pots to catch Australian spiny lobster found the risk to be negligible (Jones, 2001). However, that risk concerned exposing wild fish to wild fish material. Infection in farmed fish is often at higher prevalence, and

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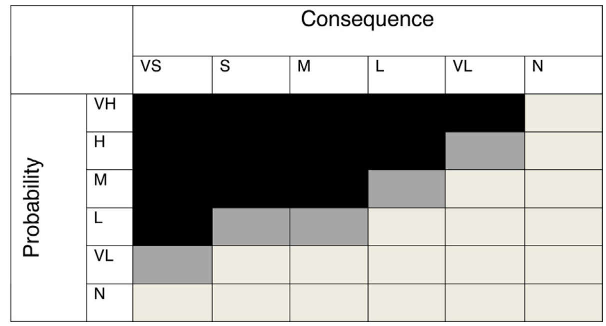
Table 1
Categorisation of qualitative probabilities used in analysis.

Negligible	**N**	So rare that it does not merit consideration
Very low	**VL**	Very rare but cannot be excluded
Low	**L**	Rare but could occur
Moderate	**M**	Occurs regularly
High	**H**	Occurs very often
Very high	**VH**	Event occurs almost certainly

Table 2
Categorisation of qualitative consequences used in analysis.

Negligible	N	No effects of infection	
Very low	VL	Extra effort e.g. diagnostic tests	<£5K
Low	L	Small reduction in site production	£5K–£50K
Moderate	M	Large reduction in site production	£50K–£500K
Serious	S	Depopulate site	£500K–£5 M
Very serious	VS	Depopulate multiple sites	>£5 M

Table 3
Suggestion for acceptable levels of risks from interaction of probability and consequence. Black = unacceptable, pale = acceptable, grey = marginal risk. Very high risk is never acceptable, unless consequence is negligible. Very high consequences are only acceptable at negligible risk, but may be considered for the case of very low probability.



therefore the salmon frames may be more likely to be a source of pathogens than the Australian bait derived from wild fish. At the same time, the larger populations on farms may allow a pathogen to become established more easily should it reach the farm. Since both salmon farming and crustacean fisheries are significant activities we have conducted a risk analysis to assess the potential for disease spread via the use of creel baits and hence the need for any additional controls on this activity.

2. Methods

2.1. Risk analysis

A widely used approach to assessing potential dangers is the use of risk analysis. This approach is widely used and has been standardised in animal health, including in aquatic animal health (Rodgers, 2001; Peeler et al., 2007; in press). Risk analysis consists of identifying a hazard (a pathogen that might cause an undesirable outcome), assessing the probability of this pathogen transmitting to the farmed salmon population and the consequence should this eventuate. In this case the hazards are pathogens, and the probability is that of resultant disease through the use of creels baited with salmon frames. The consequence is the cost imposed by such a disease outbreak, which extend beyond direct losses of fish in the immediate outbreak.

The probability of a risk can be derived in a qualitative or quantitative form (Vose, 2001). Although quantitative assessments allow a more precise estimate of risk they require substantial quantities of data and, where these data are uncertain, there will be great uncertainties in the estimated probability. The qualitative method is effective at providing a quick and rational decision as to the prospective risk. Quantitative risk considered in this analysis (Table 1) are those adopted by the Scottish Government for risk assessment of terrestrial animal disease under the EPIC (Epidemiology, Population Health and Infectious disease Control) centre of expertise (http://epicscotland.org/).

For the analysis a three stage risk assessment model is used, this requires the multiplication of qualitative risks to establish a risk chain. Here i use the rule that when two qualitative probabilities are multiplied the net risk is the lower of the two e.g. **L** × **H** = **L**, or if two similar risk are multiplied then the risk drops to the next lower value (e.g. **M** × **M** = **L**). This is subject to a potential discrepancy in a 3 step model depending on the order of the risk steps, for example **M** × **M** × **L** = **L** × **L** = **VL** while **L** × **M** × **M** = **L** × **M** = **L**, so for consistency we use the minimum value of risk when multiplying three qualitative probabilities together.

A risk consists of both a probability (Table 1) and a consequence (Table 2). The consequence can consist of direct losses through mortality and reduced productivity, but also includes costs imposed by disease control measures and factors such as reduced welfare, which may be very difficult to quantify. Consequence can also include effects on human health through zoonosis. If the consequence is small then even a high risk may be tolerated and a guidance table is provided (Table 3). Consequences can be considered as a financial estimate (Table 2). As well as damage to production, the consequences may include factors such as zoonotic risk or impact on wildlife. These are difficult (although not impossible) to quantify financially but certainly increase risk categories with respect to that derived from illustrative scale of financial damage to production.

In practice most of the higher probabilities in Table 3 are not relevant to the risk associated with frame use; they are included for completeness. As will be later shown, none of the net probabilities of transmission through all three steps are assessed as being greater than **L**, with most **VL** or **N**. Risks associated with serious and moderate consequences are both the same according to Table 1, this is a question of interpretation of grey area risk at low probability. Risk in the grey area is likely to be acceptable for moderate risks but unacceptable for a serious risk unless there are significant extenuating circumstances.

The process of evaluation of risk is iterative. Risks that are clearly negligible, or very low probability in the absence of very serious consequences, need not be considered in further detail. The same would apply to high probability risks, although in this case such risks do not apply. Risks identified as being in the marginal areas are focused on for more detailed analysis and the collection of more information.

2.2. The risk model

A specific model is developed for the use of salmon frames as creel bait (Fig. 1). This model derives a qualitative probability in a three step process: (1) are the salmon infected when sourced by a processing plant; (2) if infection is present in the salmon when they enter the processing plant, how likely is it that infection will be present in the resultant frames and (3) if the frames carry pathogens, how likely is it that infection will reach and establish on adjacent salmon farms? These conditional probabilities are combined as described above to create a net probability of infection of salmon farms by use of salmon frames. The analysis also describes (4) alternative sources of infection, which allows interpretation of marginal risks, since if there is a high probability of infection via other routes then any risk associated with frames must be considered relatively less significant. Finally there is the consequence,