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Impact of early infestation with the salmon louse *Lepeophtheirus salmonis* on the subsequent survival of outwardly migrating Atlantic salmon smolts from a number of rivers on Ireland's south and west coasts

D. Jackson *, D. Cotter, N. ÓMaoiléidigh, P. O'Donohoe, J. White, F. Kane, S. Kelly, T. McDermott, S. McEvoy, A. Drumm, A. Cullen

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ABSTRACT

The potential impact of sea lice infestation on outwardly migrating Atlantic salmon smolts has been investigated by treating populations of ranched salmon, prior to release, with a prophylactic sea lice treatment conferring protection from sea lice infestation, for up to 9 weeks. Established populations of ranched Atlantic salmon with well described rates of return were chosen to investigate the potential contribution of early infestation with the salmon louse, *Lepeophtheirus salmonis* to mortality in Atlantic salmon. Results of five releases from four locations are presented and compared with a time series of releases from Lough Furnace in Newport, County Mayo. The results of this study would suggest that infestation of outwardly migrating salmon smolts with the salmon louse (*L. salmonis*) was a minor component of the overall marine mortality in the stocks studied.

1. Introduction

Significant declines in marine survival of Atlantic salmon have been recorded in Ireland (Salmon Management Task Force Report (Anon, 1996); Jackson et al., 2011; Ó Maoiléidigh et al., 2004). The reasons for the reduced marine survival remains unclear and speculation has ranged from global warming effects (Friedland et al., 2005) to habitat changes and sea lice infestation (Finstad et al., 2007).

A long term study of lice infestations in outward migrating salmon smolts has been carried out to measure the impact of early infestation of outward migrating salmon smolts with the salmon louse, *Lepeophtheirus salmonis* Kroyer, in established ranched strains. "Ranched" salmon stocks are hatchery reared salmon deliberately released into the wild as smolts with the intention of harvesting all of the returning adults at or near the point of release. The study, based at the Marine Institute research facility in Burrishoole, Newport, County Mayo, has been running for ten years. Results, recently presented (Jackson et al., 2011) show that in the Burrishoole ranched stock over the study period, infestation of outwardly migrating salmon smolts with the salmon louse (*L. salmonis*) is not a major contributory factor to marine mortality. In order to investigate if these findings held true at other locations and for other stocks a series of five experimental releases at four locations were undertaken, two in 2001 and three in 2006. The results of these experiments are presented here and examined in the context of the results of the Burrishoole time series data (Jackson et al., 2011).

2. Materials and methods

2.1. Experimental design

The experimental design followed was similar to that employed in the Burrishoole time series study (Jackson et al., 2011). By treating experimental batches of tagged fish with a prophylactic dose of SLICE™, a commercial sea lice therapeutant, prior to release, the fish can be protected from infestation with the salmon louse for up to nine weeks. The active ingredient in SLICE™ is emamectin benzoate. It is an animal medicine licensed for use in Ireland as a treatment for sea lice infestation in salmon. Treated fish are protected from sea lice infestation in their early weeks in the sea and therefore can be expected to be free of any adverse impacts on their survival related to early lice infestation. As salmon smolts are known to migrate quickly out of the bays and into the open sea treated smolts will have moved well offshore before the protective effects of the SLICE™ treatment have worn off. Studies at Burrishoole have shown that ranched salmon smolts have moved into coastal waters within 48 hours (Moore et al., 2008). Studies by Shelton et al. (1997) and Dadswell et al. (2010) have shown that smolts from the study area have travelled a distance of over 700 km in seven weeks and are in an area north of Scotland and west of Norway. By comparing their survival and return rates with control fish, which have not been treated with the therapeutant and do not enjoy this protection it is possible to

* Corresponding author at: Marine Institute, Rinville, Oranmore, County Galway, Ireland. Tel.: +353 91 387200; fax: +353 91 387201.
E-mail address: dave.jackson@marine.ie (D. Jackson).

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Table 1
Details of release dates and numbers for all stocks.

Location of release	Stock	Release date	Control (n)	Treated (n)
Bundorracha river	Delphi/Burrishoole	02/05/2001	6385	6392
Bundorracha river	Delphi	02/05/2001	6368	6395
River Erne	Erne	04/05/2006	10357	5752
River Lee	Lee	04/04/2006	5131	5207
Screebe river	Screebe	28/04/2006	9618	10990

Table 2
Details of percentage survival and chi-squared significance test results.

Location of release	Stock	Release date	Control % survival	Treated % survival	Chi-squared test	
					X^2	p
Bundorracha river	Delphi/ Burrishoole	02/05/2001	15.39	19.05	30.035	Sig. P<0.001
Bundorracha river	Delphi	02/05/2001	13.98	13.11	2.053	NS
River Erne	Erne	04/05/2006	0.66	1.22	13.675	Sig. P<0.001
River Lee	Lee	04/04/2006	0.19	0.19	0.001	NS
Screebe river	Screebe	28/04/2006	1.26	1.43	1.121	NS

differentiate any additional mortality associated with lice infestation in the first six to eight weeks post migration.

2.2. Fish stocks and release groups

The stocks used in the study were ranched strains with a history of successful release and return over a number of years in the rivers under study. In each of the rivers a ranched stock derived from the wild stock native to the river was used. These stocks are named after the river or fishery of origin (Table 1). In addition a second stock of Burrishoole origin which was being ranched at that time in the Bundorracha river was used in an experimental release in 2001. In each release experimental groups of smolts were split into two approximately equal groups, one treated, and one control. The treated groups were administered SLICE™ as an in feed preparation at the rate of 50ug/kg/day for seven days. Treatment was completed approximately two to seven days before the release date of the smolts. Control groups were fed either with food mixed with a placebo or, in certain years, with untreated food after the method of Jackson et al. (2011). Samples of treated food were retained to ensure appropriate inclusion rates and samples of both treated and control fish was taken for flesh analysis. Fish samples were taken two days post feeding to ensure the guts were voided of medicated feed. Flesh analysis for emamectin benzoate was carried out by accredited laboratories to ensure a therapeutic dose was present in the treated groups prior to release. Details of release groups, release locations and release dates are given in Table 1.

2.3. Tagging

Experimental batches of fish were all tagged with coded wire tags. Pre-smolts were microtagged according to the methods of Browne (1982). Each magnetised microtag had a specific code which identified the release group and stock of the fish. A 1 mm long magnetised tag, etched with a specific batch code was injected into the nose cartilage of the juvenile fish. The code identifies the origin and release circumstances of any fish subsequently recaptured. All fish were anaesthetised when tagged. The adipose fin was removed to facilitate the identification of these fish in the recovery programme. A quality control check was made on the tagged fish to ensure that the tag has been correctly magnetised. Tagging mortality and tag loss were also estimated and subsequent analyses were based on the numbers of fish migrating rather than the number of fish tagged.

2.4. Tag recovery and data analysis

Information on capture location and return data of the experimental groups was gathered as part of an ongoing Irish national coded wire tag recovery programme (Browne, 1982; Ó Maoiléidigh et al., 2004). Catches from coastal commercial fisheries (drift nets, draft nets, etc.) were monitored at 15 major salmon landing ports in Ireland. These fisheries operate between May and July inclusive and catches were scanned consistently during this period. Over 50% of the catch landed in Ireland is sampled for tags each year. The number of tagged salmon taken in these fisheries (raised data) was estimated by multiplying the actual number of tagged salmon in each area by the ratio of the total declared salmon landings in these areas to the sample size examined. An adjustment for non-catch fishing mortality due to losses from nets and non-reporting of catches was also applied.

A sign test was calculated on the observed returns of treated and non-treated salmon over the entire test period to determine if

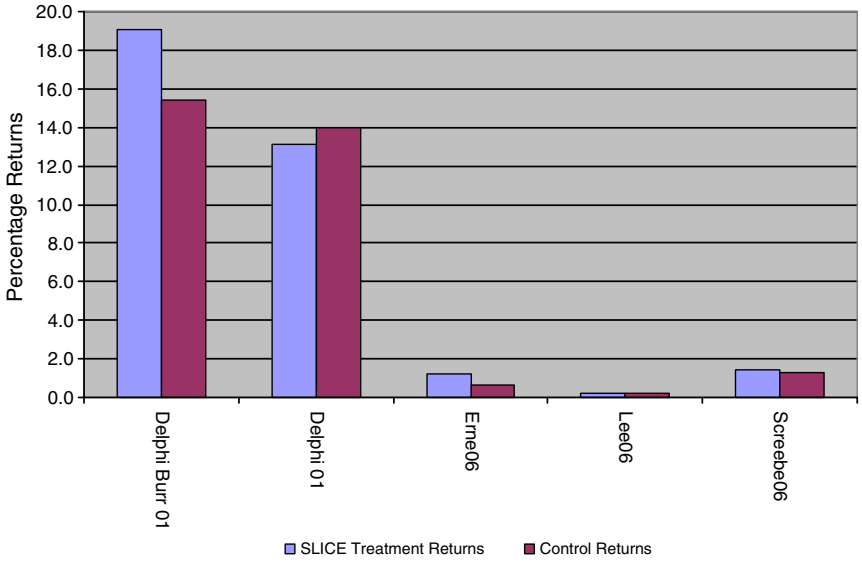

Fig. 1. Percentage returns all locations.