The life of smolts in estuaries

- a sensitive phase under pressure

Rasmus Lauridsen

Game & Wildlife Conservation Trust

Interreg France (Channel Manche) England SAMARCH Gestion des salmonidés dans la Manche Fonds européen de développement régional

NORMANDIE Grands Migrateurs

eau seine NORMANDIE Agence de l'eau

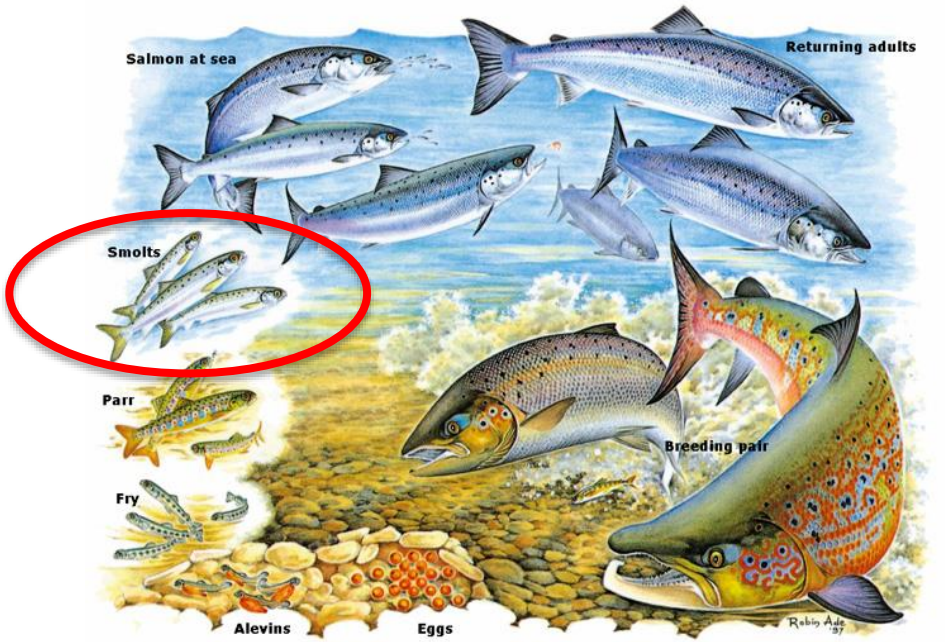
FÉDÉRATION NATIONALE PÊCHE

LA MANCHE CONSEIL DÉPARTEMENTAL

RÉGION NORMANDIE

A time of transition

- Salmon lifecycle
- Smoltification



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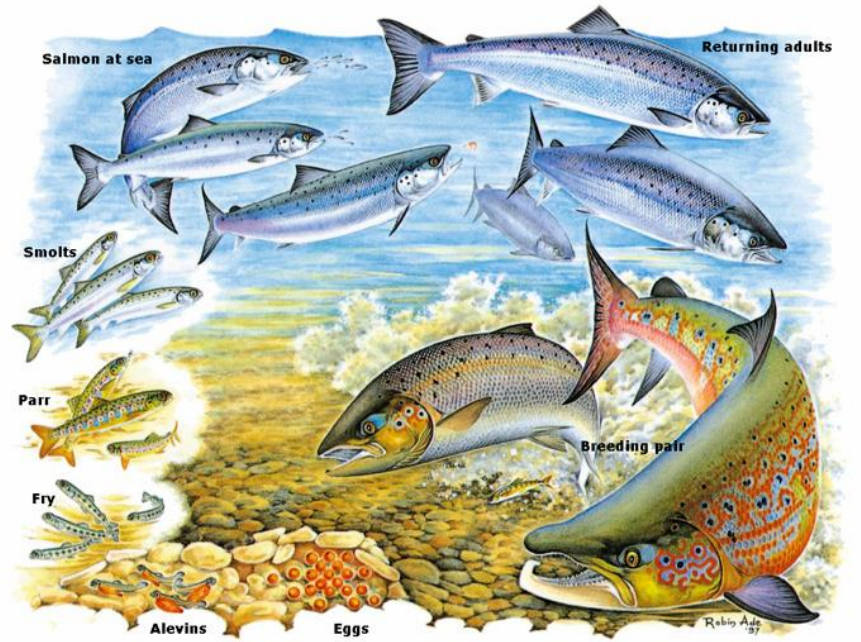
A time of transition

- Salmon lifecycle
- Smoltification
  - Physiology

A time of transition

- Salmon lifecycle
- Smoltification
  - Physiology
  - Behaviour



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A time of transition

- Salmon lifecycle
- Smoltification
  - Physiology
  - Behaviour
  - Predators

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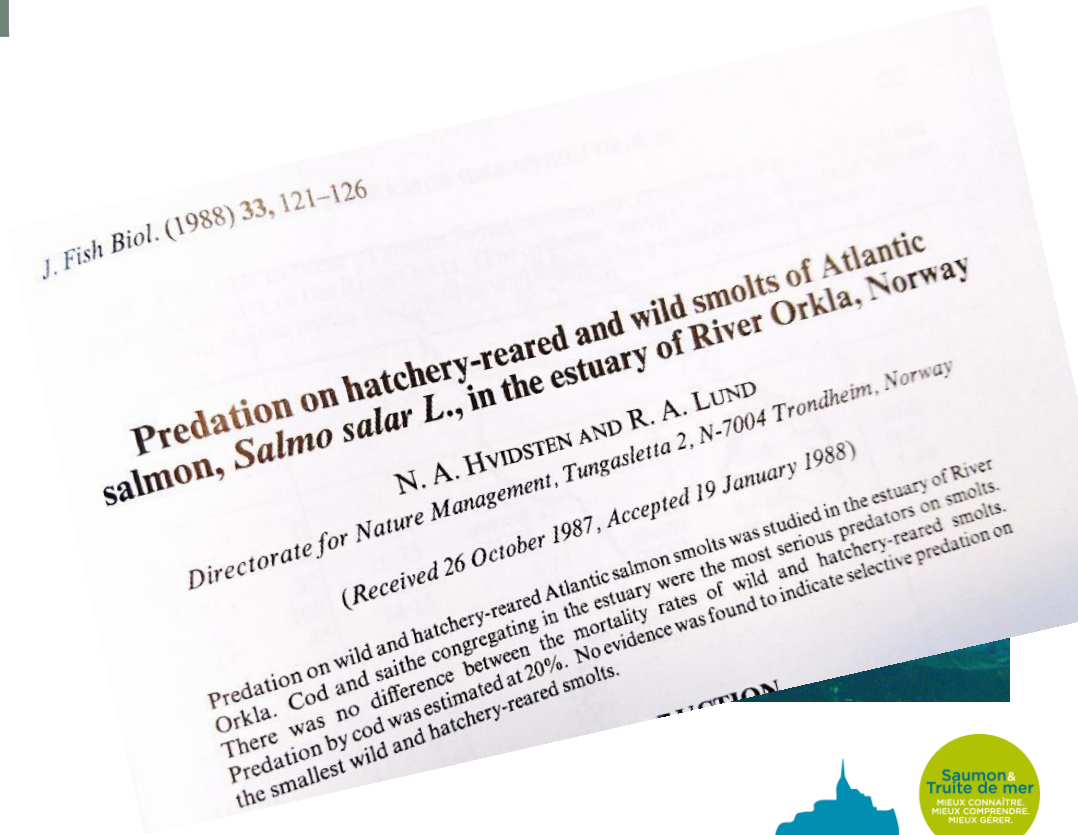
Predation - Cod

- Cod & Saithe
  - Predation 20%-65%



J. Fish Biol. (1988) 33, 121–126

Predation on hatchery-reared and wild smolts of Atlantic salmon, *Salmo salar L.*, in the estuary of River Orkla, Norway

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Directorate for Nature Management, Tungasletta 2, N-7004 Trondheim, Norway

(*Received 26 October 1987, Accepted 19 January 1988*)

Predation on wild and hatchery-reared Atlantic salmon smolts was studied in the estuary of River Orkla. Cod and saithe congregating in the estuary were the most serious predators on smolts. There was no difference between the mortality rates of wild and hatchery-reared smolts. Predation by cod was estimated at 20%. No evidence was found to indicate selective predation on the smallest wild and hatchery-reared smolts.

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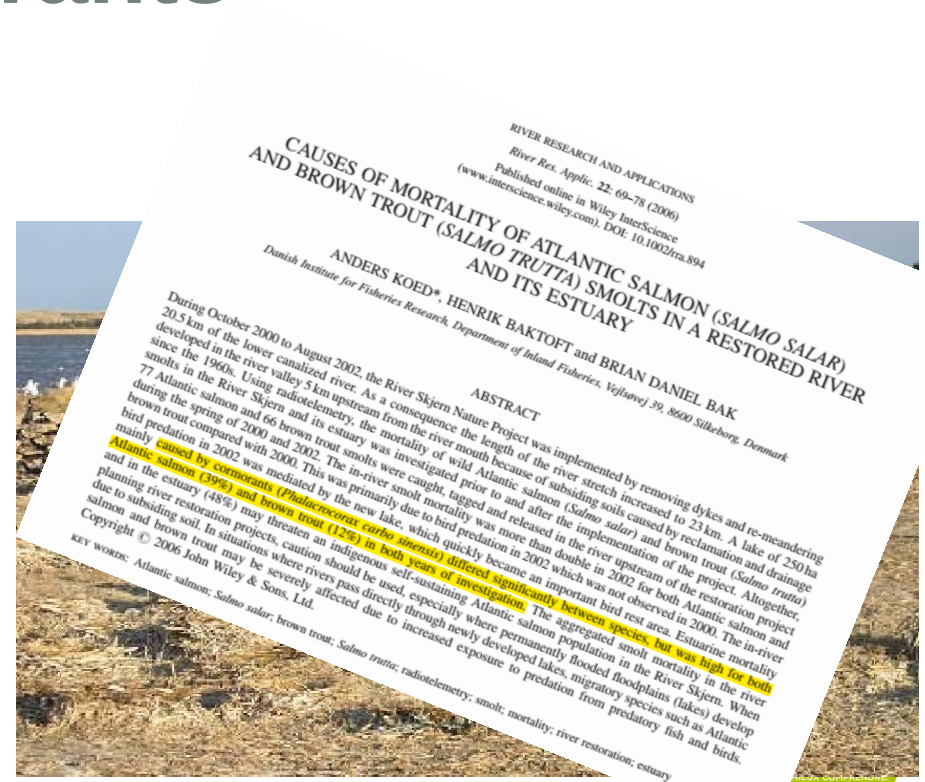
Predation - Cormorants

- Cod & Saithe
  - Predation 20%-65%
- Cormorants
  - Predation 20%-55%



RIVER RESEARCH AND APPLICATIONS
River Res. Applic. 22: 69–78 (2006)
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CAUSES OF MORTALITY OF ATLANTIC SALMON (*SALMO SALAR*) AND BROWN TROUT (*SALMO TRUTTA*) SMOLTS IN A RESTORED RIVER AND ITS ESTUARY

ANDERS KOED*, HENRIK BAKTOFT and BRIAN DANIEL BAK

Danish Institute for Fisheries Research, Department of Inland Fisheries, Vejlsøvej 39, 8600 Silkeborg, Denmark

ABSTRACT

During October 2000 to August 2002, the River Skjern Nature Project was implemented by removing dykes and re-meandering 20.5 km of the lower canalized river. As a consequence the length of the river stretch increased to 23 km. A lake of 250 ha developed in the river valley 5 km upstream from the river mouth because of subsiding soils caused by reclamation and drainage since the 1960s. Using radiotelemetry, the mortality of wild Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*) smolts in the River Skjern and its estuary was investigated prior to and after the implementation of the restoration project. Altogether, 77 Atlantic salmon and 66 brown trout smolts were caught, tagged and released in the river upstream of the restoration project during the spring of 2000 and 2002. The in-river smolt mortality was more than double in 2002 for both Atlantic salmon and brown trout compared with 2000. This was primarily due to bird predation in 2002 which was not observed in 2000. The in-river bird predation in 2002 was mediated by the new lake, which quickly became an important bird rest area. Estuarine mortality mainly caused by cormorants (*Phalacrocorax carbo sinensis*) differed significantly between species, but was high for both Atlantic salmon (39%) and brown trout (12%) in both years of investigation. The aggregated smolt mortality in the river and in the estuary (48%) may threaten an indigenous self-sustaining Atlantic salmon population in the River Skjern. When planning river restoration projects, caution should be used, especially where permanently flooded floodplains (lakes) develop due to subsiding soil. In situations where rivers pass directly through newly developed lakes, migratory species such as Atlantic salmon and brown trout may be severely affected due to increased exposure to predation from predatory fish and birds.

KEY WORDS: Atlantic salmon; *Salmo salar*; brown trout; *Salmo trutta*; radiotelemetry; smolt; mortality; river restoration; estuary

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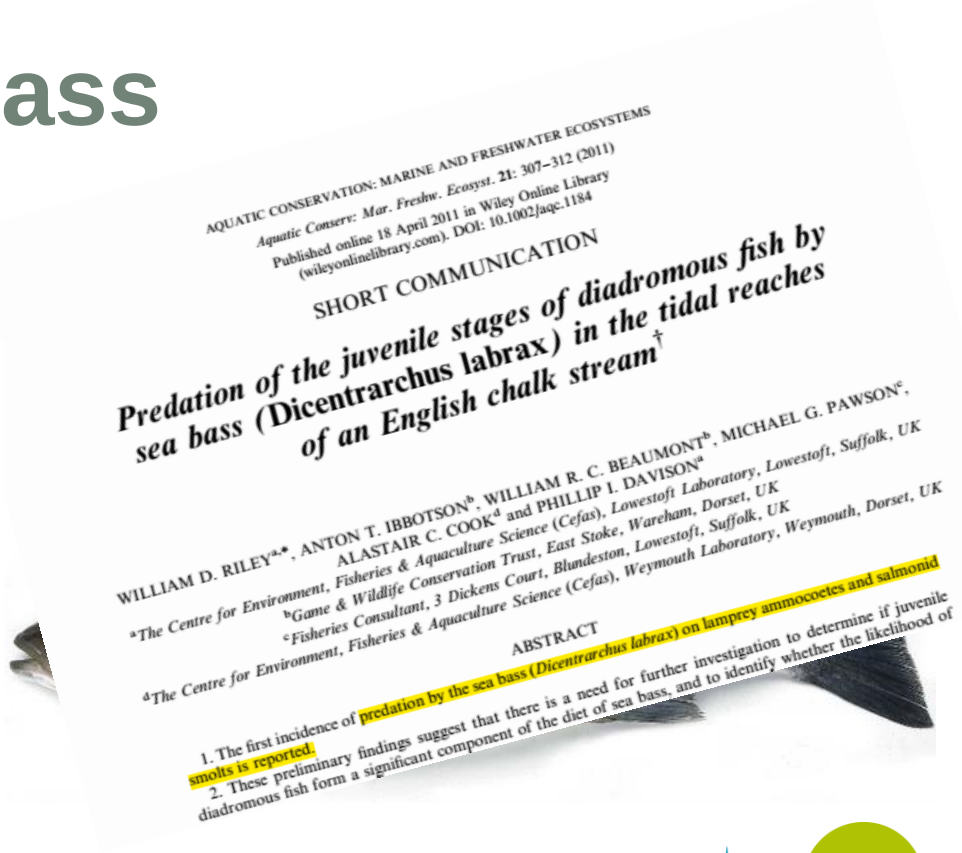
Predation – Sea Bass

- Cod & Saithe
  - Predation 20%-65%
- Cormorants
  - Predation 20%-55%
- Sea Bass



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Aquatic Conserv: Mar. Freshw. Ecosyst. **21**: 307–312 (2011)
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SHORT COMMUNICATION

Predation of the juvenile stages of diadromous fish by sea bass (Dicentrarchus labrax) in the tidal reaches of an English chalk stream†

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[b]Game & Wildlife Conservation Trust, East Stoke, Wareham, Dorset, UK
[c]Fisheries Consultant, 3 Dickens Court, Blundeston, Lowestoft, Suffolk, UK
[d]The Centre for Environment, Fisheries & Aquaculture Science (Cefas), Weymouth Laboratory, Weymouth, Dorset, UK

ABSTRACT

1. The first incidence of predation by the sea bass (*Dicentrarchus labrax*) on lamprey ammocoetes and salmonid smolts is reported.
2. These preliminary findings suggest that there is a need for further investigation to determine if juvenile diadromous fish form a significant component of the diet of sea bass, and to identify whether the likelihood of

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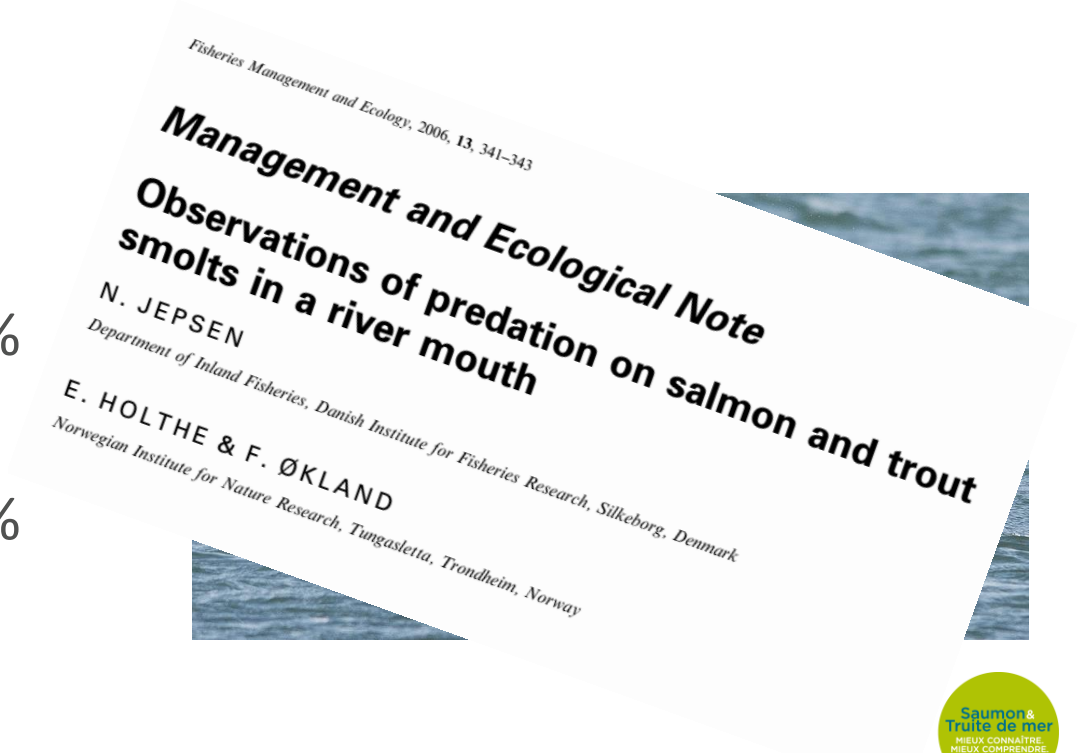
Predation – Sea Gulls

- Cod & Saithe
  - Predation 20%-65%
- Cormorants
  - Predation 20%-55%
- Sea Bass
- Sea Gulls



Estuarine Loss Rates

- Large variation
  - 0.6 – 36% km^{-1}
- Predator populations
- Natural

Journal of FISH BIOLOGY
Published for the Fisheries Society of the British Isles

Journal of Fish Biology (2012) **81**, 500–542
doi:10.1111/j.1095-8649.2012.03370.x, available online at wileyonlinelibrary.com

A critical life stage of the Atlantic salmon *Salmo salar*: behaviour and survival during the smolt and initial post-smolt migration

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The anadromous life cycle of Atlantic salmon *Salmo salar* involves long migrations to novel environments and challenging physiological transformations when moving between salt-free and salt-rich waters. In this article, (1) environmental factors affecting the migration behaviour and survival of smolts and post-smolts during the river, estuarine and early marine phases, (2) how behavioural patterns are linked to survival and (3) how anthropogenic factors affect migration and survival are synthesized and reviewed based on published literature. The timing of the smolt migration is important in determining marine survival. The timing varies among rivers, most likely as a consequence of local adaptations, to ensure sea entry during optimal periods. Smolts and post-smolts swim actively and fast during migration, but in areas with strong currents, their own movements may be overridden by current-induced transport. Progression rates during the early marine migration vary between 0·4 and 3·0 body lengths s^{-1} relative to the ground. Reported mortality is 0·3–7·0% (median 2·3) km^{-1} during downriver migration, 0·6–36% (median 6·0) km^{-1} in estuaries and 0·3–3·4% (median 1·4) km^{-1} in coastal areas. Estuaries and river mouths are the sites of the highest mortalities, with predation being a common cause. The mortality rates varied more among studies in estuaries than in rivers and marine areas, which probably reflects the huge variation among estuaries in their characteristics. Behaviour and survival during migration may also be

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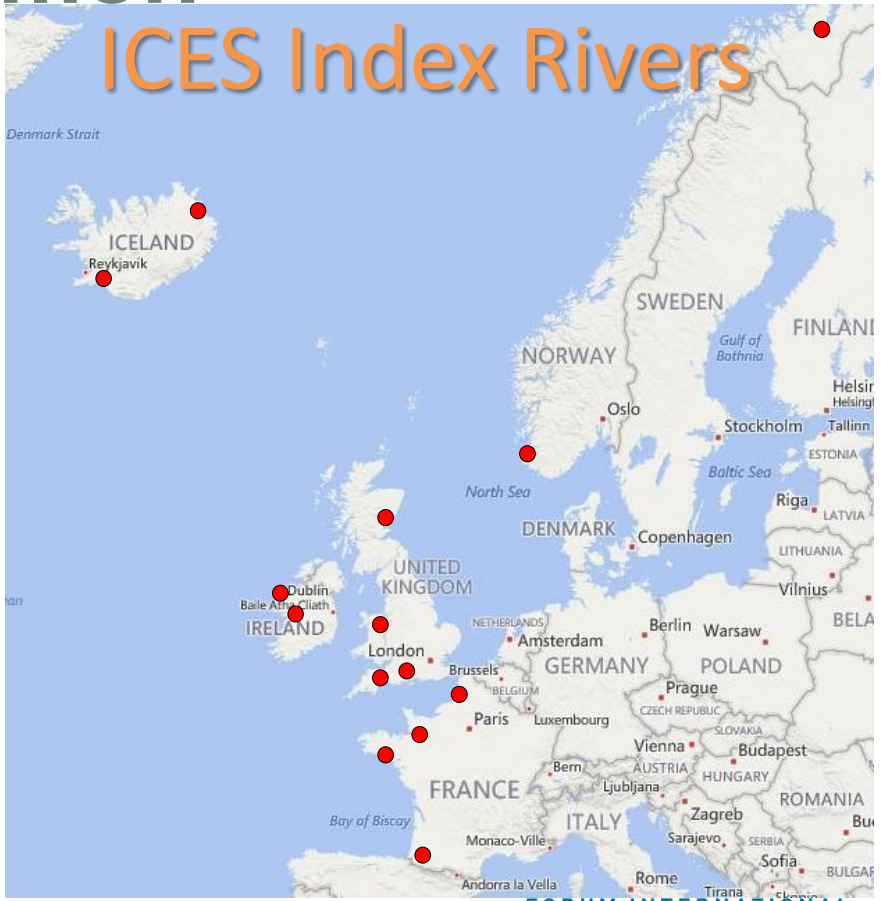
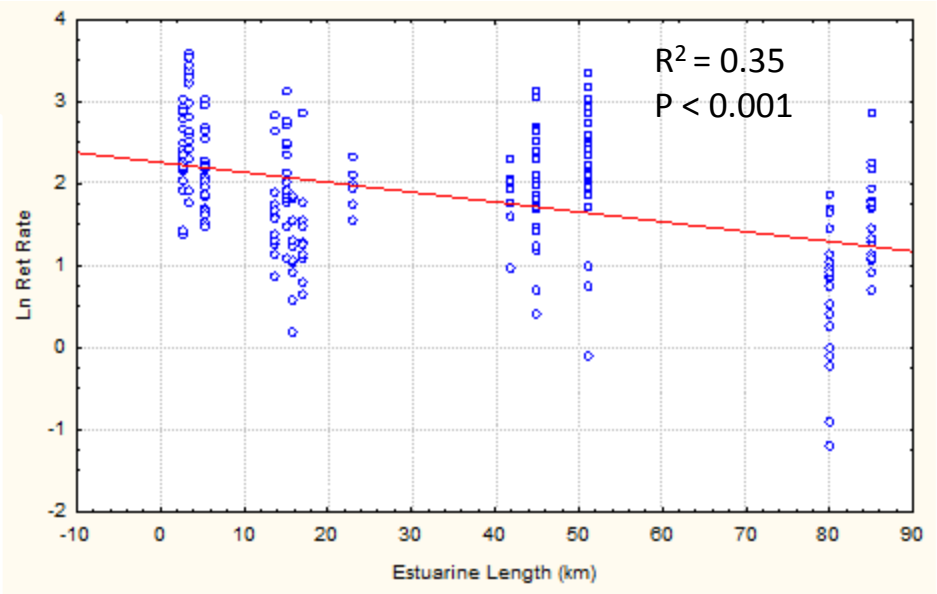
Return Rates of Salmon

- Marine return rate ICES



Return Rates of Salmon

- Marine return rate ICES
- Estuary length and return rate
- Inherent higher loss rate in estuaries?



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Anthropogenic Activity

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Anthropogenic Activity

- Dredging

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Anthropogenic Activity

- Dredging
- Fishing

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Anthropogenic Activity

- Dredging
- Fishing
- Aquaculture

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journal homepage: www.elsevier.com/locate/epidemics

ELSEVIER

Quantitative risk assessment of salmon louse-induced mortality of seaward-migrating post-smolt Atlantic salmon

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ARTICLE INFO

Keywords:
Density dependent
Sea lice
Transmission
Farmed salmon
Migration pathway
Migration time

ABSTRACT

The Norwegian government recently implemented a new management system to regulate salmon farming in Norway, aiming to promote environmentally sustainable growth in the aquaculture industry. The Norwegian coast has been divided into 13 production zones and the volume of salmonid production in the zones will be regulated based on salmon lice effects on wild salmonids. Here we present a model for assessing salmon louse-induced mortality of seaward-migrating post-smolts of Atlantic salmon. The model quantifies expected salmon lice infestations and louse-induced mortality of migrating post-smolts of Atlantic salmon. The model quantifies expected salmon into Norwegian coastal waters. It is assumed that migrating post-smolts follow the shortest path from river outlets to the high seas, at constant progression rates. During this migration, fish are infested by salmon lice of farm origin according to an empirical infestation model. Furthermore, louse-induced mortality is estimated from the estimated louse infestations. Rivers draining into production zones on the West Coast of Norway were at the highest risk of adverse lice effects. In comparison, rivers draining into northerly production zones, along with the southernmost production zone, were at lower risk. After adjusting for standing stock biomass, estimates of louse-egg output varied by factors of up to 8 between production zones. Correlation between biomass adjusted output of louse infestation and densities of farmed salmon in the production zones suggests that a large-scale density-dependent host-parasite effect is a major driver of louse infestation rates and parasite-induced mortality. The estimates are sensitive to many of the processes in the chain of events in the model. Nevertheless, we argue that the model is suited to assess spatial and temporal risks associated with farm-origin salmon lice.

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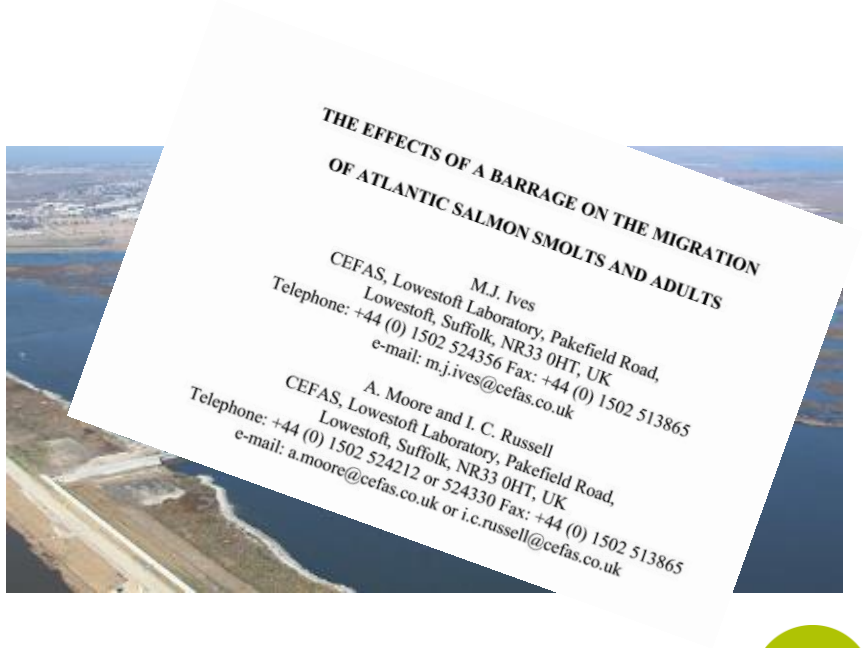
Anthropogenic Activity

- Dredging
- Fishing
- Aquaculture
- Flood defences



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Anthropogenic Activity

- Dredging
- Fishing
- Aquaculture
- Flood defences
- Renewable energy

PROCEEDINGS B

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Research

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Subject Category:
Global Change and Conservation

Subject Areas:
behaviour, environmental science, ecology

Keywords:
noise, collective behaviour, global change, shoaling, pile-driving

Anthropogenic noise pollution from pile-driving disrupts the structure and dynamics of fish shoals

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[2]Department of Agronomy, Agroequipments, Farming and Environment, AgroSup Dijon, Dijon, France
[3]Biosciences, College of Life and Environmental Sciences, University of Exeter, Exeter, UK
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Noise produced from a variety of human activities can affect the physiology and behaviour of individual animals, but whether noise disrupts the social behaviour of animals is largely unknown. Animal groups such as flocks of birds or shoals of fish use simple interaction rules to coordinate their movements with near neighbours. In turn, this coordination allows individuals to gain the benefits of group living such as reduced predation risk and social information exchange. Noise could change how individuals interact in groups if noise is perceived as a threat, or if it masked, distracted or stressed individuals, and this could have impacts on the benefits of grouping. Here, we recorded trajectories of individual juvenile seabass (*Dicentrarchus labrax*) in groups under controlled laboratory conditions. Groups were exposed to playbacks of either ambient background sound recorded in their natural habitat, or playbacks of pile-driving, commonly used in marine construction. The pile-driving playback affected the structure and dynamics of the fish shoals significantly more than the ambient-sound playback. Compared to the ambient-sound playback, groups experiencing the pile-driving playback became less cohesive, less directionally ordered, and were less correlated in speed and directional changes. In effect, the additional-noise treatment disrupted the abilities of individuals to coordinate their movements with one another. Our work highlights the potential for noise pollution from pile-driving to disrupt the collective dynamics of fish shoals, which could have implications for the functional benefits of a group's collective behaviour.

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Anthropogenic Activity

- Dredging
- Fishing
- Aquaculture
- Flood defences
- Renewable energy

Modelling fish in hydrodynamic models: an example using the Severn Barrage SEA

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[1]HR Wallingford Ltd., UK
[2]APEM Ltd., UK

Abstract

It is possible to improve our predictions of what happens to fish when they get near barrages, turbines, screens and other built structures by using a combination of hydrodynamic and behavioural models. We examine a model of salmon smolt migrating through the five shortlisted options for low head hydropower in the Severn Estuary which was made as part of the 2009 Strategic Environmental Assessment (SEA). Hydrodynamic models can be expensive and time consuming to make and calibrate, particularly around complex coastlines and estuaries, but they are often readily available and accurate, especially if they have been a requirement of the EIA (Environmental Impact Assessment) process. On the other hand, animal behaviour models are often speculative and theoretical and so, although often simple, can be tricky to apply to a predictive goal. Here we consider the practical challenges of making and reporting results from these models and discuss the methodological considerations of one such model. We do not provide any comparative assessment between the schemes which was the target of the SEA and thus outside the scope of this study. The results demonstrate the value of such models for assessment of impact of built structures in rivers and estuaries. Their primary benefit is that they accurately predict the implications of expert opinion and highlight what is unknown and what would be valuable to research.

Keywords: salmon smolts, migration, hydro-power, navigation, correlated random walk, Lévy flight.

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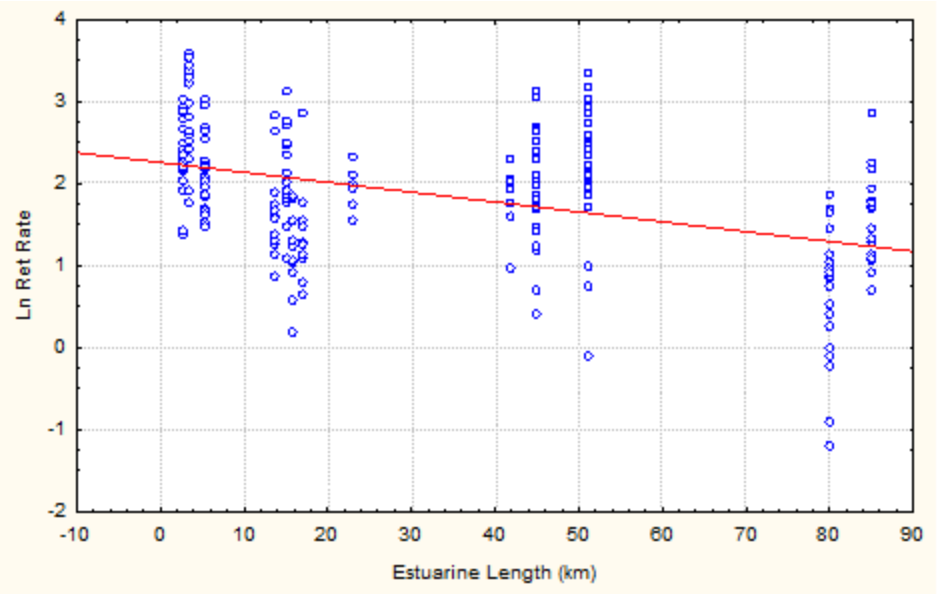
Smolt Survival in Estuaries

- Inherent loss rate in estuaries?



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Smolt Survival in Estuaries

- Inherent loss rate in estuaries?
- Anthropogenic activity exacerbate loss rates?

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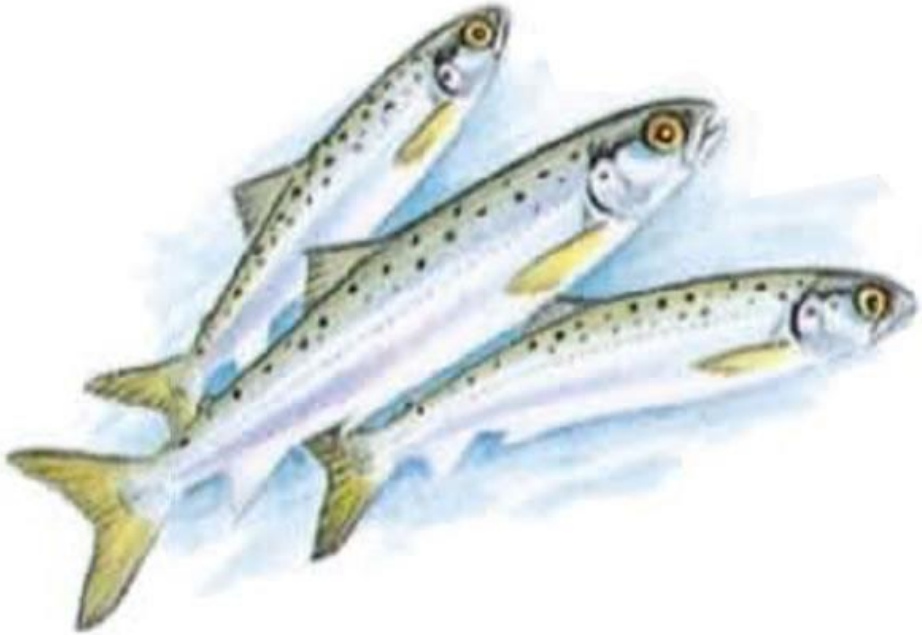

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