The use of biogeochemical tags to determine the origins and movement patterns of fishes

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Abstract

The incorporation of both trace and minor-trace elements within the otolith aragonite matrix of hatchery reared sea bass *Dicentrarchus labrax* and the possible effects of *post mortem* handling, transportation and the period of time whole fish were stored frozen were examined. Furthermore, the possible effects of temporal variability of the water chemistry within two nursery grounds and the effect on the elemental concentrations within otoliths were measured. Finally, the use of naturally occurring trace and minor-trace elements incorporated within the otolith structures of teleost fish and their use as natural biogeochemical tags to infer movement patterns over spatial scales were assessed.

Statistically significant differences were observed in the concentrations of Mg and K measured in the otoliths of hatchery reared *Dicentrarchus labrax* when whole fish were stored frozen for a period of 6 months. Similarly, the elemental concentrations of Mn differed significantly between the storage periods of 1 day and 12 months. Three elements Na, Sr and Ba indicated no significant change in their elemental concentrations in response to the methods of dispatch, transportation protocol and freezer storage period. Based on the concentrations of Na, Sr and Ba, indications show these three elements are not subject to alteration when using the most commonly used methods of euthanasia / transportation and storage duration for *D. labrax*.

Significant inter-annual and intra-annual differences were observed in the elemental concentrations of otoliths from juvenile *Pleuronectes platessa* sampled over a period of 7 years (2004-2010) from two nursery grounds Llanfairfechan and Llandonna in North Wales. Inter-annual (between years) variation at the site Llanfairfechan was observed for Mg in each of the 3 years 2007-2010, similarly between the 2 years 2009-2010 and the concentrations of Na. Differences were also observed in the concentrations of Sr and between each of the 5 years 2005-2010. Inter-annual variation was observed at the site Llanfairfechan for Na between each of the 3 years 2007-2010, between the 2 years 2007-2010 for K, and between the two years 2007-2009 and 2009-2010 for Sr and Ba respectively. Some degree of temporal stability could be observed for Na, Mg and Ba at Llanfairfechan and for Na, K, Sr and Ba within the site at Llandonna over short time scales (*i.e.* 2-3 year periods), increasing to 4 years (2004-2007) for Na and Ba at Llanfairfechan and K and Ba at Llanddona. There appeared to be some temporal stability on an inter-
annual scale over a short term: *i.e.* 2-3 years, with some elements such as Ba being more stable for a period up to 4 years.

Significant differences in the elemental concentrations of Mg, Mn, Sr and Ba were observed in the otoliths of *Salmo trutta* parr sampled from each of 36 main sea trout producing rivers in SW Scotland, NW England, Wales, Isle of Man and the east coast of Ireland which flow into the Irish and Celtic Seas. Using quadratic discriminant function analysis (QDFA), 74% of juvenile trout parr were classified back to their natal rivers, with 66% of trout parr correctly classified to region. Using the elements Mg, Mn, Sr and Ba from trout parr otoliths a freshwater biogeochemical baseline was produced to assign “blind” run parr samples to their source, with 27/39 (69%) of “blind” run trout parr correctly classified back to their natal river. Using the biogeochemical freshwater baseline created from the QDFA adult sea trout of unknown origin were assigned to their putative natal region using their period of freshwater residency. Classification was low with > 20% of adults correctly assigned to their putative region of origin. Although classification accuracy of trout parr to river / region was high and indicated the freshwater baseline was robust, the results for the present study suggest that the poor classification of adults to their putative natal region may indicate migratory patterns for adult sea trout within the Irish Sea are more extensive than previously understood.
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To my Mother

You were always by my side in mind and now in spirit
You always believed in me no matter what direction I took
I have now finally achieved my dream
I wish you were here to see it
Thank You
# Thesis Contents

Abstract

Acknowledgments

Dedication

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