

Environmental and physiological influences on otolith chemistry in a fully marine flatfish



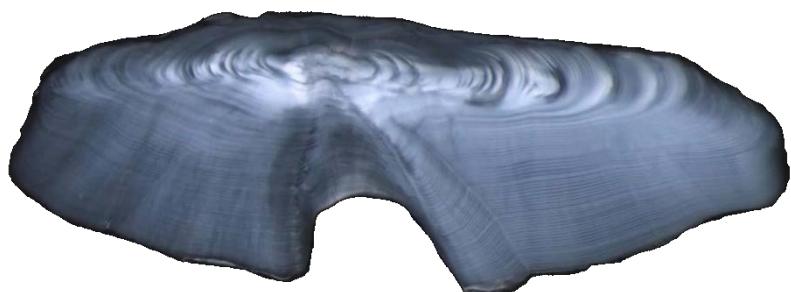
Anna Sturrock, Clive Trueman, Ewan Hunter



Otoliths

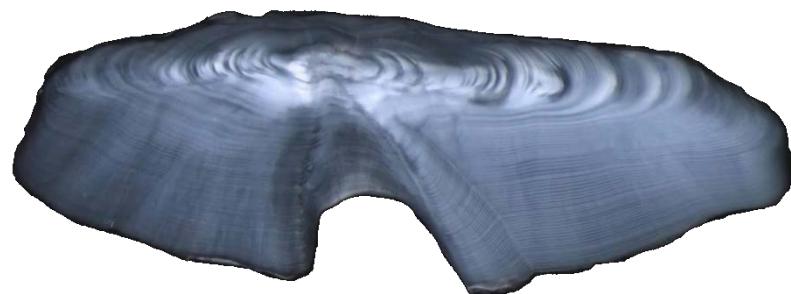


Tracking movements of adult marine fish: challenges



Tracking movements of adult marine fish: challenges

1. Temporal resolution?

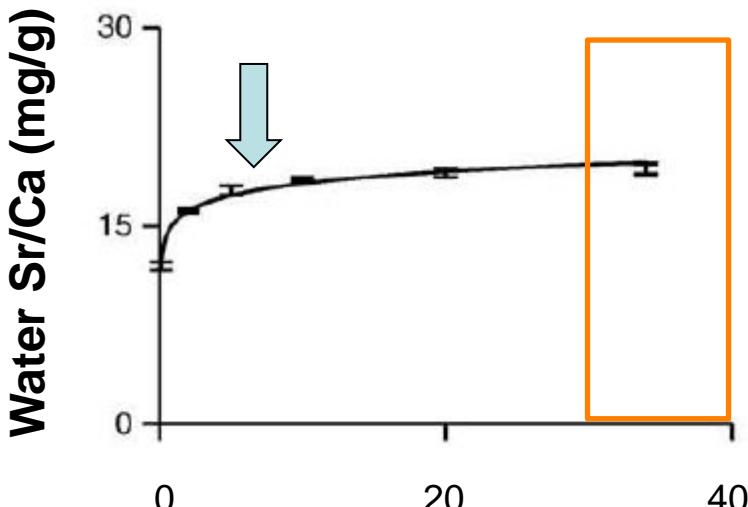
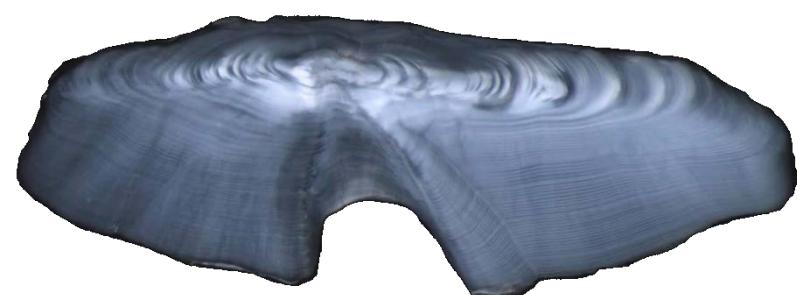
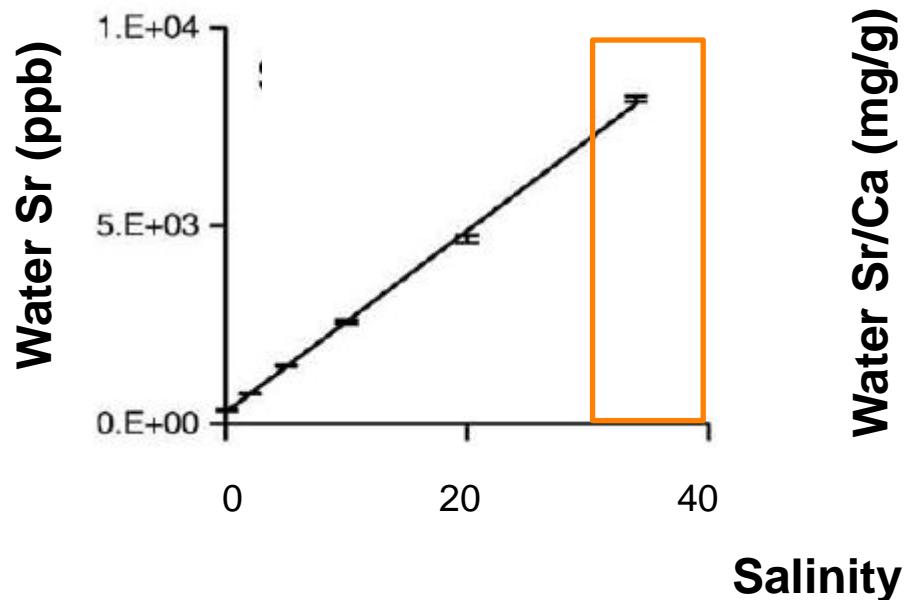


*Thin section of a splitnose rockfish
otolith*

<http://people.oregonstate.edu/~Blackbry/reserach.htm>

Tracking movements of adult marine fish: challenges

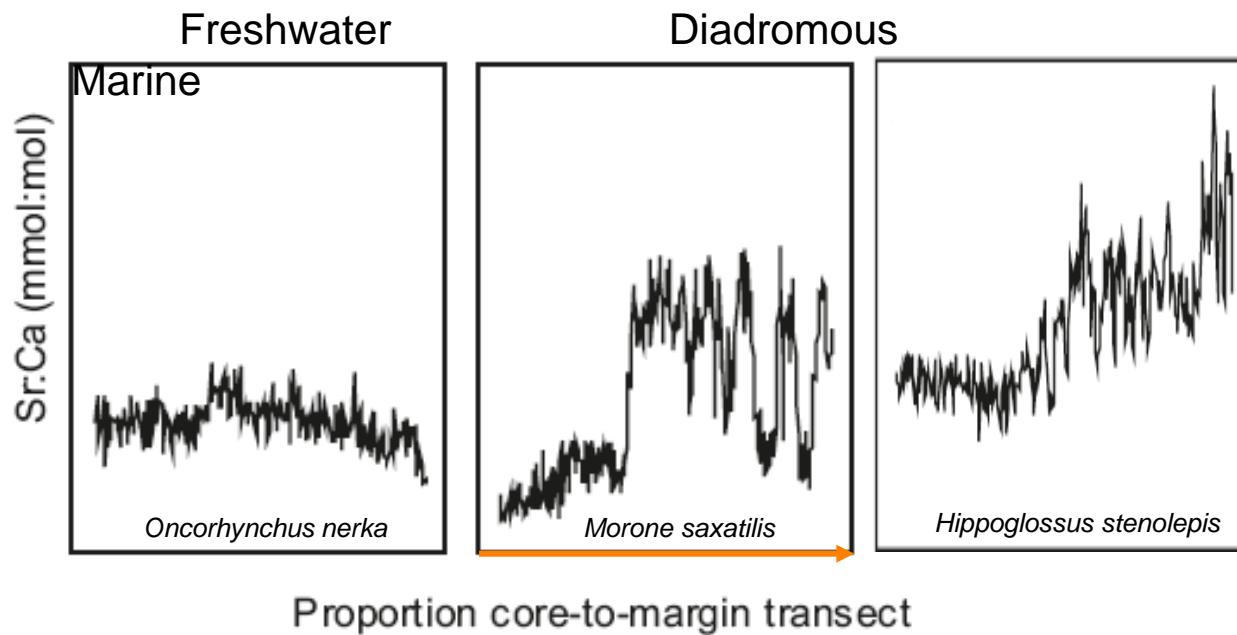
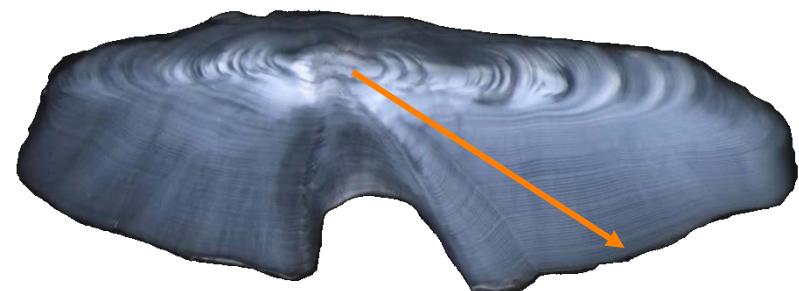
1. Temporal resolution?
2. Elemental variability?



Hicks et al (2010)

Tracking movements of adult marine fish: challenges

1. Temporal resolution?
2. Elemental variability?
3. Physiology?



Brown and Severin
(2009)

Aims

To partition environmental vs. physiological influences

- (i) by quantifying the relationship between water, blood and otolith chemistry in non-migrating plaice

- (i) by coupling otolith elemental profiles with 'known migrations' in wild DST tagged plaice



Methods (experiment)

Time series, water → blood → otolith

Plaice (*Pleuronectes platessa*)

Irish Sea and English Channel

Duration: 1 year

June and Oct 2009 – June 2010

Day 1: OTC and PIT tag

Day 230: GnRH treatment

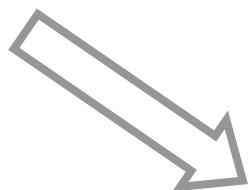
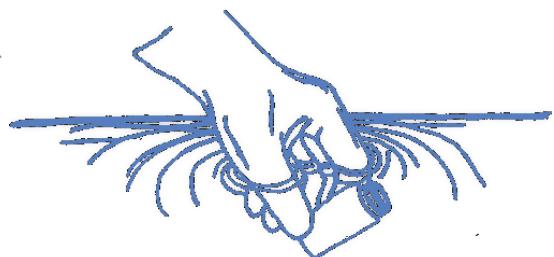
Diet: Live, local lugworms



n=19

Methods (experiment)

WATER



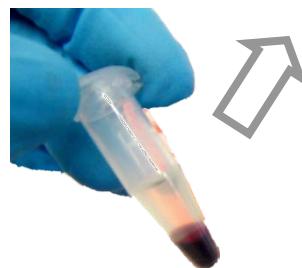
BLOOD PLASMA



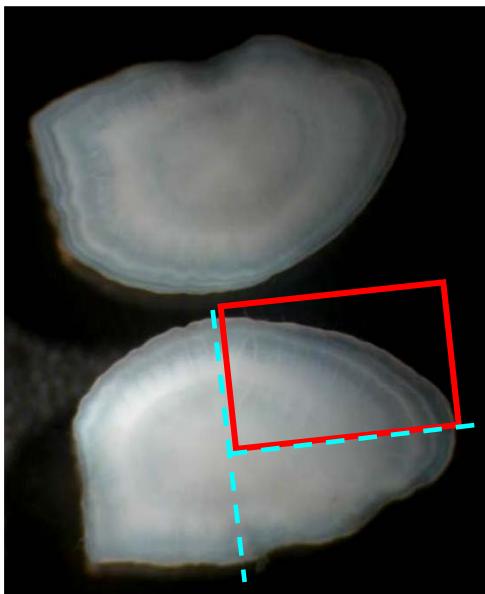
High resolution inductively coupled plasma mass spectrometer (HR-ICPMS)

Sr, Zn, Ca, Li, Ba

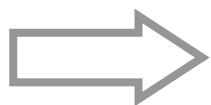
K, Mg, Mn, Cu, Se, Rb, Pb



Methods (otoliths)



OTOLITH



Secondary ion mass spectrometer (SIMS)

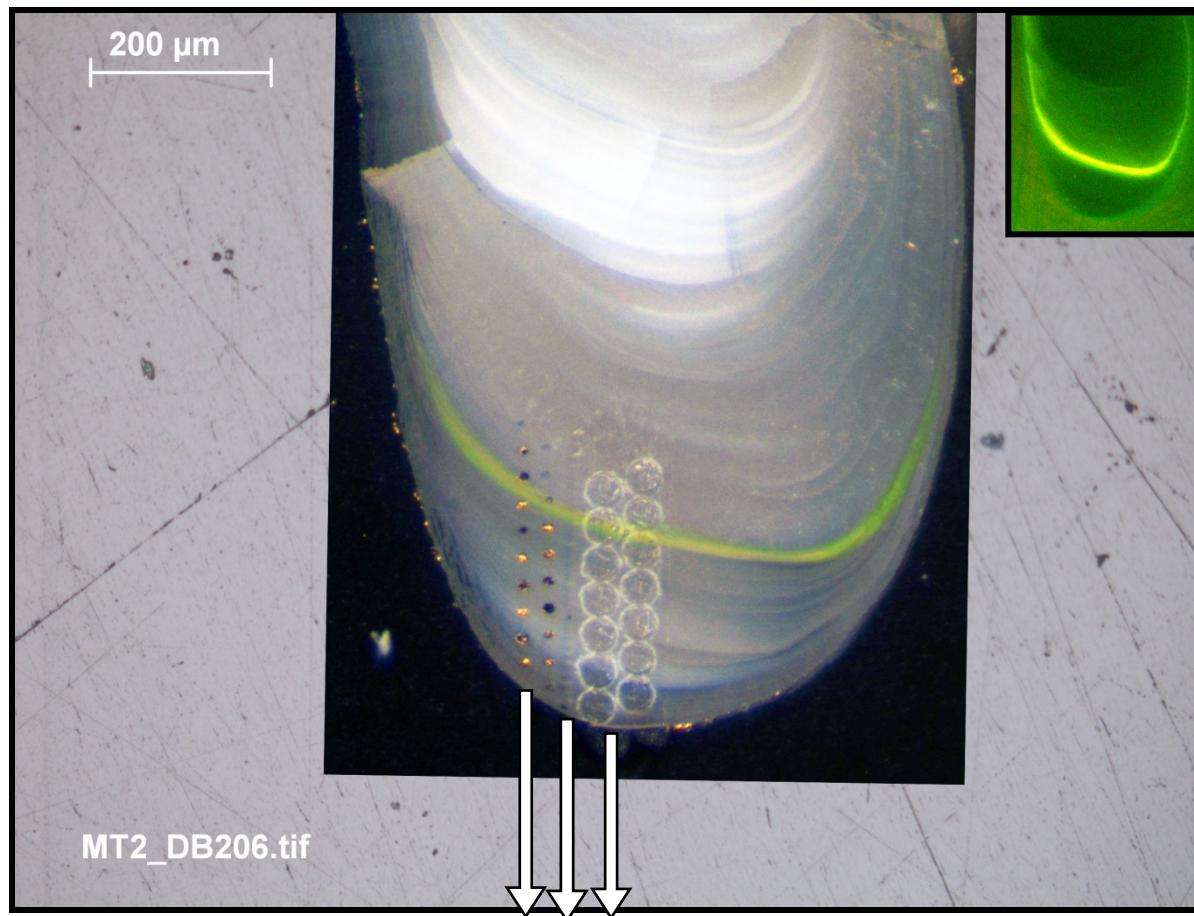
$\delta^{18}\text{O}$ (20 μm spots)

Li/Ca, Sr/Ca, Ba/Ca, Mg/Ca, K/Ca (8 μm)

Laser ablation HR-ICPMS (LA-HR-ICPMS)

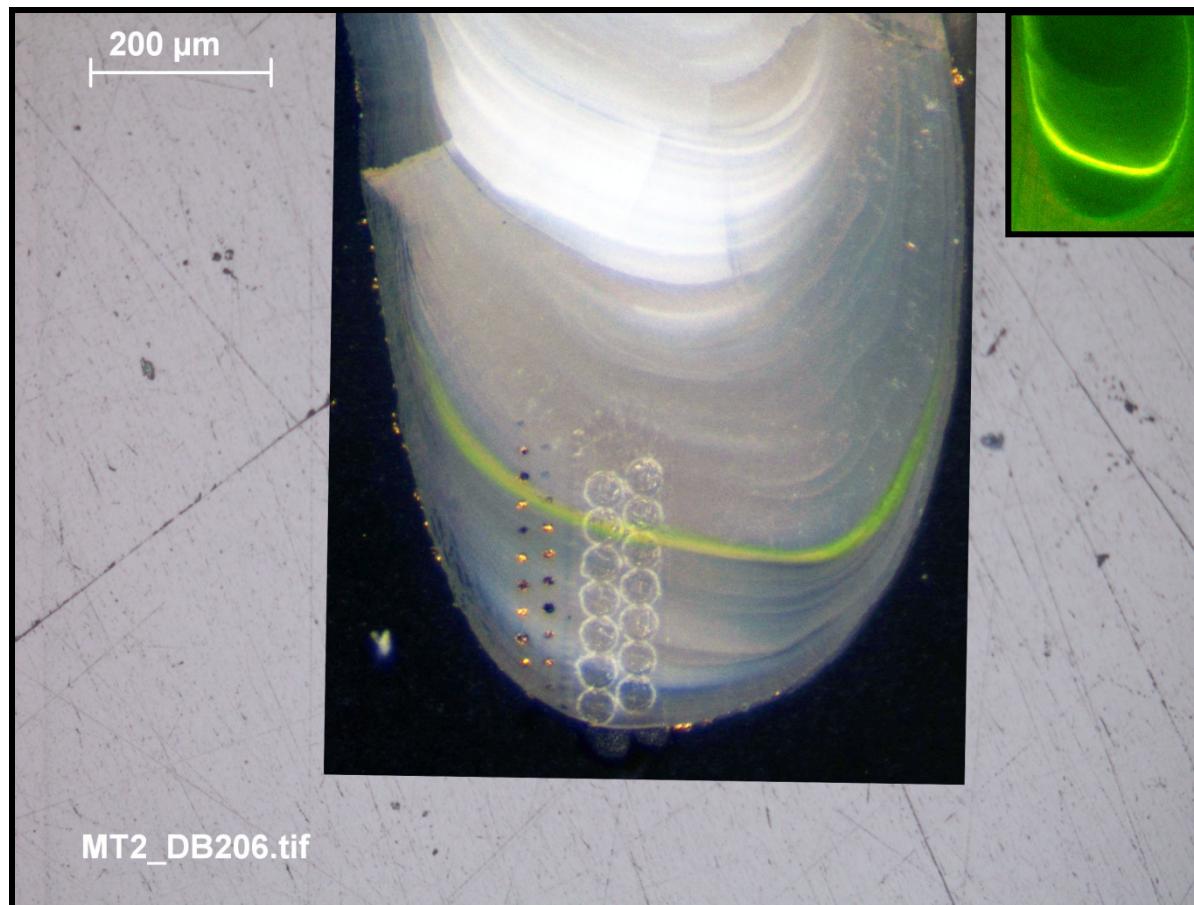
Zn/Ca, Sr/Ca, Ba/Ca, Mn/Ca, Cu/Ca (35 μm)

Methods (otoliths)



Assign calendar dates (AnalySeries)

Methods (statistics)

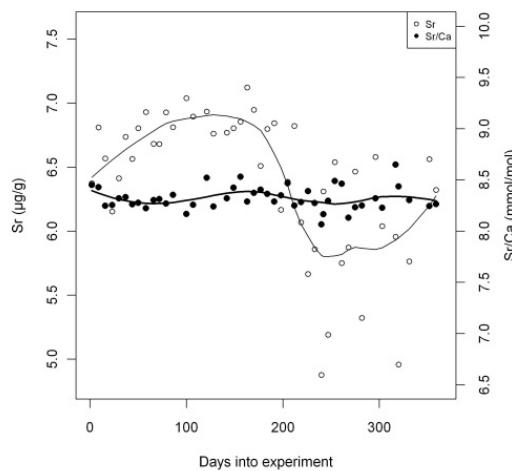


DATA →
(Imer, R)

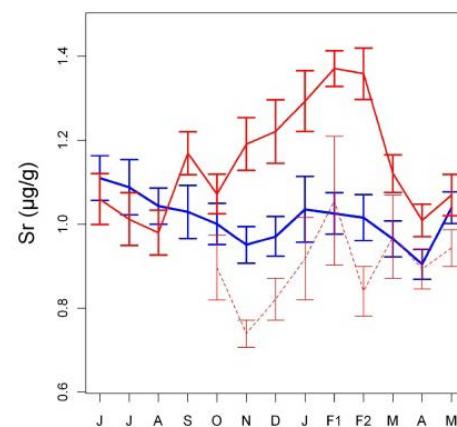
LINEAR MIXED EFFECTS MODELS

STRONTIUM

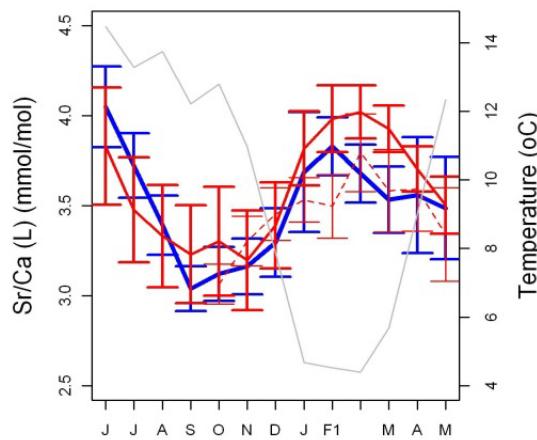
WATER Sr and Sr/Ca



BLOOD Sr



OTOLITH Sr/Ca

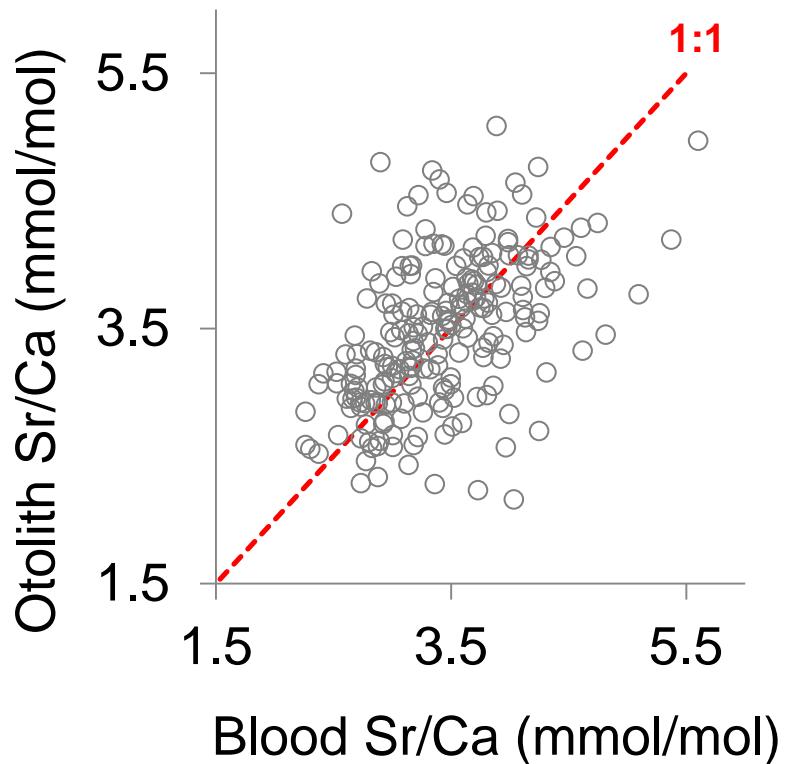


— Irish Sea females

···· English Channel females

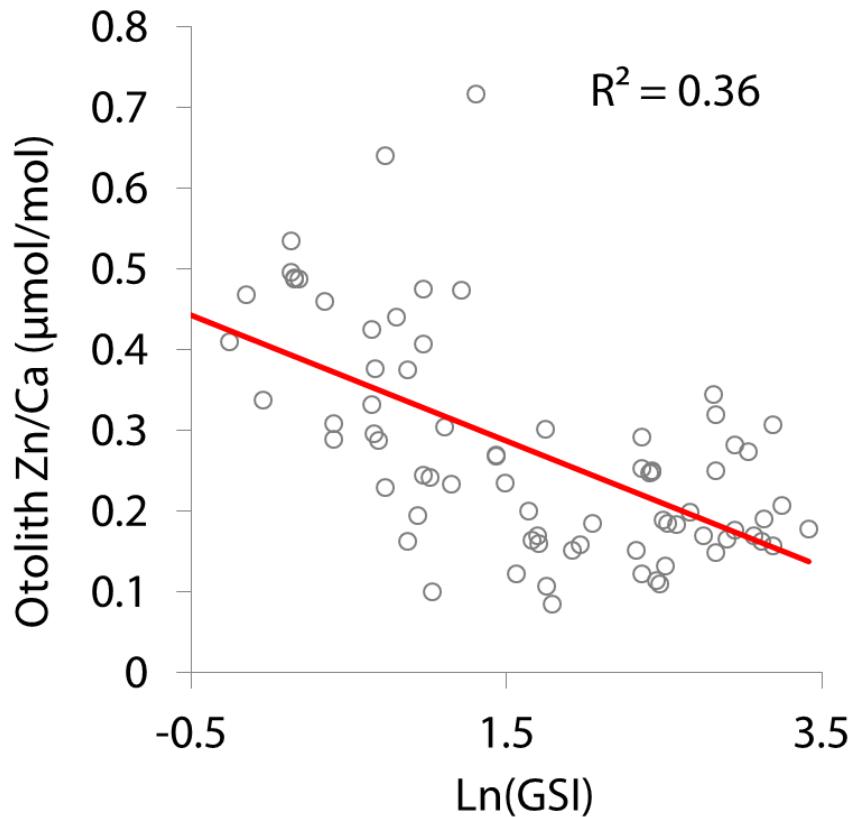
— Irish Sea males

STRONTIUM



25% of variation in otolith
Sr/Ca explained by near 1:1
relationship with blood
Sr/Ca (= physiology)

ZINC

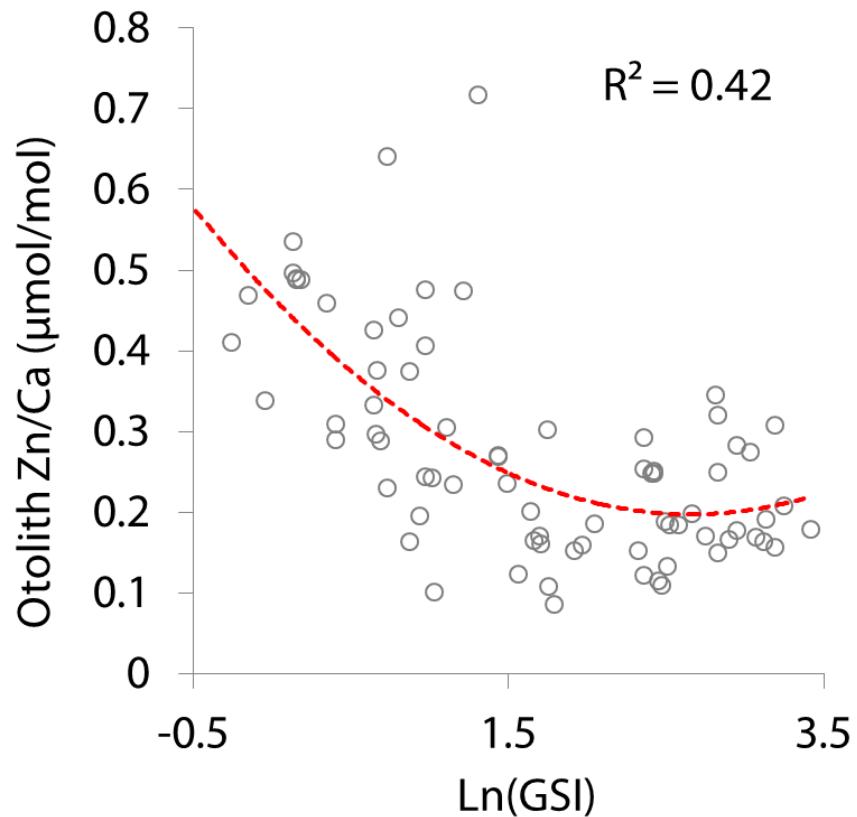


Otolith and blood Zn depleted in females.

36-42% explained by GSI in spawners

→ spawning signal?

ZINC

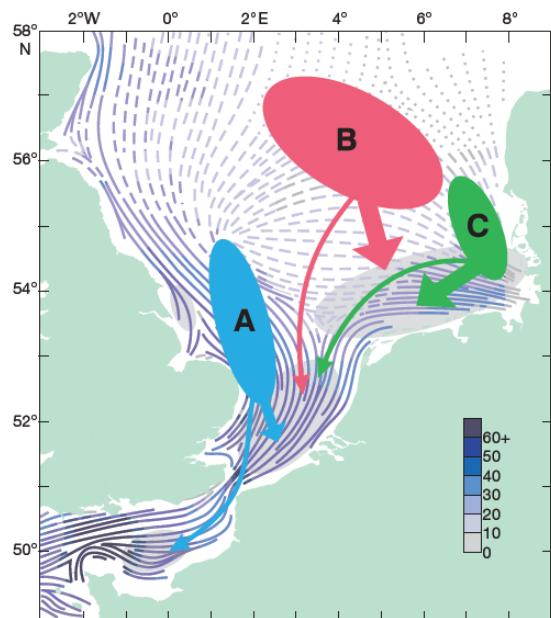


Otolith and blood Zn depleted in females.

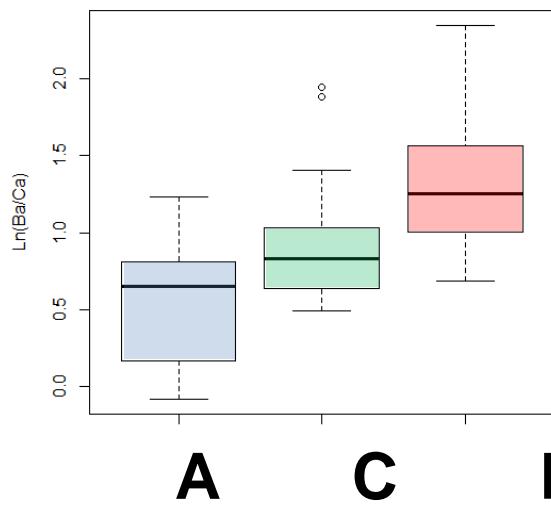
36-42% explained by GSI in spawners

→ spawning signal?

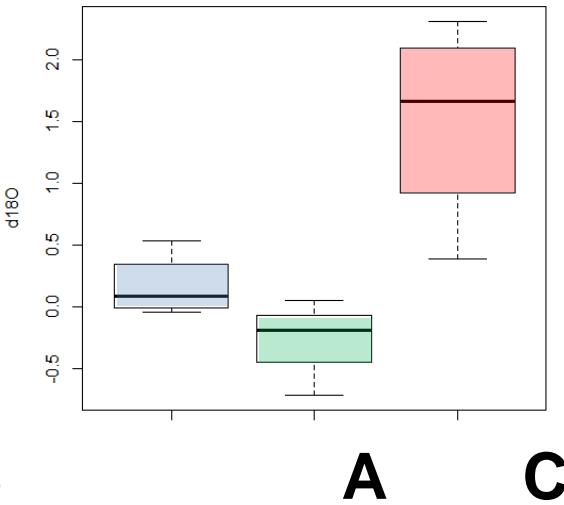
Wild fish?



Ba/Ca

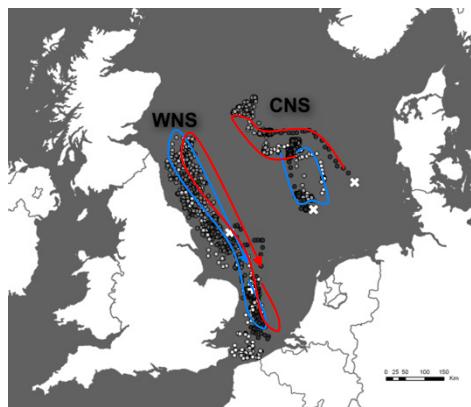


$\delta^{18}\text{O}$

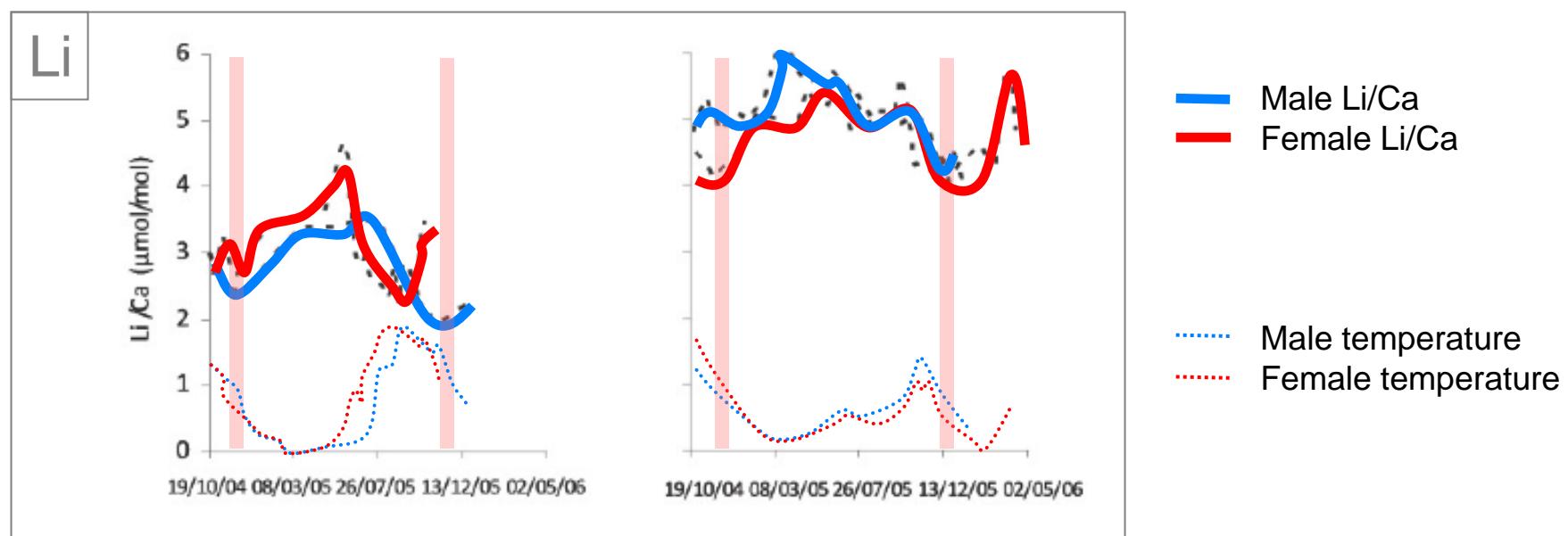


Hunter *et al.* (2009)

Wild fish?



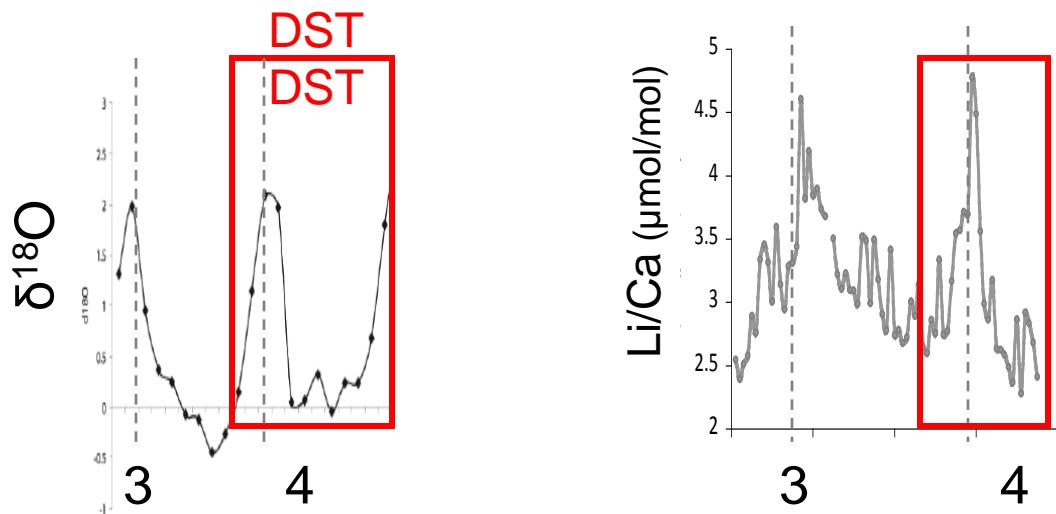
Temperature vs. Li/Ca (-ve)
 $(r^2 = 0.47, p < 0.001)$



APPLICATION

WNS female

$\delta^{18}\text{O}$ and Li/Ca imply similar migration in pre-DST year



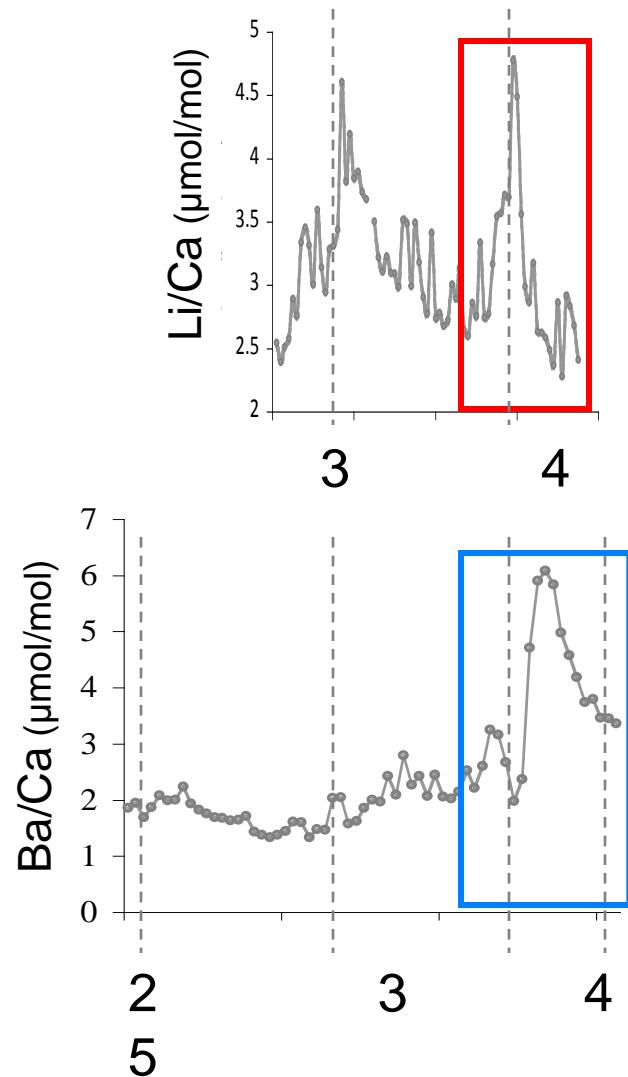
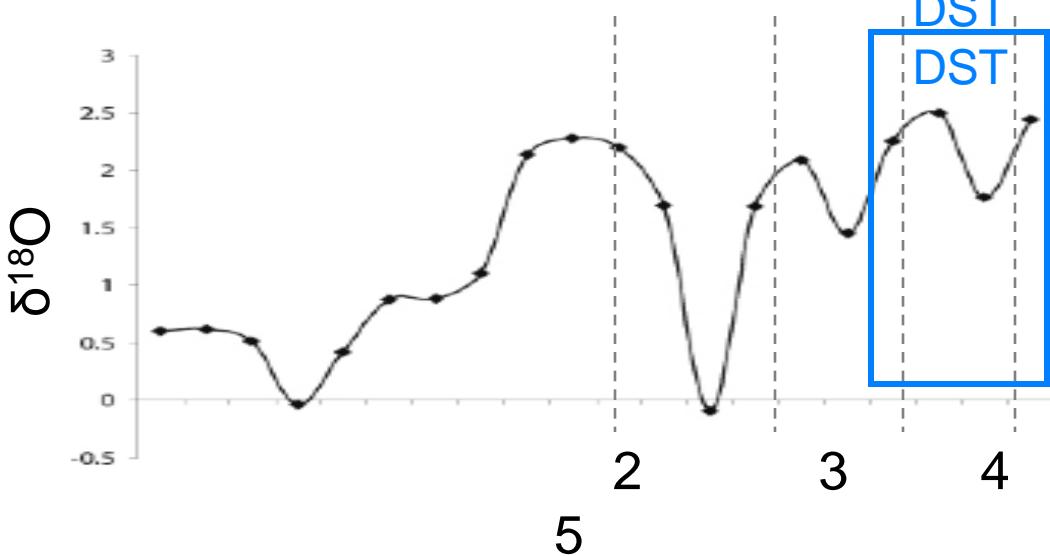
APPLICATION

WNS female

$\delta^{18}\text{O}$ and Li/Ca imply similar migration in pre-DST year

CNS male

$\delta^{18}\text{O}$ implies warmer previous summer; low Ba/Ca \rightarrow diff area?



Take home messages

- Growth, condition, age, GSI & sex can affect otolith composition
- Temperature effects appear indirect (except possibly Li)
- Otolith Sr is a poor environmental recorder in marine fish
- Ba, Li and $\delta^{18}\text{O}$ = promising geographic signals
- Zn and Sr = promising spawning signals

Stock discrimination

Tracking individual movements?

Assessing reproductive outputs?

Acknowledgements



FSBI for PhD studentship

FSBI and ICES for grants to attend this conference

Defra contract M1102 (MEMFISH); EIMF/NERC (SIMS)

UCSC: Rachel Johnson

EIMF: John Craven, Richard Hinton and Cees-Jan de Hoog

NOCS: Andy Milton and Matt Cooper

University of Montpellier: Audrey Darnaude

University of Portsmouth: Colin Waring

CEFAS: Christie Stewart, Julian Metcalfe, Stuart Hetherington, Matt Eade, Sam Roslyn, Matt Smith, Alexander Scott, Johan van der Molen, Glenn Saunders, Andy Smith, Stefan White,

Lorraine Greenwood, Steve Milligan, Antonio Pliru, James Pettigrew, James Hammond,

Lucia Privitera, Michael Godard and all the DST experiment contributors

Questions?

