THE THERMAL REGIMES EXPERIENCED BY ADULT ATLANTIC SALMON (*Salmo salar* L.) AND SEA TROUT (*Salmo trutta* L.) IN FRESHWATER, AS INDICATED BY TEMPERATURE-SENSING ACOUSTIC PINGER TAGS

by A. M.Walker, B. J. Bendall and A. Moore

Introduction

- Temperatures exceeding 22°C in aquaria significantly reduce the reproductive success of Atlantic salmon [1].
- In summer 2003, a number of English salmon rivers reached temperatures exceeding 25°C.
- Rivers in the U.K. may be becoming warmer as a consequence of local and more widespread impacts, such as:
  - ABSTRACTION for agriculture, aquaculture, industry and amenities reduce river discharge.
  - EFFLUENT and RUN-OFF from industrial and urban sources may be warmer than the rivers they discharge to.
  - CANOPY REMOVAL increased water temperatures up to 2°C in 1st order streams [2].
  - CLIMATE CHANGE models suggest mean summer air temperatures in the south of England might increase 6°C by 2080 [3].
- Knowledge of the impact of increased thermal regimes on migrating salmonids is essential to those responsible for the conservation of stocks and the sustainable management of associated fisheries.

Method

- In 2004, CEFAS began a 5-year study of the behaviour and thermal regime use of adult salmon and sea trout in the River Tyne, England (Plate 1).

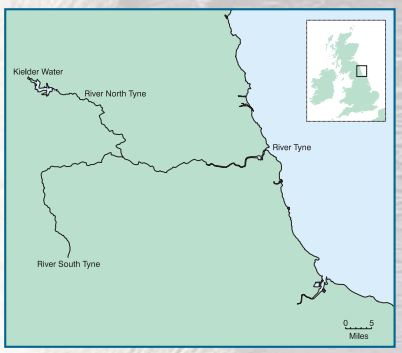

Plate 1: Schematic of the River Tyne and its two main tributaries (Northumberland, UK).

- Here we highlight some of our research questions, and present preliminary results to illustrate how our methods are being used to provide the answers.
- Fish are captured in the mouth of the estuary and tagged with a VEMCO temperature-sensing acoustic transmitter (Plate 2).
- The patterns of movement of the fish and the water temperatures experienced are monitored with VR2 automatic and VR60 manual receivers. Catchment thermal regimes are monitored with Gemini TinyTag loggers.

Plate 2: VEMCO VR16 and VR13 acoustic pinger tags and a VR2 receiver.

Questions and Results

How does thermal regime vary throughout the River Tyne catchment?

- Temperature differences between the two major tributaries, the North and South Tyne (Plates 3 and 4), varied by as much as 4°C during the autumn and winter (Figure 1). Kielder Reservoir (1068 ha) most likely has a buffering effect on the thermal regime of the North Tyne.

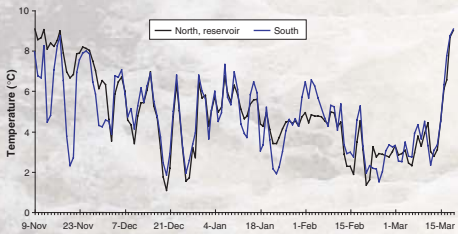

Figure 1: Thermal variation between tributaries of the River Tyne during winter - daily mean temperature.

Plate 3: The North Tyne is characterised by pools and long glides.

Plate 4: The South Tyne is characterised by riffles and runs.

What thermal regimes do autumn migrating adult salmonids experience in the River Tyne?

- Figures 2 and 3 present the upstream and downstream movements of a sea trout and a salmon that entered freshwater in the autumn, along with the water temperature and river flow regimes they experienced. The cumulative thermal experience of the sea trout was 202 degree-days (salmon data incomplete). In comparison, a fish entering the river in the summer might incur 2000+ degree-days before spawning.
- The temperatures experienced by the fish were very similar to river temperatures recorded by adjacent temperature loggers (daily means differed < 0.5°C).

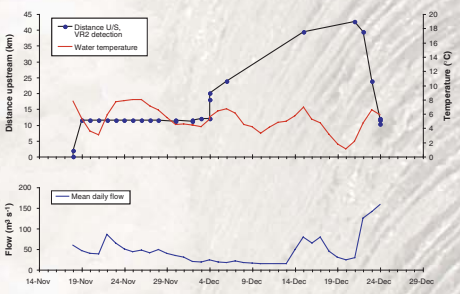

Figure 2: Thermal exposure of a migrating autumn sea trout in the River Tyne.

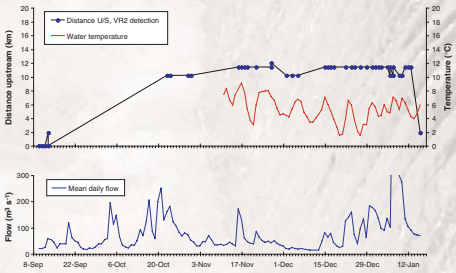

Figure 3: Thermal exposure of a migrating autumn salmon in the River Tyne

Does an intraperitoneal tag represent ambient water temperature?

- A V13T tag inside a sea trout carcass equilibrates to a 5°C (15 ↔ 10°) change in ambient water temperature within 2.5 hours (Figure 4). The rate of change is exponential: 90% of the change is achieved within 1 hour.

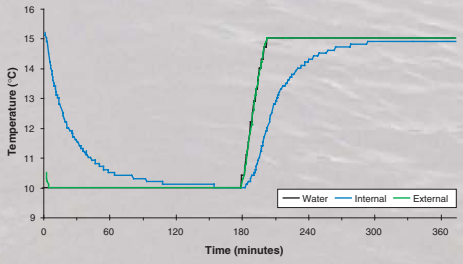

Figure 4: V13T temperature equilibrium rate in the peritoneal cavity of a sea trout carcass (59 cm, 2.1 kg), compared to cooling and warming water temperature.

Work in Progress

- Examine the freshwater thermal experiences of salmon and sea trout tagged in spring, summer and autumn. Investigate whether River Tyne fish use cool-water refugia, either at pool, reach or tributary scales.
- Analyse results in relation to species, sex, dates of freshwater entry and spawning, cumulative thermal experience and distribution within the catchment.
- Laboratory trials to examine the impact of seasonal temperature regimes on salmon fecundity.

Acknowledgements

This research is funded by the Department for Environment, Food and Rural Affairs (Defra) UK under contract SF0246. We are grateful for the assistance of the Environment Agency and the support of riparian owners and fishing interests on the River Tyne.

References

1 King *et al.* (2003) *J. Fish Biol.* 63, 153-167
2 Hetrick *et al.* (1998) *Trans. Am. Fish. Soc.* 127, 859-875
3 Hulme *et al.* (2002) www.ukcip.org.uk

CEFAS
The Centre for Environment, Fisheries & Aquaculture Science

The Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK. http://www.cefas.co.uk a.m.walker@cefas.co.uk