

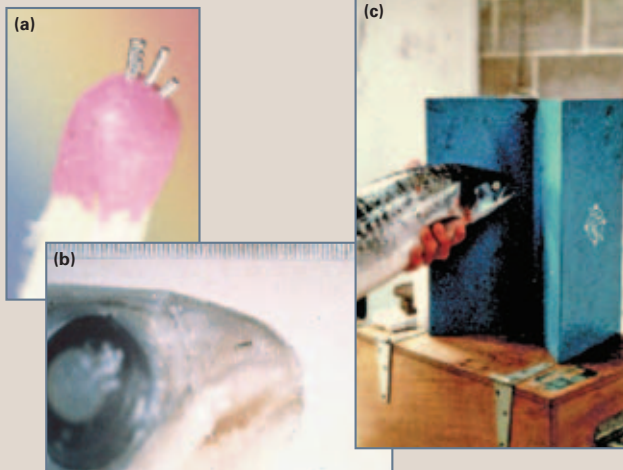
# The effect of coded wire tagging on stress levels and seawater survival in Atlantic salmon smolts (*Salmo salar* L.)

## Abstract

The effect of a routine fish assessment technique on Atlantic salmon smolts was assessed using a non-invasive method to measure the levels of the stress hormone cortisol released into the water. Handling, implantation of Coded Wire Tags and adipose fin clipping under anaesthesia did not induce a measurable elevation in cortisol release. Surprisingly, handling without anaesthesia also did not produce an immediate significant acute stress response. On transfer to seawater 4 days after handling or tagging, there was an indication that cortisol release was elevated in all groups (over the control), although it was only significant ( $P < 0.05$ ) for fish handled without anaesthesia. The results suggest that it is the handling of the fish rather than the presence of the tag itself that induces a stress response. Further studies on the impact of tagging freshwater smolts on their subsequent performance in seawater are recommended.

## Introduction

The decline in Atlantic salmon stocks in the NE Atlantic has been partly attributed to poor natural survival in the marine environment. The marine survival of salmon is therefore being monitored in a number of rivers with large scale tagging programmes utilising Coded Wire Tags (CWT). Estimates of return rates are reported annually to the ICES North Atlantic Salmon Working Group. In 2005 69,000 hatchery-reared salmon parr and smolts and 12,000 wild salmon smolts were implanted with CWT and released in England and Wales.



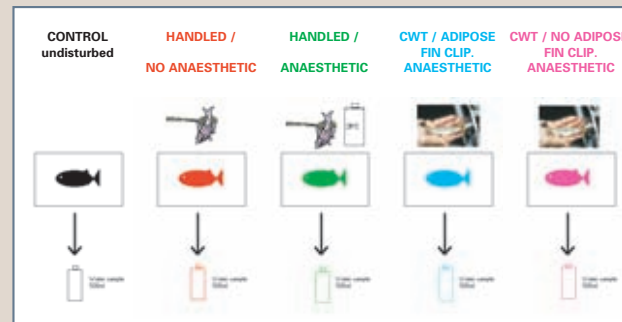
A coded wire tag (a) is a length of stainless steel wire 1.1mm long and 0.25mm diameter, marked with rows of notches denoting individual codes. The tags are inserted into the nasal cartilage (snout) of fish (b) and are detectable in live fish with specialised magnetic detectors (c), but only readable after removal from the carcass.

However, concerns have been raised that the procedures involved in the tagging of both wild and hatchery-origin fish (i.e. handling, anaesthesia and tag insertion) may affect marine survival in monitored stocks. Therefore, there is a need to critically assess tagging techniques that are routinely used as tools for assessing fish populations.

This study utilises a non-invasive method of monitoring the primary stress response in salmon smolts to assess the effect of the CWT tagging procedure.

## Methods

- Hatchery-reared smolts were placed individually in opaque plastic tanks (30L), surrounded by a black behaviour screen to ensure minimal disturbance.
- There was a constant measured inflow of aerated water, and photoperiod (52°N) and water temperature were ambient. The experiment was carried out in early May, the peak migratory period in the wild for this stock.
- Smolts were randomly assigned to 5 groups (n=6 per treatment) and water samples were collected from taps at the front of the tanks.



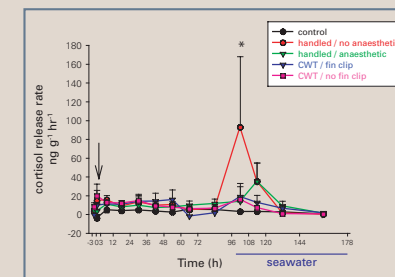
- The release of cortisol into the water by the smolts was monitored in freshwater for 4 days, the average time taken for smolts in the wild to move downstream and into the marine environment. This was followed by an *in situ* transfer to ambient seawater (29-33 ppt) for 3 days.
- The cortisol release rate ( $\text{ng g}^{-1} \text{h}^{-1}$ ) was calculated from the amount of cortisol released by the individual fish within a given time interval, the water volume, the rate of decrease due to dilution from the inflow water, and the fish biomass.
- At the end of the experimental period, the fish were sampled for some of the physiological parameters associated with smoltification.



The cortisol was concentrated from the water within a solid-phase extraction cartridge, retrieved by solvent elution and measured by radioimmunoassay.

## Results

- No immediate significant acute stress response to handling or tagging was observed in any treatment group, although these fish did show an elevation in cortisol release rates compared to the control (undisturbed) fish.
- The presence of CWT in the fish, with or without the removal of the adipose fin, did not induce a further increase in the cortisol release rate over the experimental period (7 days in total) ( $P = 0.349$ ;  $P = 0.358$  respectively).
- Despite an indication that all treatment groups released cortisol at a higher rate than the control fish, only smolts that were handled without anaesthetic (but not tagged) had significantly higher cortisol release rates over time compared to the control fish ( $P = 0.009$ ).
- On transfer to seawater 4 days later, all handled or tagged groups appeared to show an elevation in cortisol release over the control group, although this was only significant for smolts that were handled without anaesthetic ( $P < 0.001$ ).



Effect of handling, with and without anaesthetic, and CWT with and without adipose fin clip, on the cortisol release rate of salmon smolts in freshwater and after transfer to seawater (n=6 per treatment). Arrow indicates timing of stressor (0h). Values are plotted at the midpoint of the time interval that release rates were measured over. \* $P < 0.001$  compared to control and all other treatment groups.

- Levels of plasma cortisol measured at the end of the experiment were similar in all groups ( $69 \pm 6 \text{ ng/ml}$ ;  $P = 0.713$ ).
- There was no significant difference in gill  $\text{Na}^+ \text{K}^+$  ATPase activity between groups ( $P = 0.744$ ), suggesting all smolts were physiologically adapted to the change in salinity.

## Discussion / Conclusions

- The lack of a demonstrable acute stress response in the handled / no anaesthetic group was surprising. This may have been due to the elevated cortisol levels associated with smoltification, or that fact that the smolts were of hatchery origin and may have been less stress-responsive to handling.
- Although insertion of CWT into salmon smolts did not induce a significant acute stress response nor produce significantly elevated cortisol levels during seawater transfer, there was an indication of elevated cortisol levels in treatment groups throughout the experiment. The results indicate that further examination of the impact of tagging on subsequent performance is warranted.
- The study suggests that it is the handling of the fish rather than the presence of the tag itself that induces a stress response. The use of anaesthetic during handling may also be an effective stress-reducing method.
- The results indicate that events during the freshwater stage of salmon may influence physiology in the marine environment.
- Wild smolts may show an increased responsiveness to stress compared to their hatchery counterparts and further studies should be carried out to determine the impact of other routine handling and tagging procedures on the seawater adaptability of these fish.
- The experiment demonstrates the value of the non-invasive assay which allows the cortisol status of different treatment groups of smolts to be monitored over time.

## Acknowledgments

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