

## Long-term trauma? Studying the effects of catch-and-release on Atlantic cod behavior using acoustic telemetry

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### Summary

A recent study on catch-and-release (C&R) behavior of marine angling tourists in Norway showed that large proportions of Atlantic cod (*Gadus morhua*) catches are released. To investigate the potentially negative consequences of C&R on cod in their natural environment, 80 cod were caught in fyke nets, fitted with acoustic tags and released. Nine individuals were subsequently recaptured and released at least once by experimental recreational angling using rod and line, following best release practice. All cod survived the release event, but three individuals showed short term behavioral alterations, e.g. reduced swimming activity or disruption of diel vertical migrations after the release event. To minimize the negative effects of C&R, fishery managers are encouraged to consider C&R practice in future management regulations, in conjunction with the development of best practice guidelines and angler education on proper fish handling.

### Introduction

Marine recreational fishing in Norway has a long tradition. In addition, marine angling tourism expanded rapidly during the last two decades (Borch, 2009), and the landings in organized marine angling tourist businesses were estimated at around 3,300 tons during 2009 (Vølstad *et al.*, 2011). The emergence of sport fishing (in contrast to subsistence fishing) and new management regulations in recent years, i.e. minimum landing sizes and bag limits, have increased the practice of C&R in Norway (Ferber *et al.*, 2013a). In fact, the proportions of cod catches released by marine angling tourists are among the highest in Europe (Ferber *et al.*, 2013b), with release rates of 62% and 66% in southern and northern Norway, respectively. This has led to public discussions on the ethical aspects of C&R, and release mortalities, as well as sub-lethal effects are feared to be substantial. Post-release mortalities depend on a variety of factors including hooking location, temperature and capture depth (Bartholomew and Bohnsack, 2005), and to date no studies have investigated the potential impacts of C&R on cod in Norway. However, Weltersbach and Strehlow (2013) investigated the mortality of cod released by charter boat anglers in the Baltic Sea, and estimated an average mortality of 11.2% after correction for handling and tagging effects. While this study yielded information on the overall proportion of mortality caused by C&R, it did not study possible individual behavioral alterations, e.g. changes in feeding and movement patterns, which may be caused by the C&R event. Therefore, by using acoustic telemetry the present study investigated if cod show any behavioral changes after being caught and released into their natural environment under best release practice.

## Materials and Methods

The study area was a semi-sheltered basin in the central part of the Norwegian Skagerrak coast, close to the town of Arendal, and comprised an area of about 3 km<sup>2</sup> with a maximum depth of about 30 m. During May 2012, 80 cod were captured using fyke nets, and equipped with V9P acoustic transmitters (Vemco Division, Amirix Systems Inc., Halifax, Canada) which were surgically implanted into the body cavity. Additionally each cod was tagged with an individually numbered external T-Bar anchor tag (Hallprint Pty. Ltd, Holden Hill, South Australia) for identification. To record movement patterns of the cod, 44 ultrasonic receivers (VR2W, Vemco Division, Amirix Systems Inc., Halifax, Canada) were installed in the study area. After a recovery period of at least 14 days after release, experimental angling was conducted in the study area. Only lures with single or small triple hooks were used to reduce hooking damage. During this angling, nine cod with acoustic transmitters were recaptured, landed with a net, and released carefully after de-hooking and measuring. After three months, the acoustic tagging data were downloaded from the acoustic receivers, processed in a VUE database (Vemco Division, Amirix Systems Inc., Halifax, Canada) and imported into R for statistical analysis. To test if the C&R event had an impact on the behavior of the cod, a generalized linear model was used to compare the vertical movements (as a proxy for activity) before the cod was caught, and after it had been released.

## Results and Discussion

All cod survived the release event, and while six of the fish did not show any significant changes in activity, three individuals showed behavioral alterations, e.g. reduced activity or disruption of diel vertical migrations after the release event. The recovery time for the cod with altered behavior ranged from 10 to 15 hours. After this period all cod had returned to their normal behavior patterns. Thus, although short-term effects are possible, C&R does not have significant lethal or long lasting sub-lethal effects on cod when the fish are caught in shallow water (< 20 m), handled properly and fishing gear that minimizes hooking damage is used. As the cod were tagged and released several weeks prior to the actual angler C&R event it was possible to separate tagging effects from C&R effects, which otherwise could have led to biased results (Donaldson *et al.*, 2008). To minimize the negative effects of C&R, fishery managers are encouraged to consider C&R practice in future management regulations, in conjunction with the development of best practice guidelines (e.g. Cooke and Suski, 2005) and angler education on proper fish handling.

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