A novel approach to validate, analyze and display acoustic telemetry data

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Summary
In recent years researchers have observed tremendous advances in acoustic telemetry. Transmitters have been miniaturized to less than a gram and receivers have become less expensive, smaller and more sophisticated. Analytical techniques and PC software, however, have not kept pace. In this presentation we will introduce techniques to validate, analyze and display telemetry data focusing on Atlantic salmon (*Salmo salar*) smolt and post-smolt migratory studies. We will demonstrate how one can analyze millions of detection data in a migratory study from thousands of fish with just a few hours of setup time. This novel technique can easily apply to other study designs as well.

Introduction
Atlantic salmon populations have precipitously declined in recent decades and it is thought that the primary limiting factors occur in the marine environment (Potter and Crozier 2000). Many studies have focused on the juvenile salmon's transition into the marine environment, a critical period when mortality is thought to be high (Friedland et al. 1998, Thorstad et al. 2000). Recent advancements in acoustic telemetry have allowed researchers to track fish for longer periods of time and further into the ocean to better understand behavior and survival challenges (Davidson et al. 2009). Millions of tag detection data can be accrued in a single telemetry study and the challenge is the amount of time it takes to set up and analyze these large data sets. In this presentation we will demonstrate a software application developed in NET/C# called MyTrack which enables the analysis of large telemetry datasets. Specifically, we will demonstrate many of the features of MyTrack applied to two years (2012 and 2013) of telemetry data from an Atlantic salmon smolt and post-smolt migration study.

Materials and Methods
A total of 531 salmon smolt were sonically tagged over a two year period (2012 and 2013) during their seaward migration from three rivers draining into the Gulf of St. Lawrence, Canada (Miramichi, Restigouche, and Cascapedia Rivers). Tagged animals were detected by strategically deployed VEMCO (Halifax, Nova Scotia) receivers. For each river, complete receiver coverage was positioned across the head of tide and near the exits to the Gulf of St. Lawrence (Miramichi and Chaleur Bays). The northern exit from the Gulf of St. Lawrence was also covered with an array positioned at the Strait of Belle Isle between Green Island Cove Newfoundland, and L'Anse a Loup, Labrador.

The MyTrack application was used to analyze data from both technological system performance and biological analysis perspectives. Animal telemetry data was used to: 1) investigate acoustic gate performance and individual receiver performance to illustrate the efficacy of the telemetry array design and 2) to investigate river/ocean survival and movement data.

Results and Discussion
Data are collected from all receivers and exported as comma separated value (CSV) files consisting of fish ID code, date and time, receiver serial number and receiver station name. To use the MyTrack application, the user must also assemble two metadata files that describe relevant data for the receivers and released fish transmitters in the system, as well as other information pertinent to the study (river

flow and water temperature data, sunrise/sunset date and times, false detection records). The metadata files consist of the following: (1) Receiver file: contains location, river km, receiver deployment and retrieval date, station name and receiver serial number for each acoustic receiver; and (2) Transmitter file: contains ID code, fish number, species label, release date and location, transmitter activation date, transmitter type, and transmission interval for each transmitter.

Metadata and detection data are then read into the software. If detection is determined to be valid, it is assigned a fish number, location, receiver serial number, station, gate, river route and branch; these assignments are based on cross-referencing the detection data with the metadata provided in the receiver and transmitter files. This information is required to build a history for each fish.

The detection data are then used to investigate receiver and gate performance by displaying single and multiple detections/fish for each receiver and gate. If double gates are present, the software will also calculate gate detection probability metrics. Daily diagnostic data recorded by each acoustic receiver are also used to investigate receiver and gate performance. This information, along with site specific information on receiver location, can be used to assess each receiver location in the study. These data are extremely useful, enabling researchers to make adjustments to the equipment.

Various biological analysis are also performed providing insight into route choice, river reach survival, river to ocean survival, swimming speed and fish responses to external variables such as tidally influenced river flow and water temperature. Where relevant, analysis outputs are displayed on a GIS scaled plot.

MyTrack can analyze up to 10 species or populations in a single study, and it can accommodate up to 200 receivers and 10,000 animal IDs. The software can easily be expanded to handle more receivers and transmitters. There is no limit on the number of transmitter detections in the study. To date we have analyzed more than 15,000,000 detections in one study. Once the metadata files are completed, analysis takes approximately 60 seconds or less. MyTrack is a novel analytical application that can minimize the amount of time spent inputting and analyzing data compared to using commercial off the shelf database and statistical applications.

References

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