MICHIGAN STATE UNIVERSITY

Quantitative Fisheries Center (QFC) Ongoing Project Briefing

Evaluating Performance of Hidden Markov Models with Acoustic Telemetry Detection Data

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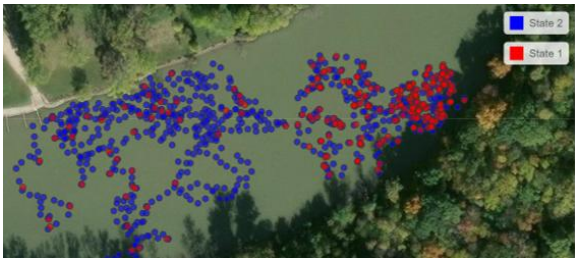
Goal: Test the performance of hidden Markov models (HMMs) when applied to acoustic telemetry data and sensitivity to factors such as positioning error and location interpolation due irregular observations or missing observations



Caption: Simulated locations using a 2 behavioral state parameterization within the boundaries of the Sandusky river.

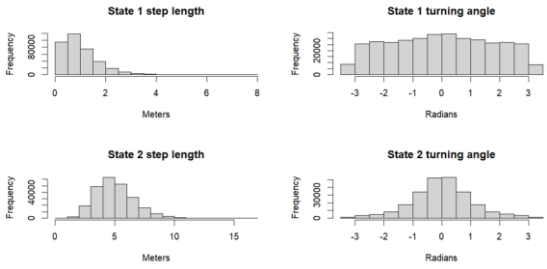
Objectives:

1. Evaluate performance of HMMs under positioning uncertainty by quantifying how varying levels of location error in acoustic telemetry-derived fish position affect accuracy and reliability of inferred states.
2. Assess robustness of HMMs to irregular observation intervals and missing detections.
3. Investigate the influence of model complexity on behavioral inference.

Management Implications: Hidden Markov Models (HMMs) are widely used to identify distinctive behaviors by inferring unobserved states (e.g., foraging, transiting, resting) from animal movement data, where each state manifests as characteristic movement trajectories. By capturing switches between these behaviors, HMMs help reveal how fish respond to environmental conditions, which in the case of an invasive species could allow for more targeted suppression effort. Using simulations to evaluate HMM performance is beneficial for fisheries management because it allows for testing model reliability under known conditions, assessing uncertainty and bias, and better understanding of how well inferred behaviors can inform management decisions.

Methods:

- Simulate fish movement within a river system assuming distinctive movement patterns characterized by differences in movement step length and turning angle.
- From simulated movement trajectories, simulate acoustic telemetry detections subject to differing levels of positioning error, observations intervals, and degree of missed detections.
- Fit candidate HMMs to simulated datasets and compare model estimates (number of identified states, estimated step length and turn angle) to known conditions.



Caption: Distributions of step length and turning angle for locations of grass carp simulated within the Sandusky River, Ohio

Prelim. Findings/ Next Steps:

- Methods for simulating movement and acoustic telemetry detections in river systems with user-defined behavioral states and that respects physical boundaries of the river has been completed.
- Simulation scenarios consisting of different number of behavioral states and movement parameters, level of positioning error, and degree of observation irregularity are being discussed and developed.

QFC Supporting Partners

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