# Geolocation of Atlantic cod off New England using archival tagging data and hidden Markov models

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**Abstract:** Understanding fish movement is critical for describing spatial processes and population dynamics. Archival electronic tags present the opportunity to acquire high resolution data on fish movements. Geolocation methods using archival tags have been commonly used to estimate daily positions of pelagic species using tidal features, temperature, depth, and other environmental data. However, the development and validation of alternative methods is required for geolocation of demersal species, because of considerable error in estimated positions. In this effort we developed geolocation methods for Atlantic cod off New England using hidden Markov models (HMMs). The geolocation approach is based on a modification of the observation likelihood and behavior models of an existing HMM framework (Pedersen et al., 2008) and addresses both region- and species-specific challenges. The HMM emission probabilities are described by the likelihood model which compares environmental data recorded on the tag with those derived from an oceanographic model. Likelihood distributions are depth- and temperature-based with tidal-based exclusion. The transition probabilities are described by the behavior model which constrains the horizontal movement of the fish. The Viterbi algorithm was applied to the HMM-constructed posterior probability distribution to generate the most probable track. Validation experiments were performed using a comprehensive quantitative skill assessment process relying on stationary tags moored on the seafloor, double-tagged fish (archival tag and acoustic transmitter), and simulated tracks. Known data, including fish locations and activity level metrics, showed good agreement with those estimated by the HMM geolocation model. Processing the recovered archival tagging data using the developed geolocation methods is expected to improve our understanding of cod movements and population dynamics, which will be helpful for informing future stock assessments and fishery management plans.

## References

Pedersen, M.W., Righton, D., Thygensen, U.H., Andersen, K.H., and Madsen, H. (2008) Geolocation of North Sea cod (*Gadus morhua*) using hidden Markov models and behavioural switching. *Canadian Journal of Fisheries and Aquatic Sciences*, **65**(11):2367–2377.