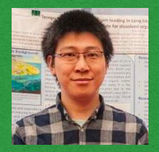
Pop-up satellite archival tagging and geolocation of Atlantic halibut off Cape Cod



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Background

Atlantic halibut are a 'Species of Concern' in U.S. waters, and little is known about their stock structure and life history. The rejection of the 2015 stock assessment and the 2017 update assessment drew attention to the paucity of information for assessing and managing this stock. To investigate movement patterns and stock structure, we tagged halibut in summer 2017 off Cape Cod using pop-up satellite archival tags (PSATs) and data storage tags (DSTs).

Archival Tagging

Fig. 1: A MiniPAT (left) and a Star-Oddi centi DST (middle) attached internally to an Atlantic halibut with a jaw tag (right).

Twenty MiniPAT PSATs from Wildlife Computers Inc. were rigged following specific recommendations from colleagues who have experience attaching MiniPATs to sharks.

- ✦ The programmed pop-up dates are June 26, 2018 and August 2, 2018.
- ✦ MiniPAT tagging protocols followed methods developed by Seitz et al. (2003), and Star-Oddi DST tagging protocols were developed with guidance from our collaborators at Maine Department of Marine Resources (DMR) who tagged halibut with DSTs in the Gulf of Maine.
- ✦ As of December 2017, Eight single-day trips and one multi-day trip were completed to deploy the PSATs. Ten PSATs and four DSTs were deployed east of Cape Cod and along the edge of Platts Bank in the Gulf of Maine (Figure 2).

Specifications and Settings for Wildlife MiniPATs:

- Time interval for archived data: 5 seconds
- Time interval for transmitted data: 10 minutes
- Depth sensor resolution: 0.5 m

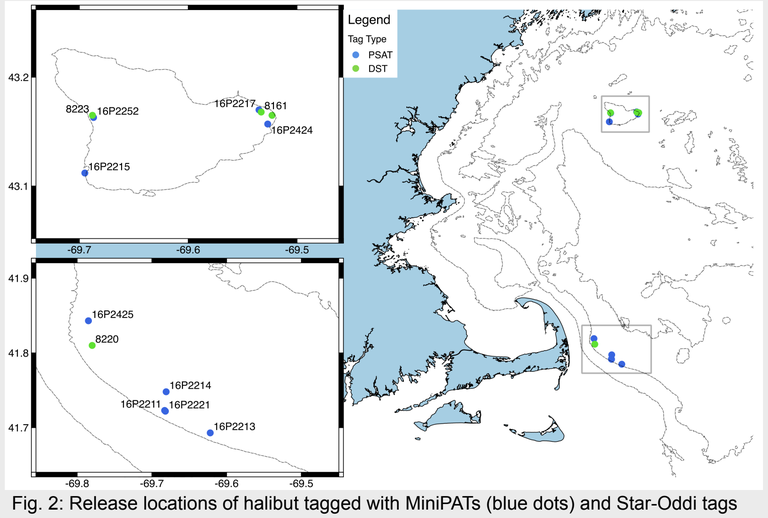

Fig. 2: Release locations of halibut tagged with MiniPATs (blue dots) and Star-Oddi tags (green dots).

PSAT Analyses and Geolocation

A hidden Markov model-based (HMM) geolocation method that was previously developed for other groundfish species (Liu et al., 2017) will be used to estimate the movement tracks of the tagged halibut, based on the PSAT-recorded depth and temperature data which will be available after summer of 2018. Meanwhile, to demonstrate the applicability of the method to halibut, we geolocated an existing PSAT dataset derived from halibut tagged off coastal Maine by DMR (Seitz et al., 2016).

Activity level classification for lower resolution depth data

Modifications were made to the HMM geolocation method designed for DST data to address the challenges related to the PSAT data. A primary challenge, for example, is the reduced depth resolution (Figure 3), which compromises the activity level classification scheme that works well for the DST data in the original method (Liu et al., 2017).

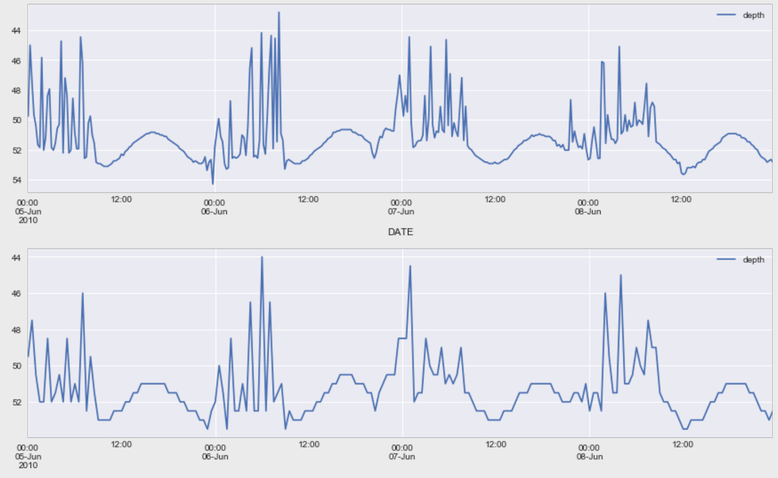

Fig. 3: Decreased depth resolution of cod DST data from Liu et al. (2017) from 0.1 m (upper) to 0.5 m (lower) results in compromised tidal-based activity level classification.

Here we present an alternative method for activity level classification. Using the depth time series data, we first compute daily accumulative depth change. The Jenks algorithm was then used to cluster the daily accumulative depth change into three activity levels, by computing the natural breaks among the three groups. These breaks are determined such that the average deviation from the mean is minimized for each group, while each class's deviation from the means of the other groups is maximized. When applied to depth data from tag #7 which has a resolution of >0.5 m, this method provides classification of three activity levels (Figure 4).

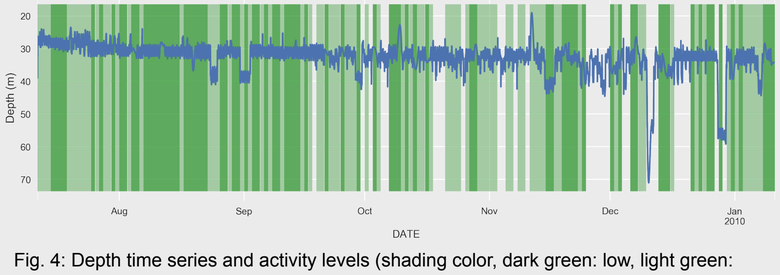

Fig. 4: Depth time series and activity levels (shading color, dark green: low, light green: moderate, white: high) determined using the Jenks natural breaks algorithm for DMR tag #7.

Geolocation results

The geolocation were performed for the four PSAT-tagged halibut (Table 1). The HMM geolocation method was able to reconstruct the estimated movement tracks and associated probability distributions for these four fish with different time and depth resolutions (Figure 5). The testing results provide confidence that the PSAT specification will yield reliable geolocation results for our current tagging project.

Geolocation analyses of the PSAT tagging data will provide further insights into halibut movements, behavior, and stock structure by recreating the migration tracks of these fish.

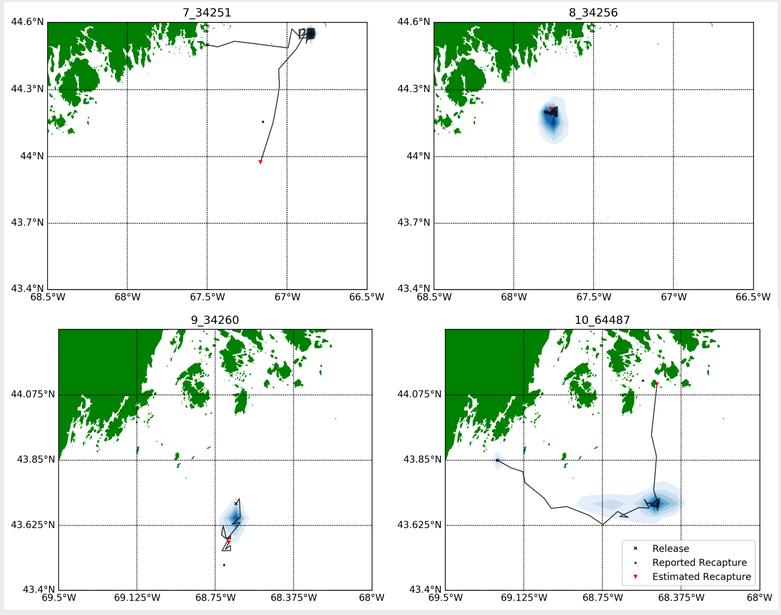

Fig. 5: Most probable tracks and associated probability distributions for four PSAT-tagged halibut.

Table 1: Summary of the DMR PSAT halibut tagging data.

Fish ID #	Tag #	Time Resolution (min)	Depth Resolution (approx. m)	Days at Large
7	34251	15	0.7	184
8	34256	15	5	29
9	34260	15	5	14
10	64487	4	0.3	31

References

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Acknowledgements

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