Estimation of Latent Behavioral States

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Behavior Estimation

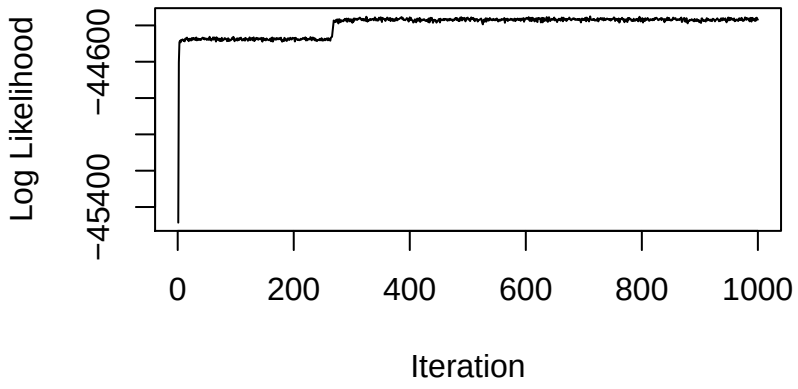
Movement parameters (SL/TA/TAA) have already been used to delineate time segments of different behavioral patterns. This document displays the output of the subsequent stage: the clustering of behavioral time segments into behavioral states. While some of the components of the clustering model are flexible (e.g., setting the max number of behaviors) or may be ambiguous (e.g., attribution of behaviors to clusters of time segments), this model relies on the user's experience with and knowledge of their study organism. Given prior knowledge about how the focal species moves within their environment, this *a priori* knowledge can be used to guide the assignment of latent behavioral states.

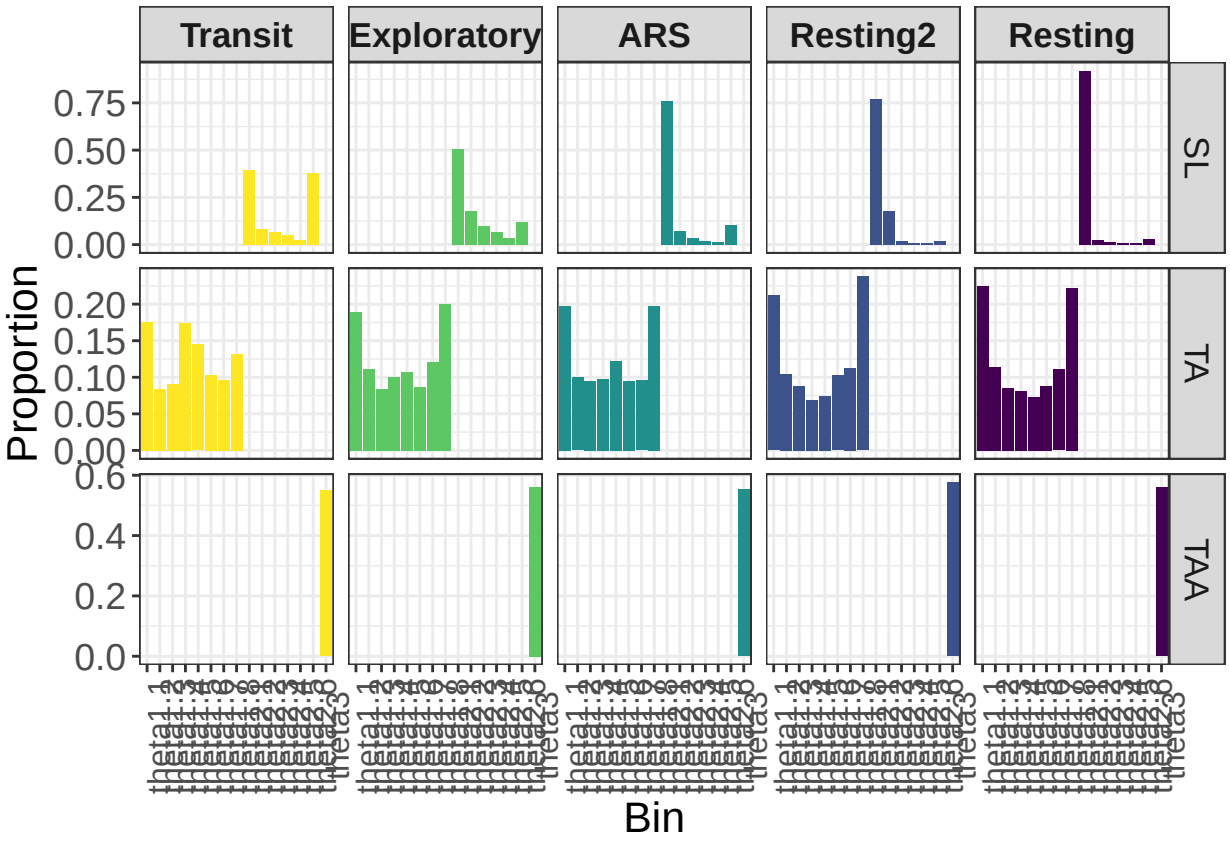
Output of behavioral assignment to time segments (as well as to the whole time series analyzed) will be visualized using multiple methods and components of the data to get a better sense of how the model has clustered time segments, the time series of behavior changes per individual, and the probability that an organism is in each behavioral state by time segment.

Identifying behaviors

As stated above, time segments were clustered by similar features of their multinomial (SL, TA) or bernoulli (TAA) distributions. An upper limit of 5 possible behaviors was set when running the model over 1000 iterations. Assuming the Gibbs sampler converged after the burn-in period (500 iterations) as determined by an asymptote of the log likelihood, the remaining 500 samples were purported to come from the posterior distribution. In some cases, all posterior samples were used in the analysis, whereas in others only the maximum *a posteriori* (MAP) value was used to assign behavioral states.

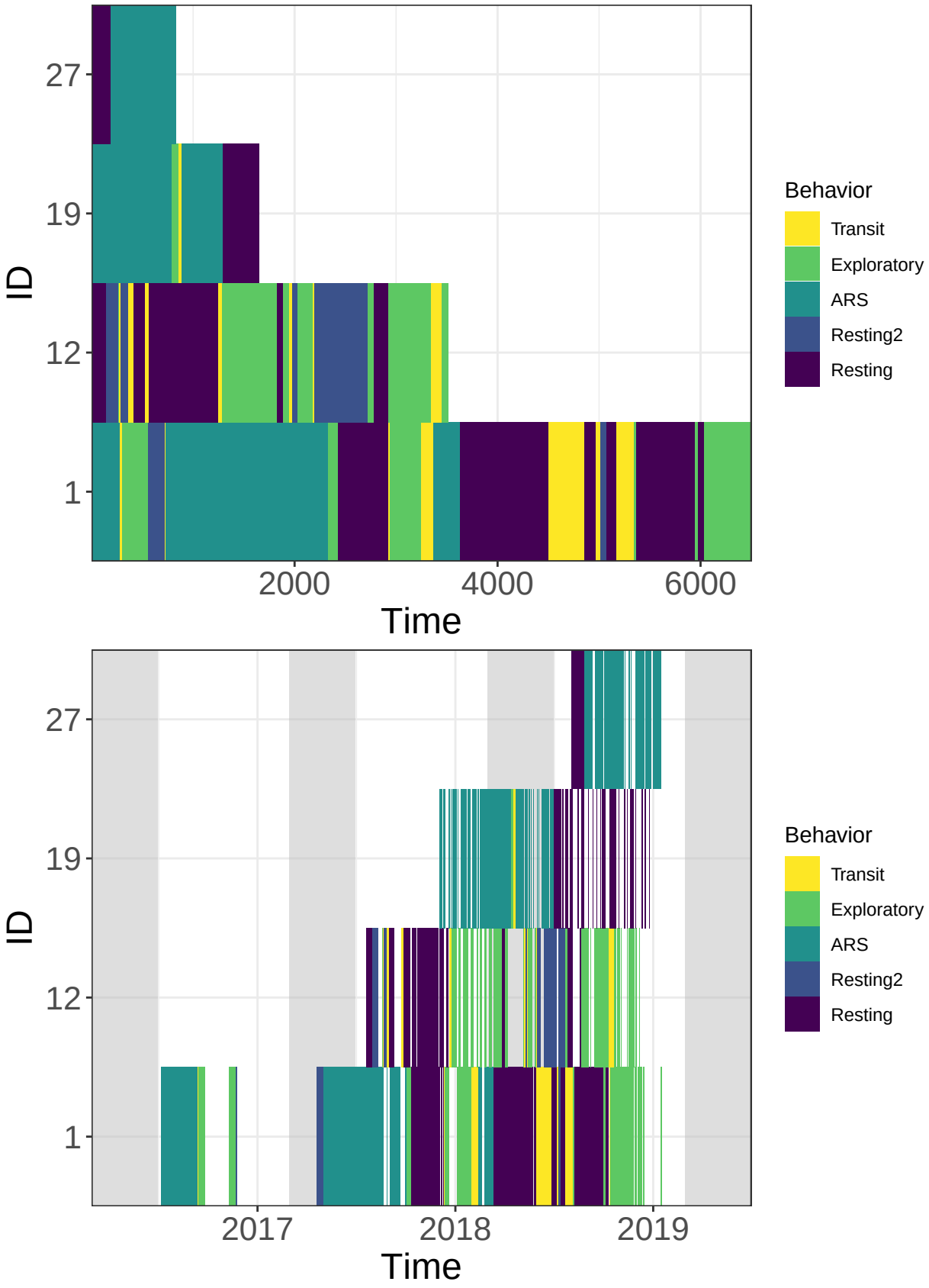
To get a sense of the behaviors identified, plots of the movement parameter distributions (SL/TA/TAA) are shown for each of the five behaviors. These behaviors are named according to likely movement based on these distributions. Labels on the x-axis (*theta1.x*,*theta2.x*,*theta3*) represent the bins for TA, SL, and TAA, respectively.





Time series of behavior by ID

Now that the behaviors have been roughly defined, I will now show how this looks over time across all individuals. This will provide a better sense of the transitions between behaviors and how long each ID spends in certain behaviors. These plots will be aligned by first observation as well as by date to give a sense of movement patterns as snail kites get older and how this relates to peak breeding season (March 1 to June 30). Additionally, plots that display the proportion of behaviors assigned to a given time segment (from the posterior of the *z's*) will be shown to provide a measure of the uncertainty associated with the behavioral assignments from the MAP value.


ID
27
19
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1
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Time
Behavior
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Resting2
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ID
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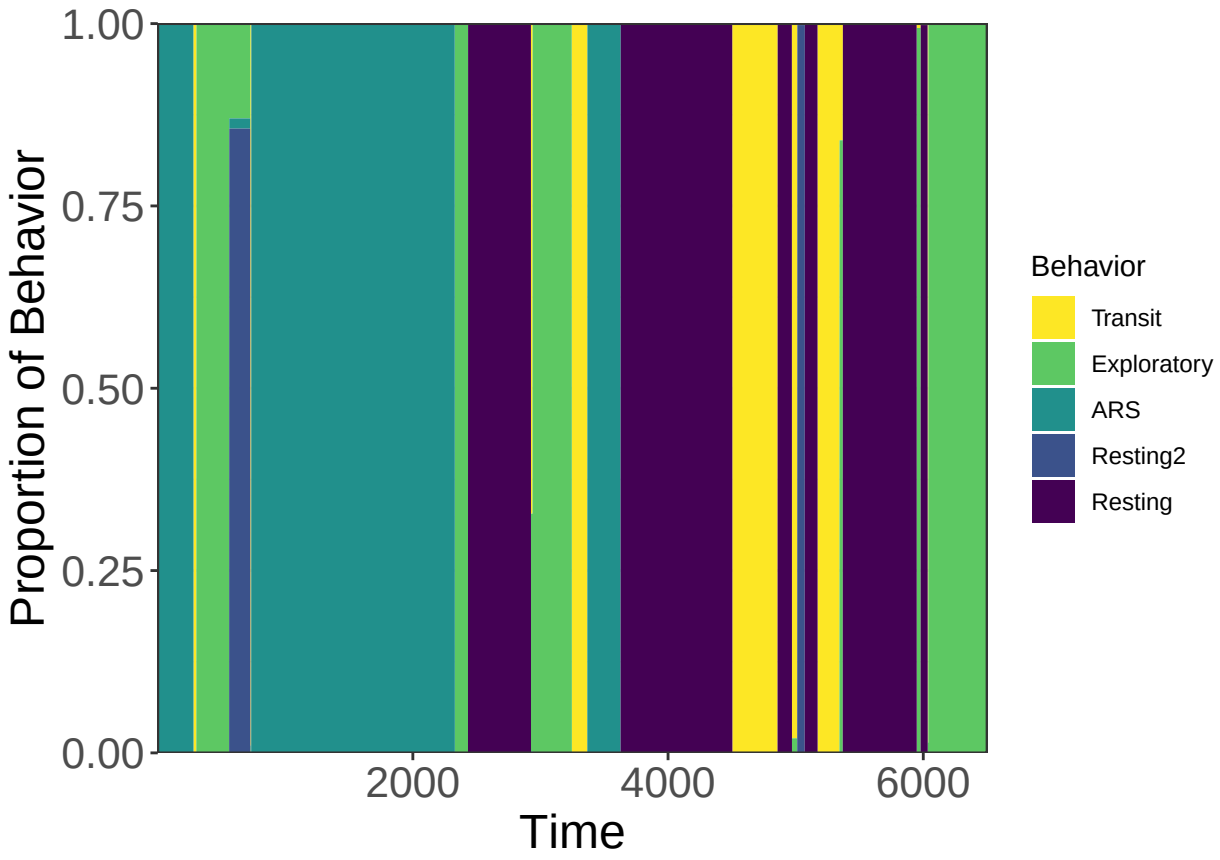
1.00
0.75
0.50
0.25
0.00
Proportion of Behavior
2000
4000
6000
Time
Behavior
Transit
Exploratory
ARS
Resting2
Resting

Maps of behavioral assignments by ID

Now that a behavioral state has been assigned to all observations (with a 1 hr time step), these values will be plotted in geographic space to visualize how well these classifications match up with perceived movement patterns.