

Behavior Segmentation

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Background

After running the time segmentation model, a behavioral segmentation model was run for the entire dataset of each individual. The original behavior segmentation model uses three movement parameters (step length, turning angle, and turning angle autocorrelation) to identify distinct behavioral states. Since the output from this original model was not satisfactory upon visualization of the movement parameters and their associated breakpoints, other forms of this model were tested. While multiple derived variables were used in addition to the original parameters of the original model, a separate model that only used persistence and turning velocity (V_p and V_t) were included. These variables were included per their utility described in the behavioral change point analysis by Gurarie et al. (2009):

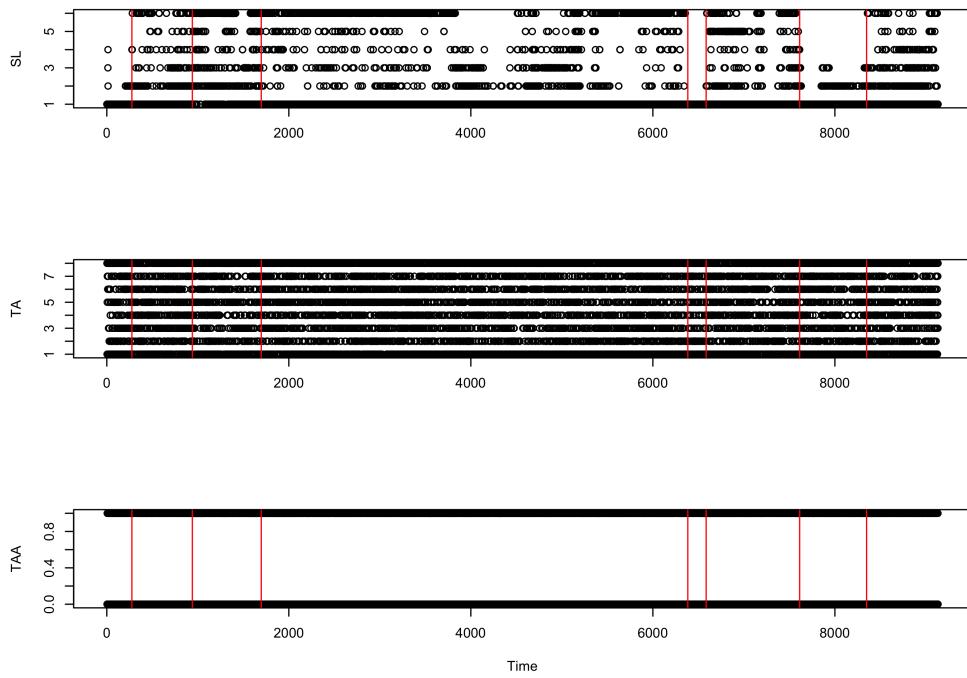
“We further transform the data by decomposing every speed estimate and turning angle into orthogonal components of persistence velocity $V_p(t)$ and turning velocity $V_t(t)$ defined as $V_p(t) = V(t)\cos(\theta(t))$ and $V_t(t) = V(t)\sin(\theta(t))$, where $V(t)$ is the speed and $\theta(t)$ is the turning angle at time t . V_p captures the tendency and magnitude of a movement to persist in a given direction while V_t captures the tendency of movement to head in a perpendicular direction in a given time interval. Thus, the primary descriptive features of movement, namely speed, directional persistence and variability are captured in these variables.”

Additionally, the segmentation of behaviors was mapped to discern if the models characterized behavioral changes appropriately. This was conducted for each of the four individual snail kites. All models were analyzed on the full sets of data with irregular temporal sampling. A quick analysis showed that a one hour time step produces the greatest number of observations, but I have not yet filtered tracks for this sampling interval.

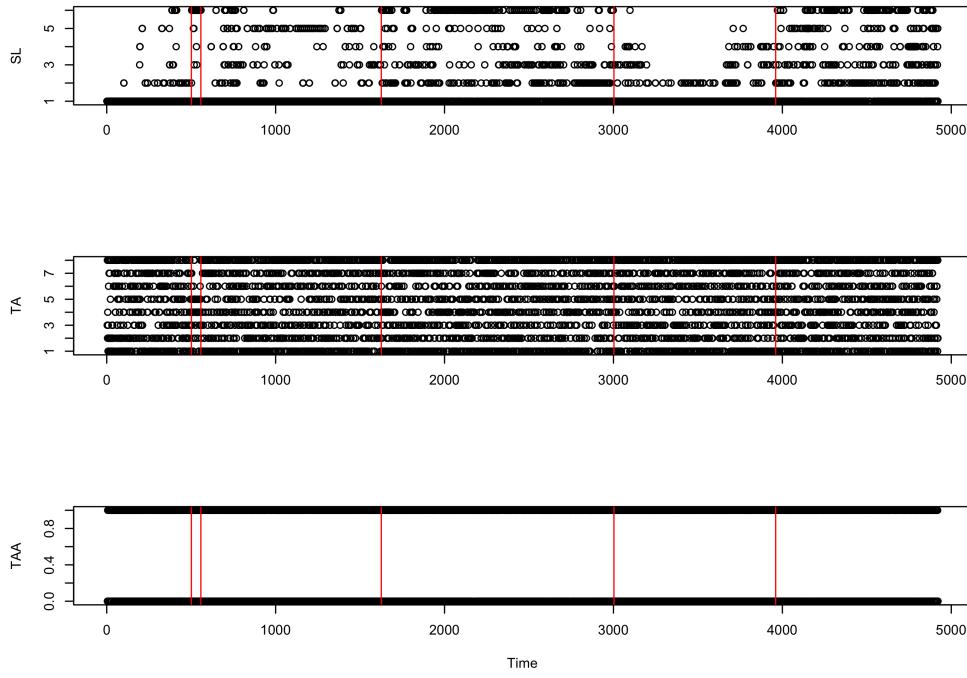
Original Model

All of the behavioral segmentation models analyzed with the original variables (SL,TA,TAA) were run using 10000 iterations. Additional model output (# of breakpoints, log marginal likelihood) was also evaluated with traceplots, but are not included in this document.

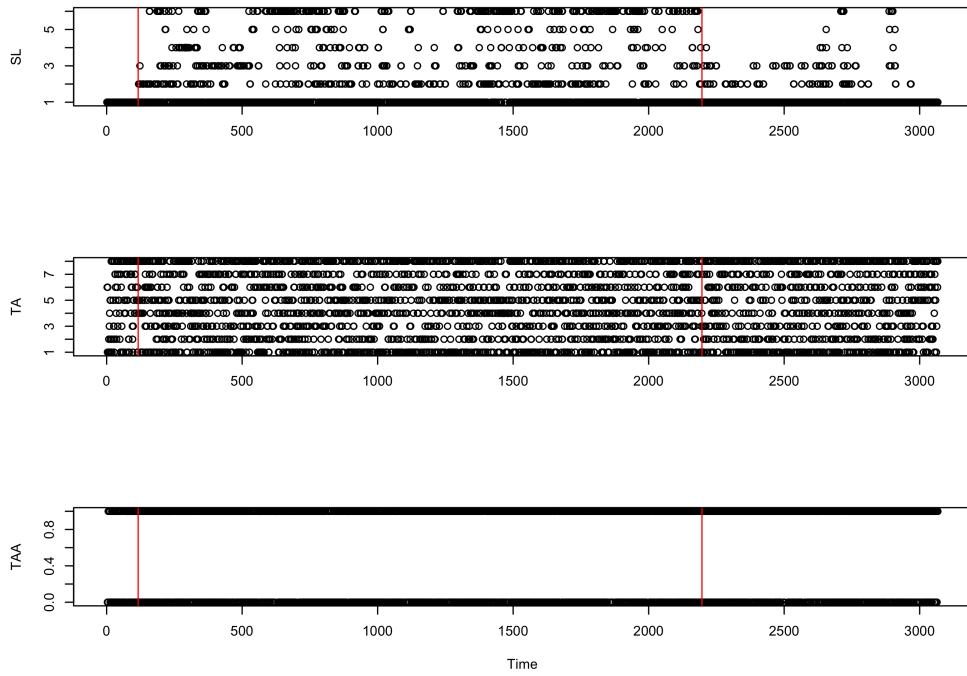
ID 1



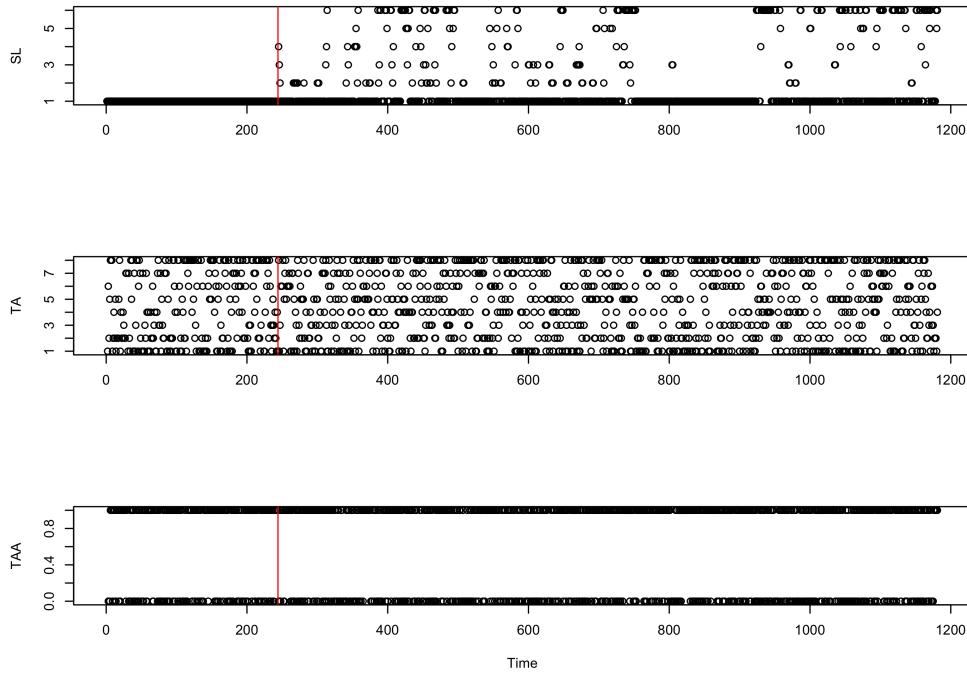
ID 12



ID 19



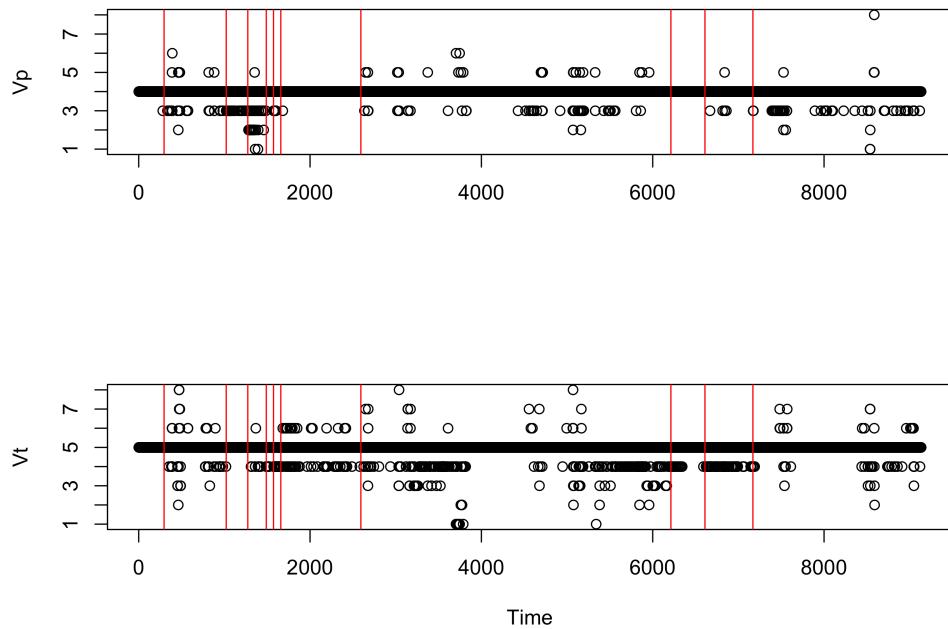
ID 27



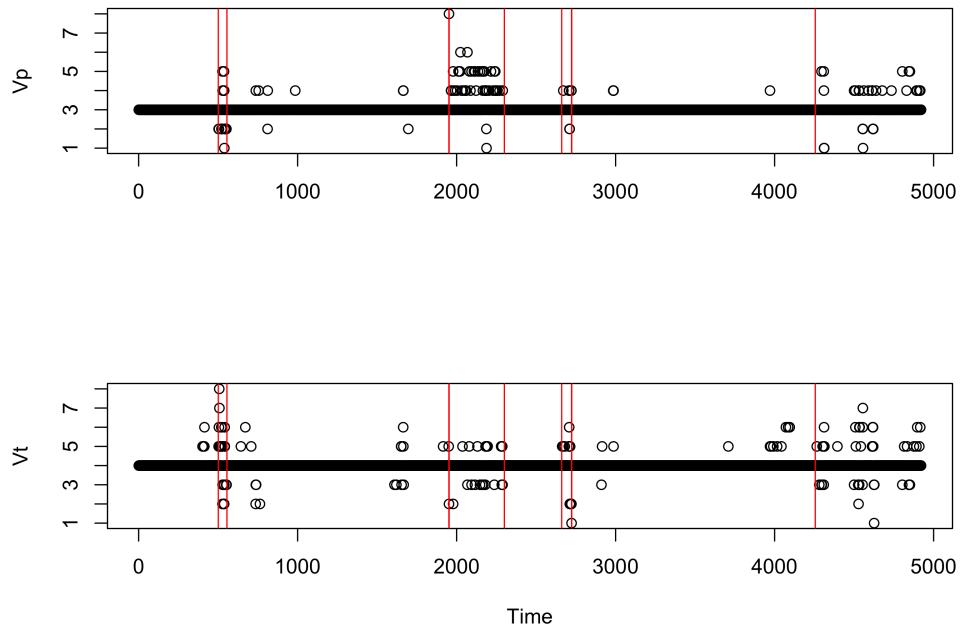
Velocity Model

As opposed to the original model that evaluated three movement parameters, two of which were estimated from a multinomial distribution (SL,TA) and one from a Bernoulli distribution (TAA), the velocity model only includes two variables that were both estimated from a multinomial distribution. Due to the traceplots of the breakpoints and LML not reaching a clear asymptote, the Gibbs samplers were run for 20000 iterations, but likely would need more to have converged properly.

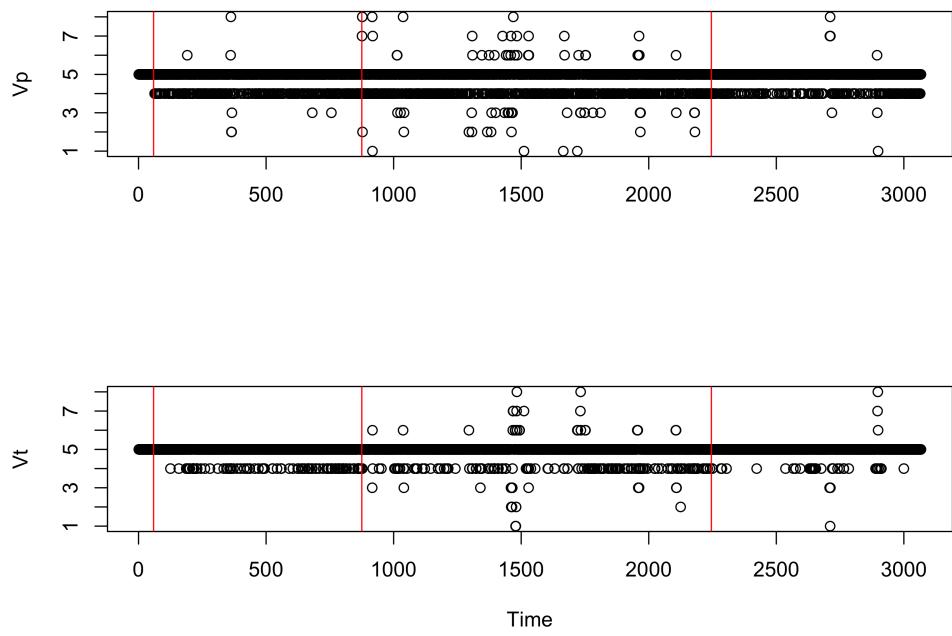
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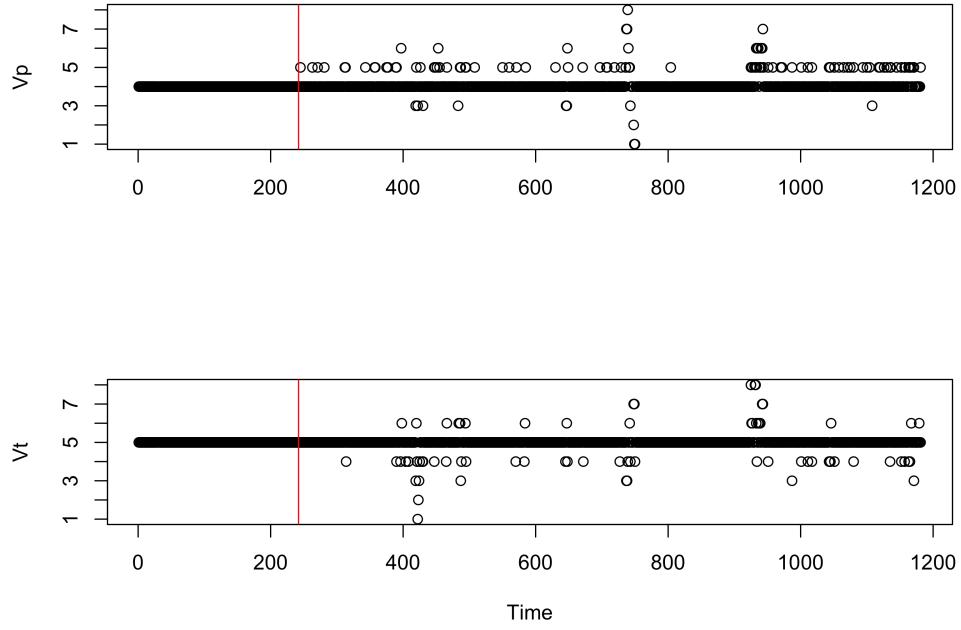
ID 12



ID 19



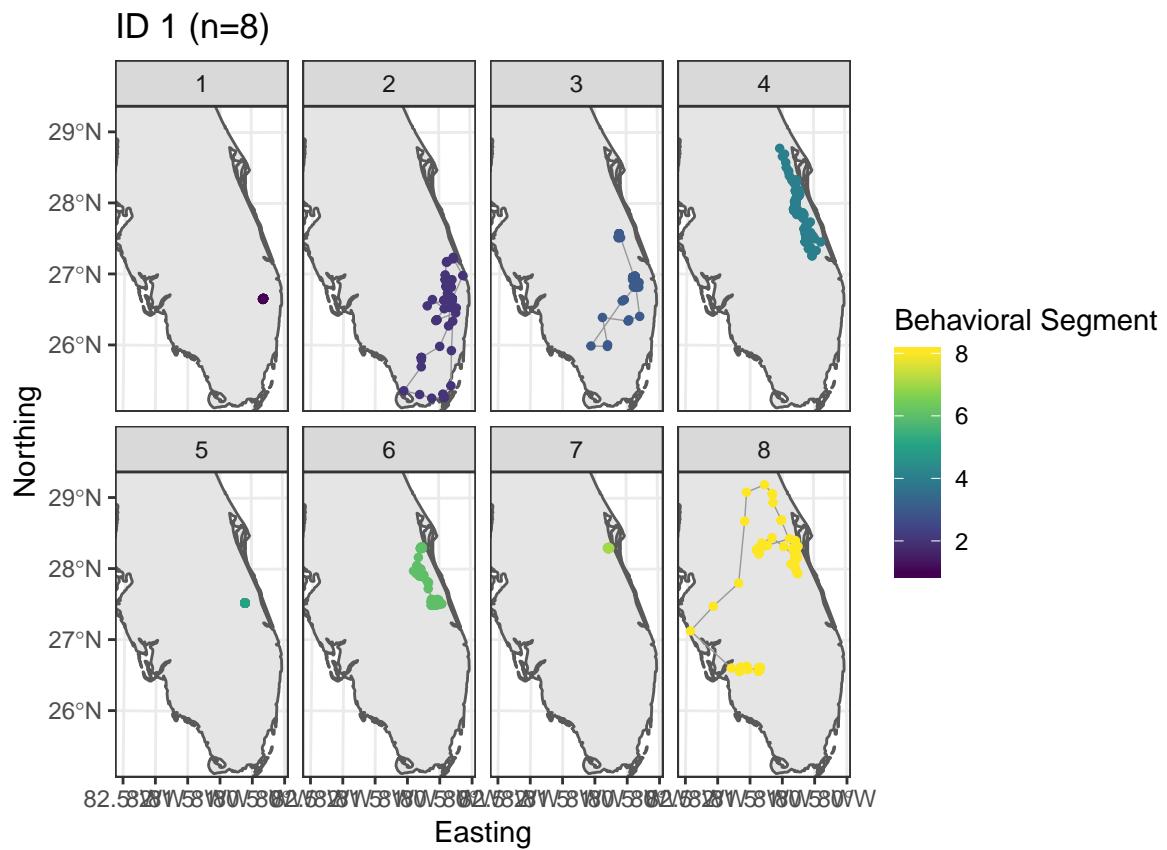
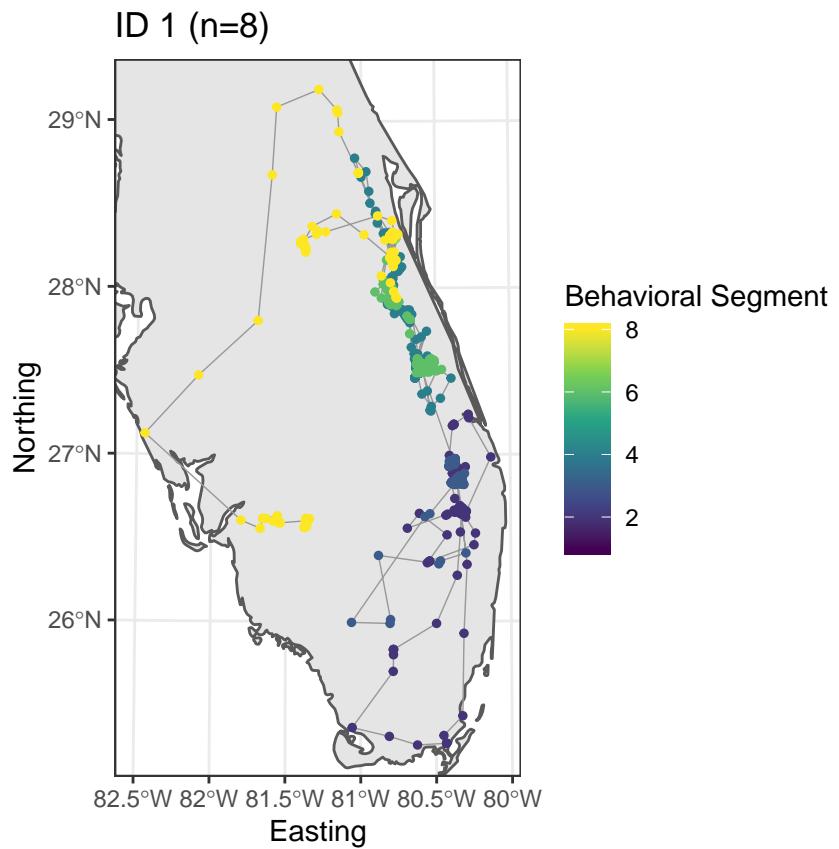
ID 27



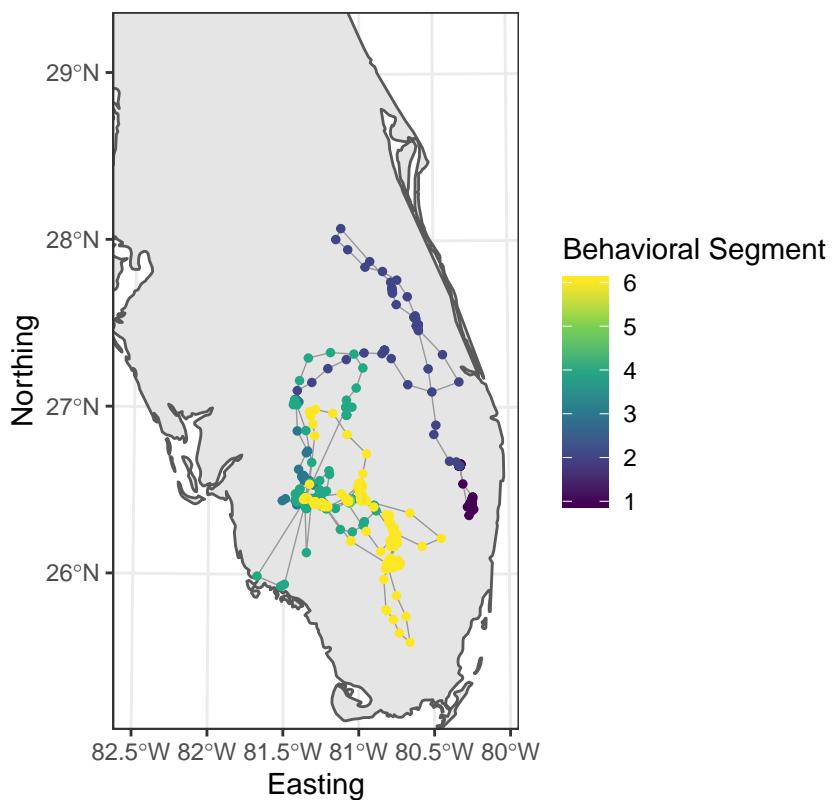
Mapping the Model Output

Original Model

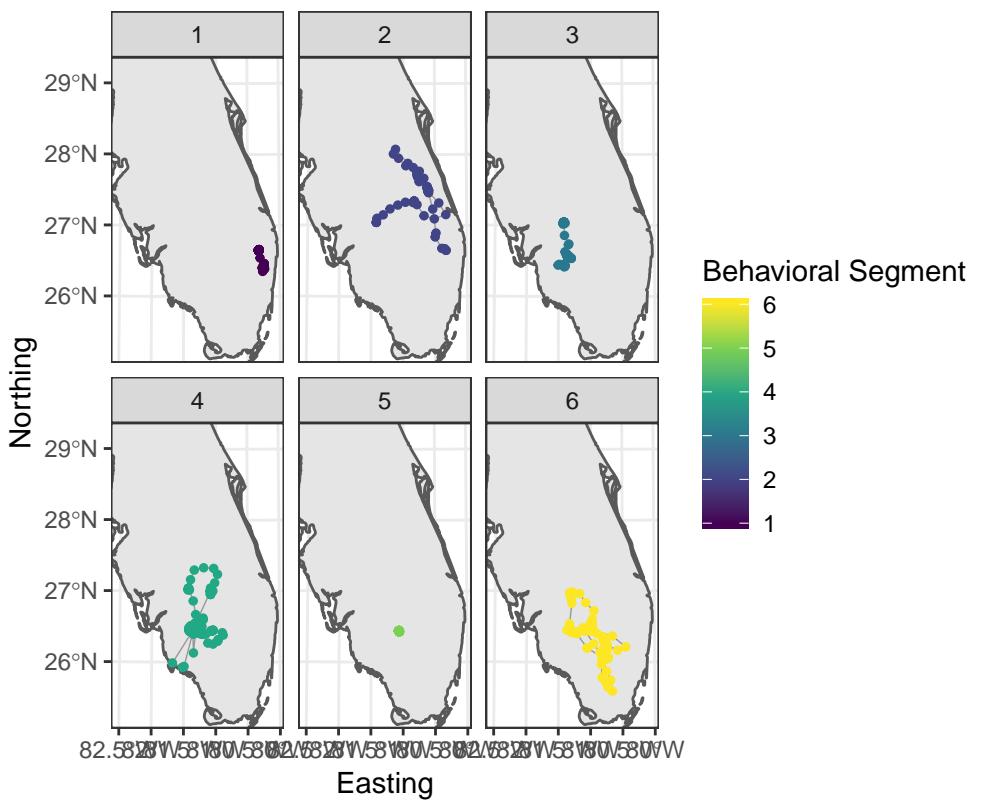
Some of the following behavioral segments appear to match up well with movement patterns, while others appear to be aggregated. This also varies by individual and the duration of the track. For example, **ID 1** has 8 estimated behavioral segments, whereas **ID 27** only has 2.



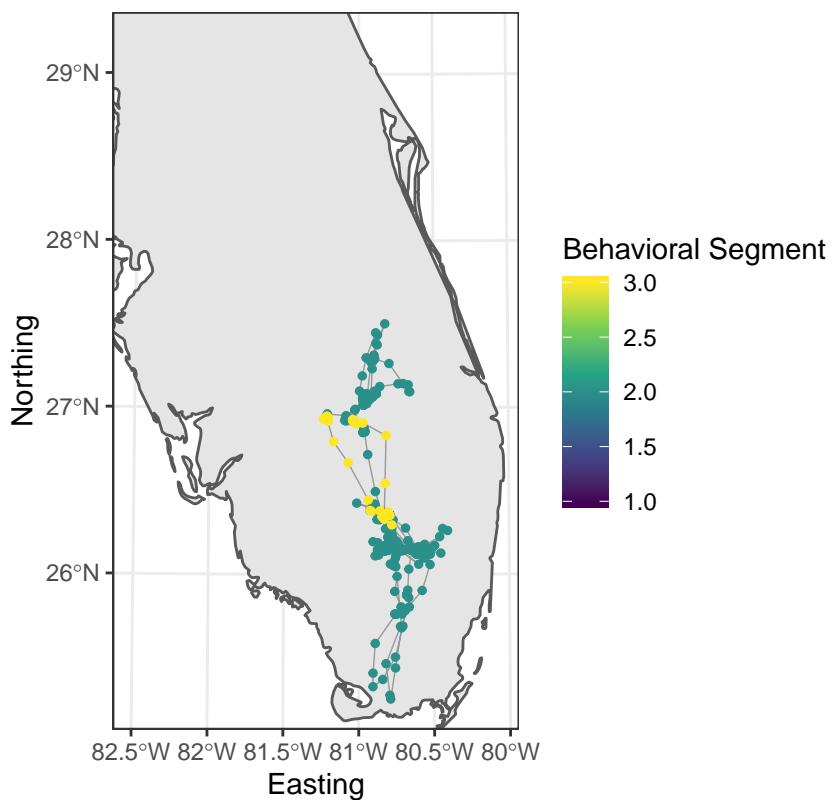
ID 12 (n=6)



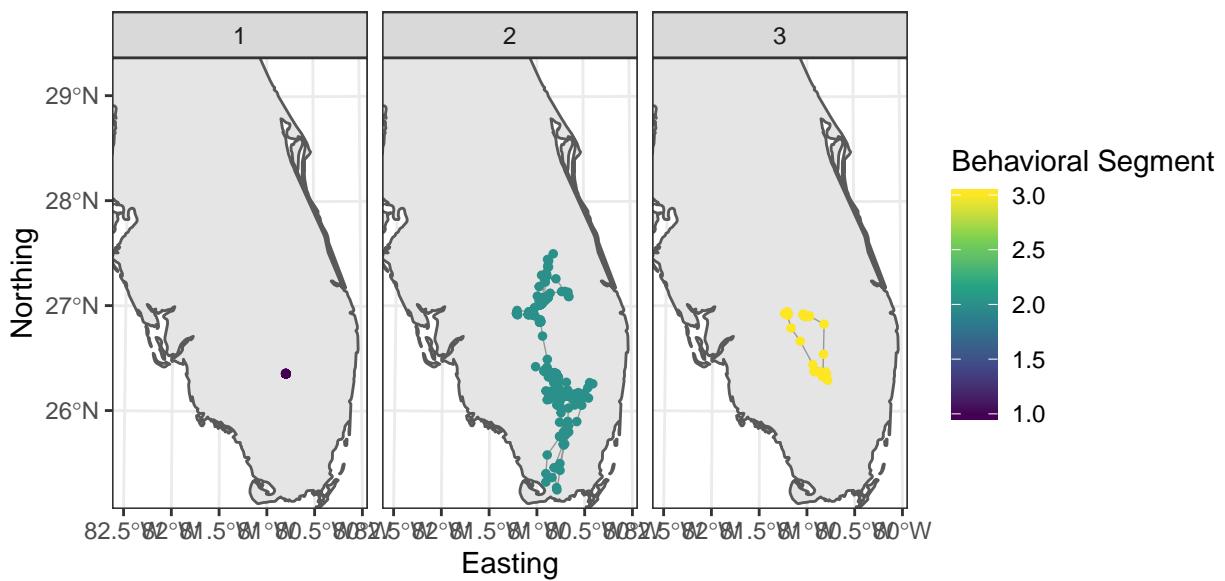
ID 12 (n=6)



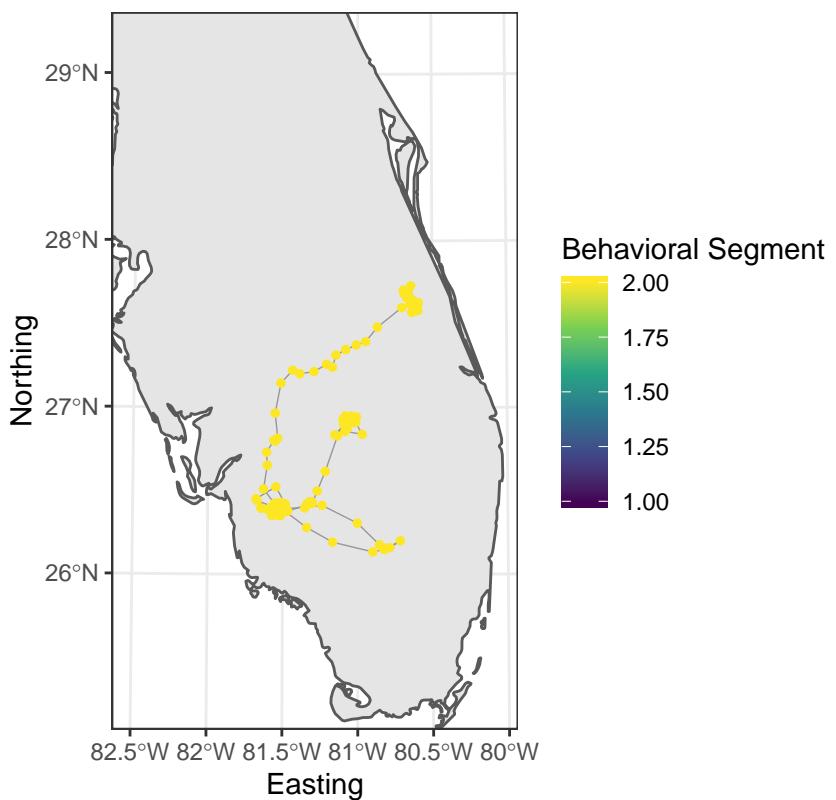
ID 19 (n=3)



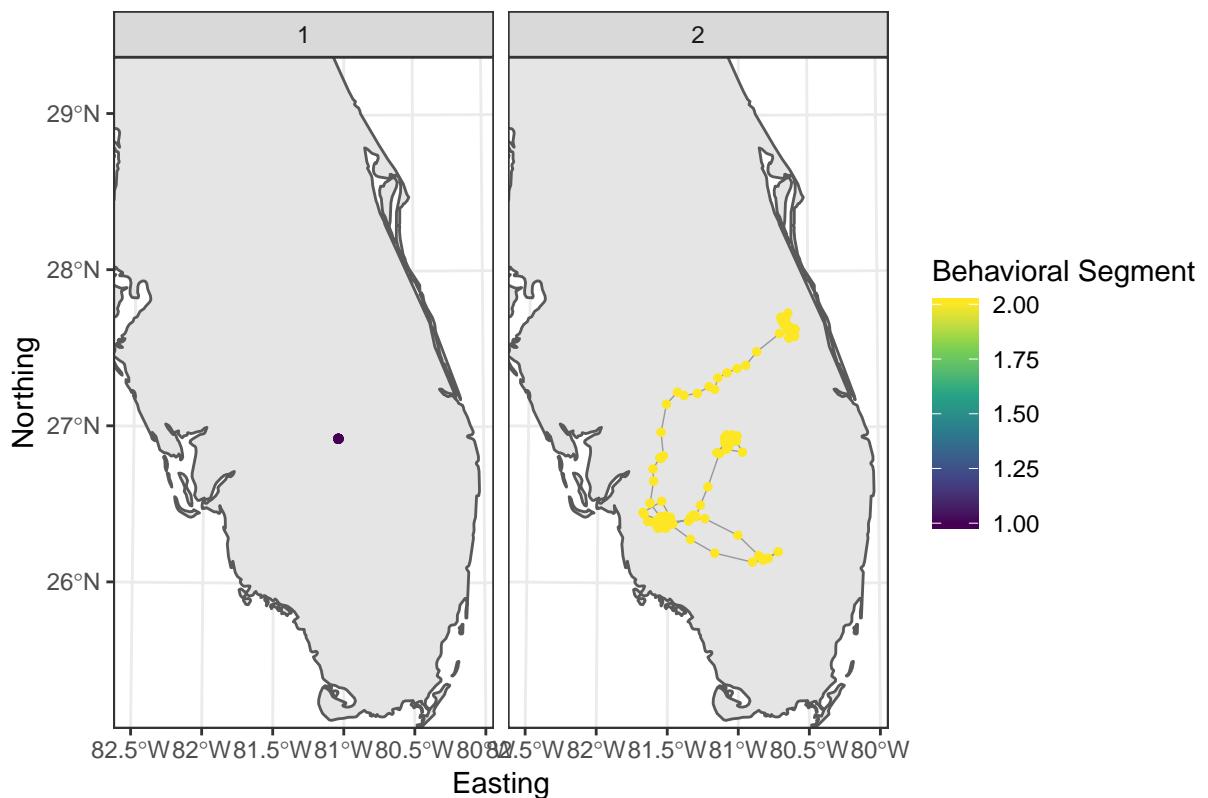
ID 19 (n=3)



ID 27 (n=2)



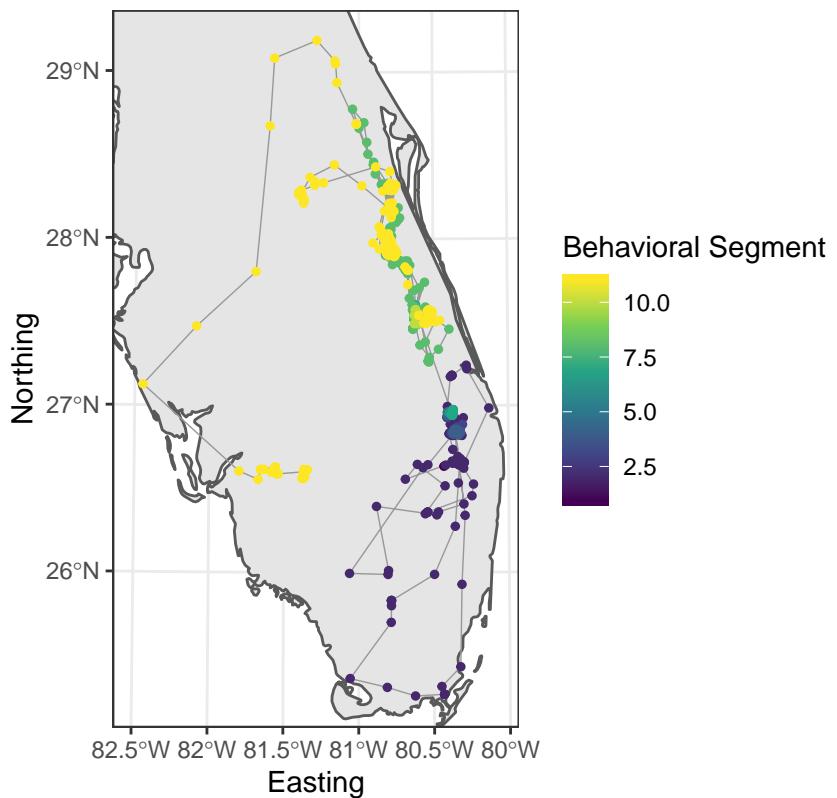
ID 27 (n=2)



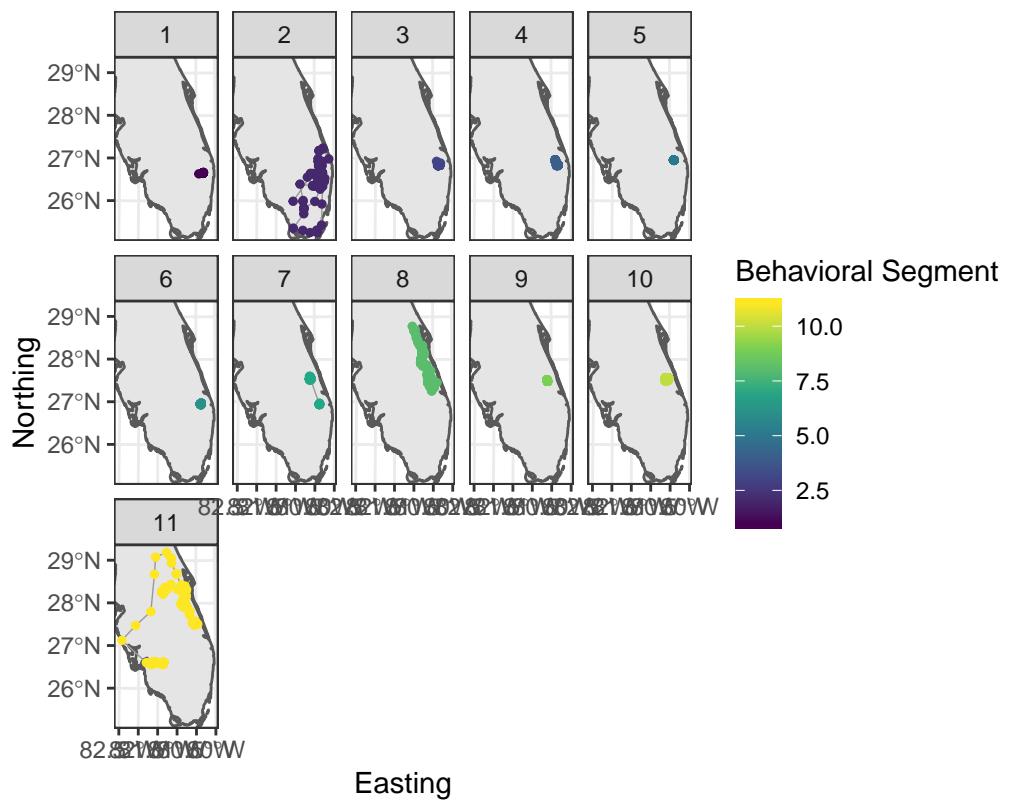
Velocity Model

In general, this model estimated a greater number of behavioral segments than the original model, but not substantially more. There appears to be some agreement between both sets of breakpoints, but there appear to be more differences. These differences in segmentation occur with respect to whether certain foray loops or locations of intense use are separated out or grouped together.

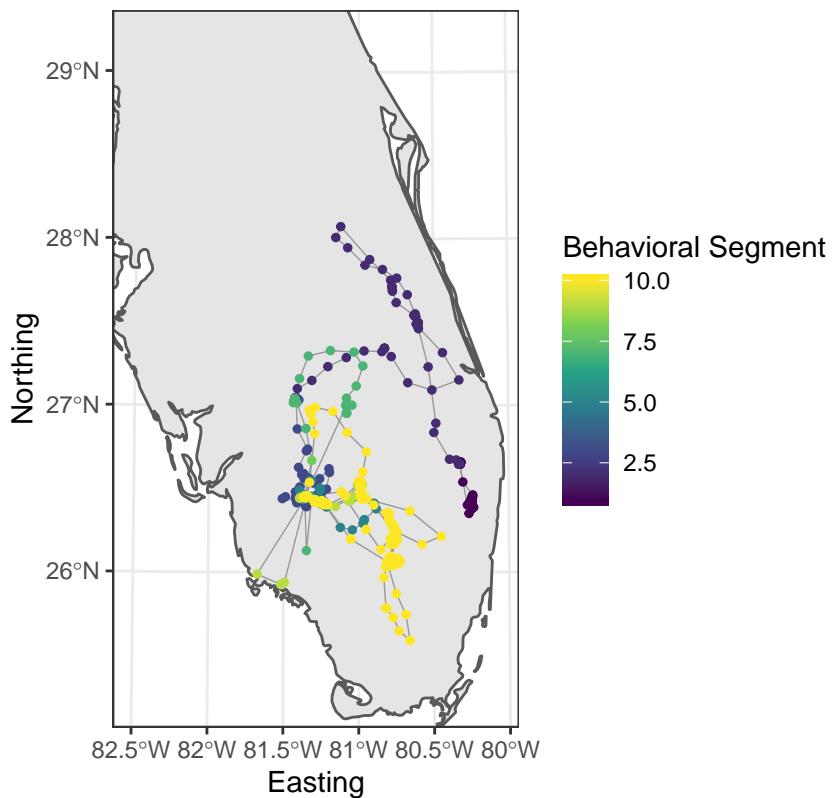
ID 1 (n=11)



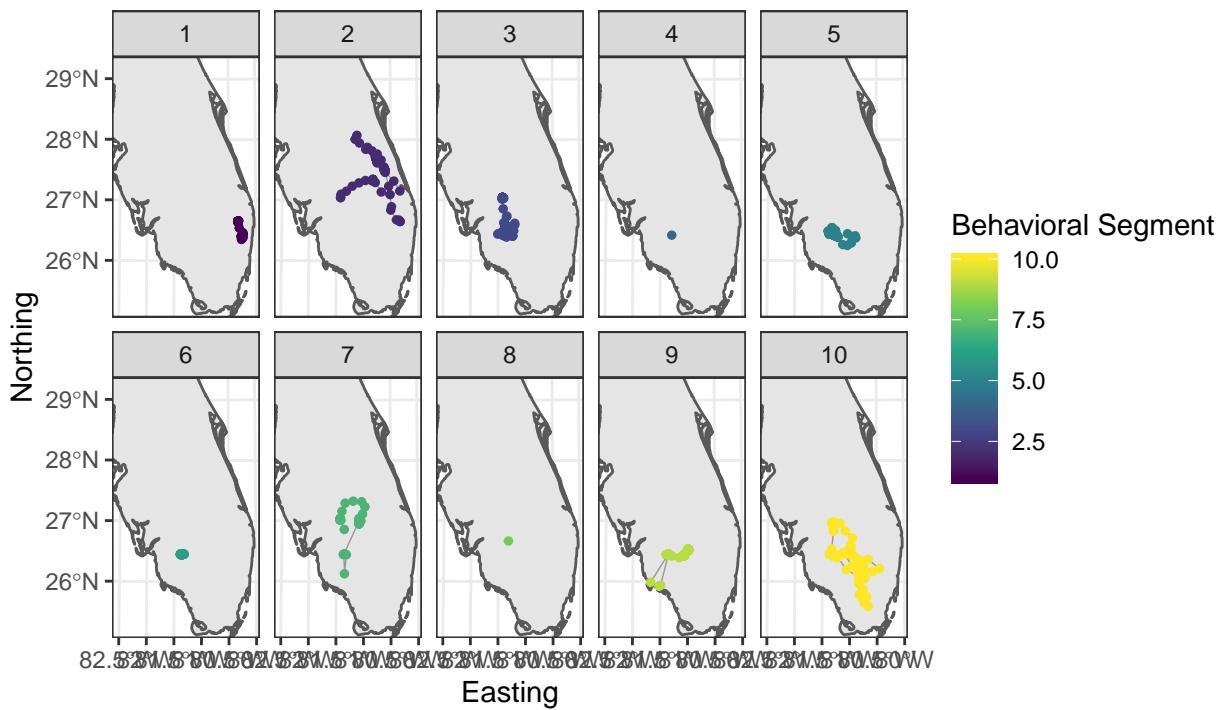
ID 1 (n=11)

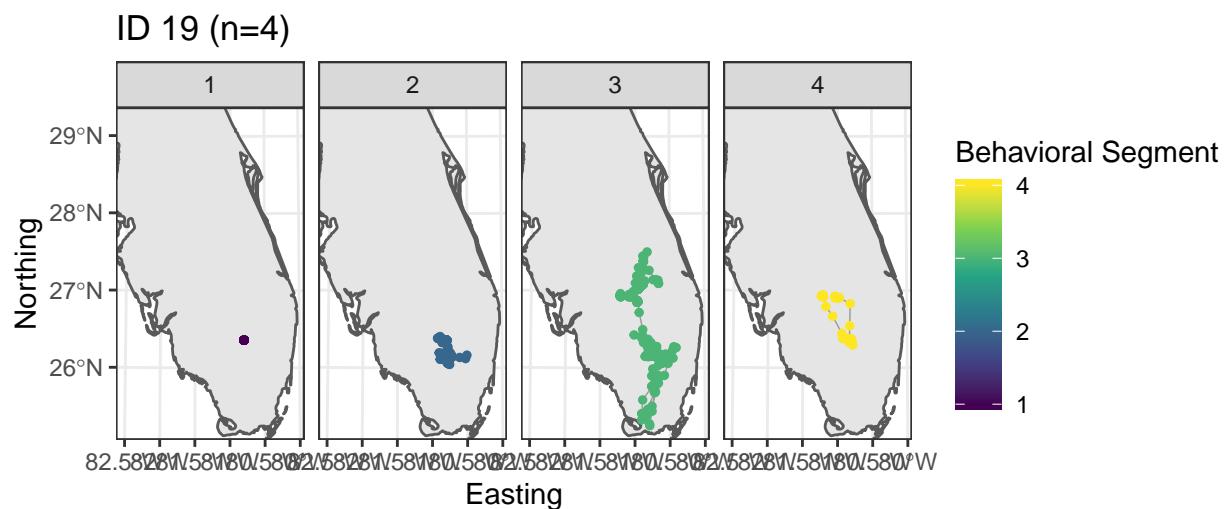
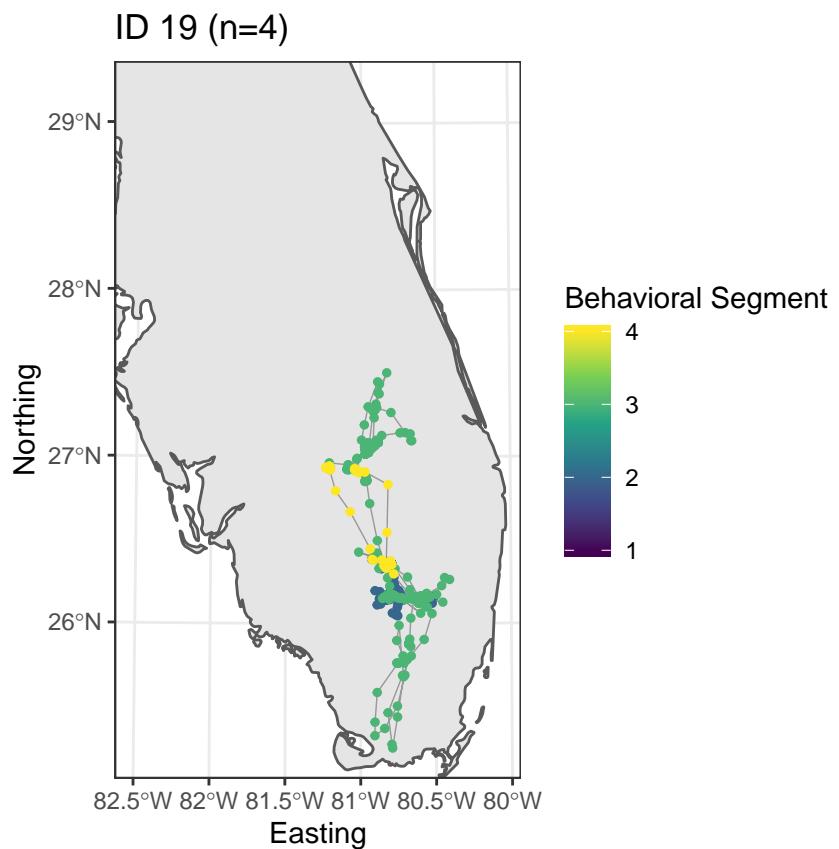


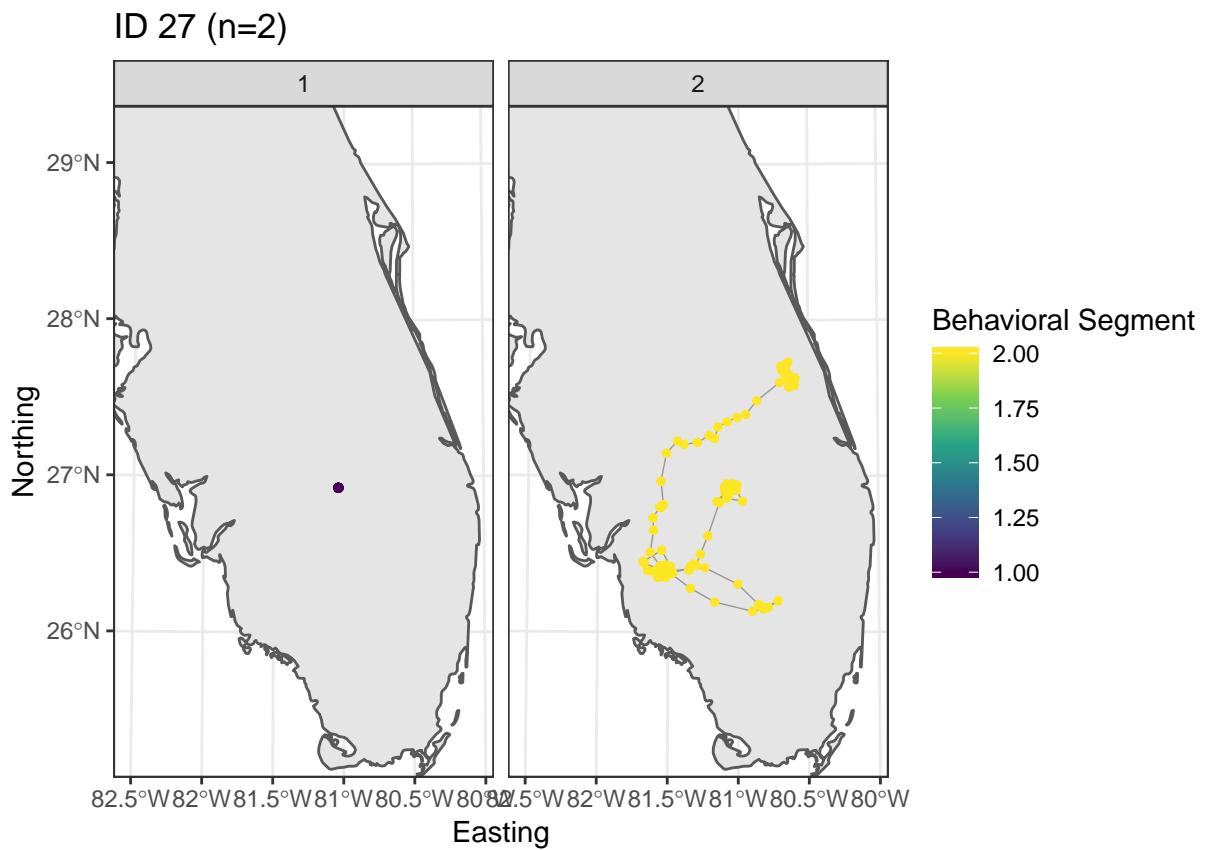
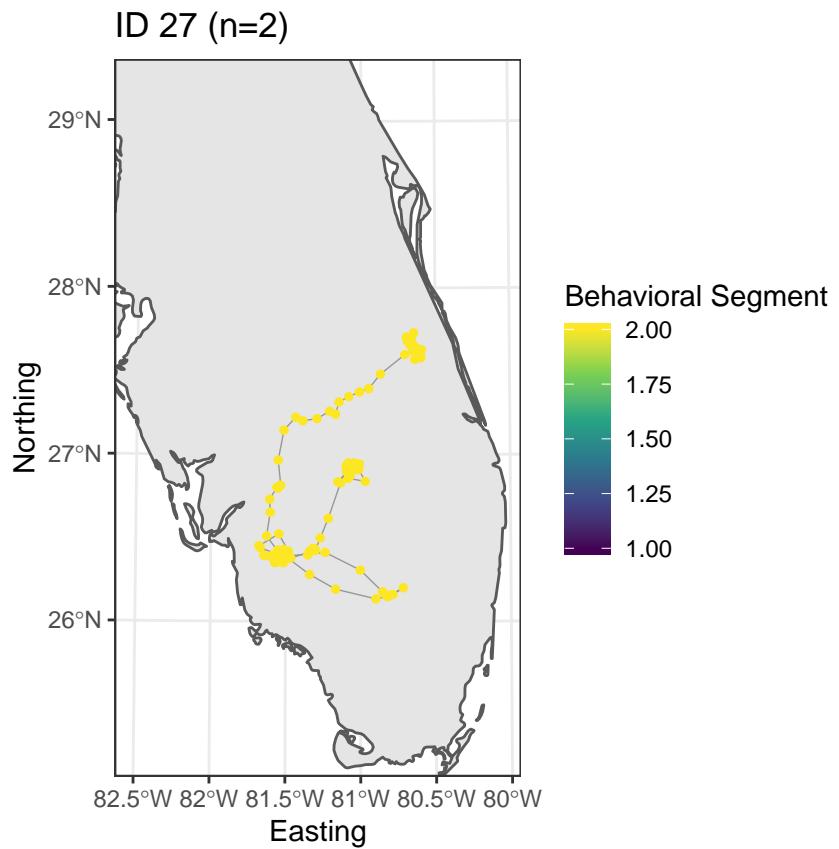
ID 12 (n=10)



ID 12 (n=10)







Breakpoint Comparison

For direct comparison, below is a printout of the breakpoints for each ID estimated from each model:

ID 1

Original	Velocity
275.5473	296.0562
939.8563	1021.4084
1697.1017	1273.3019
6383.8489	1489.0457
6585.3296	1573.7515
7612.7773	1658.6949
8348.2341	2593.2620
NA	6212.1949
NA	6609.6223
NA	7169.5573

ID 12

Original	Velocity
501.1231	500.9182
557.3528	555.3696
1625.5440	1951.4441
3002.8700	1952.8899
3960.3963	2300.2316
NA	2660.9366
NA	2722.9924
NA	2723.8599
NA	4255.6489

ID 19

Original	Velocity
116.3781	58.99883
2196.6675	875.16492
NA	2245.45902

ID 27

Original	Velocity
244.0893	242.1506