Text S1. One-behavior first-difference correlated random walk (DCRW) state-space model supplemental methods

Like Cote et al. (2019), we applied a one-behavior first-difference correlated random walk (DCRW) state-space model based on the case study presented in Auger-Méthé et al. (2017). Rather than applying a joint approach, this model was fitted by individual to maintain the independence of each track.

The resulting DCRW model was written using the process equation:

$$x_i = x_{i-1} + \gamma \frac{\Delta t_i}{\Delta t_{i-1}} (x_{i-1} - x_{i-2}) + \epsilon_i$$

Where $\epsilon_i \sim N(0, \Sigma_i)$, and Σ_i is:

$$\Sigma_i = \begin{bmatrix} \Delta t_i^2 \sigma_{\text{lon}}^2 & 0 \\ 0 & \Delta t_i^2 \sigma_{\text{lat}}^2 \end{bmatrix}$$

Here, σ_{lon} and σ_{lat} are the standard deviations of the longitude and latitude, respectively, and γ is a correlation parameter. The measurement equation is:

$$y_i = x_i + \eta_i$$

where $\eta_i \sim N(0, \Phi_i)$, and Φ_i is:

$$\Phi_i = \begin{bmatrix} \alpha_{\text{lon}}^2 \phi_{\text{lon}}^2 & 0 \\ 0 & \alpha_{\text{lat}}^2 \phi_{\text{lat}}^2 \end{bmatrix}$$

Here, ϕ_{lon} and ϕ_{lat} are the standard deviations of the longitude and latitude measurement errors, respectively, and α_{lon} and $\alpha_{\text{lat}}$are scaling parameters to account for measurement error. The α_{lon} and α_{lat} parameters were estimated using an independent analysis of the sync tag and reference tag data, which revealed that measurement error tended to decrease as the number of receivers contributing to the detection increased (Supplement A; Cote et al. 2019). In general, measurement error is expected to be < 7.8 m for 90% of the detections. In an effort to minimize signal collisions within the study array, transmission intervals were programmed to change randomly through time. To account for time differences between subsequent locations, we adjusted the distance interval and variance by Δt $(t_i - t_{i-1})$. That is, we expected locations separated by greater time intervals to be further apart and be less informed by the previous location.

Literature Cited

Auger-Méthé, M., Albertsen, C.M., Jonsen, I.D., Derocher, A.E., Lidgard, D.C., Studholme, K.R., Bowen, W.D., Crossin, G.T. and Flemming, J.M., 2017. Spatiotemporal modelling of marine movement data using Template Model Builder (TMB). *Marine Ecology Progress Series*, *565*, pp.237-249. https://doi.org/10.3354/meps12019

Cote, D., Nicolas, J.M., Whoriskey, F., Cook, A.M., Broome, J., Regular, P.M. and Baker, D., 2019. Characterizing snow crab (*Chionoecetes opilio*) movements in the Sydney Bight (Nova Scotia, Canada): a collaborative approach using multiscale acoustic telemetry. *Canadian Journal of Fisheries and Aquatic Sciences*, *76*(2), pp.334-346. https://doi.org/10.1139/cjfas-2017-0472

Table S1: American lobster IDs included in the short- and long-term analyses with additional information on attributes such as sex, carapace length, number of interpolated observations (obs.) included in each analysis as well as the temporal range of data points included.

Transmitter ID	Sex	Carapace length (cm)	10-day post-release			Long-term		
			Obs.	First Obs.	Last Obs.	Obs.	First Obs.	Last Obs.
19888	Male	10.7	131	10/26/2014	10/28/2014			
19890	Male	8.8	674	10/28/2014	11/4/2014	13292	11/4/2014	5/12/2015
19892	Male	10.9	43	10/26/2014	10/27/2014			
19898	Female	8.9	70	10/26/2014	10/27/2014			
19901	Male	9.5	313	10/27/2014	11/2/2014			
19903	Male	9.7	859	10/26/2014	11/4/2014	13895	11/4/2014	5/13/2015
19908	Male	9.5	285	10/26/2014	10/29/2014			
19911	Male	11.3	347	10/27/2014	10/30/2014			
19913	Male	8.9	824	10/27/2014	11/4/2014	11882	11/4/2014	4/30/2015
19914	Male	8.5	864	10/26/2014	11/4/2014	8964	11/4/2014	5/13/2015
19915	Male	9.6	859	10/26/2014	11/4/2014	13805	11/4/2014	5/12/2015
19917	Male	12.6	810	10/26/2014	11/4/2014	15062	11/4/2014	4/30/2016
19918	Male	8.9	403	10/26/2014	10/31/2014			
19920	Male	11.4	864	10/26/2014	11/4/2014	5501	11/4/2014	12/31/2014
19921	Male	8.6	812	10/27/2014	11/4/2014	331	11/4/2014	12/18/2014
19922	Male	8.7	55	10/26/2014	10/27/2014			
38248	Male	12	773	10/6/2015	10/15/2015			
38249	Male	9.15	158	10/6/2015	10/8/2015			
38250	Male	8.6	488	10/6/2015	10/12/2015			
38251	Male	10.35	245	10/6/2015	10/9/2015			
38253	Male	9.2	138	10/6/2015	10/8/2015			
38259	Male	8.9	589	10/6/2015	10/13/2015			
38262	Male	8.75	605	10/10/2015	10/16/2015	2994	10/16/2015	5/11/2016
38264	Male	9				12146	10/24/2015	4/18/2016
38265	Male	8.6	232	10/6/2015	10/9/2015			
38267	Male	8.2	648	10/6/2015	10/13/2015			
38271	Female	8.7	400	10/6/2015	10/14/2015			
38272	Female	8.2	923	10/6/2015	10/16/2015	849	10/16/2015	10/25/2015
38273	Female	8.35	947	10/6/2015	10/16/2015	6554	10/16/2015	12/23/2015
38274	Female	10.15	385	10/7/2015	10/16/2015	10872	10/16/2015	5/4/2016
38277	Female	8.8	217	10/6/2015	10/8/2015			
38278	Female	8	626	10/6/2015	10/13/2015			
38280	Female	8.1	947	10/6/2015	10/16/2015	2865	10/16/2015	11/15/2015
38282	Female	7.9	887	10/7/2015	10/16/2015	11490	10/16/2015	2/13/2016
38283	Female	7.7	217	10/6/2015	10/8/2015			
38284	Female	7.6	948	10/6/2015	10/16/2015	20028	10/16/2015	5/12/2016
38286	Male	8.9	841	10/6/2015	10/15/2015			

Table S2: Model selection results for the short and long-term American lobster momentuHMM movement models. For the long-term dataset, results are included for both the conventional and generalized HMM models.

Dataset	HMM Type	Mean Step Length	Directional Persistence	State transition probability	AIC	ΔAIC
10 days post-release	Conventional	NA	NA	Null	66036.56	0
				Diel	65941.31	-95.25
				TSR (Time since release)	65962.51	-74.05
				Sex	66002.03	-34.53
				Length	66030.54	-6.02
				Temp	66036.16	-0.4
				Tide height	66043.1	6.54
				Diel + TSR	65865.84	-75.47
				Diel + Sex	65903.75	-37.56
				Diel + Length	65936.01	-5.3
				Diel + Temp	65938.83	-2.48
				Diel + Tide height	65948.23	6.92
				Diel + TSR + Sex	65825.96	-39.88
				Diel + TSR + Length	65861.62	-4.22
				Diel + TSR + Temp	65869.79	3.95
				Diel + TSR + Tide height	65872.37	6.53
				Diel + TSR + Sex + Temp	65820.25	-5.71
				Diel + TSR + Sex + Length	65823.66	-2.3
				Diel + TSR + Sex + Tide height	65831.14	5.18
				Diel + TSR + Sex + Temp + Length	**65815.42**	**-4.83**
				Diel + TSR + Sex + Temp + Tide height	65827.59	7.34
				Diel + TSR + Sex + Temp + Length + Tide height	65823.25	7.83
Long-term	Conventional	NA	NA	Null	152224.70	0.00
				Sex	152077.40	-147.30
				Diel	152132.20	-92.50
				Temp	152149.40	-75.30
				Length	152157.80	-66.90
				Tide trend	152226.00	1.30
				Sex + Temp	151863.90	-213.50
				Sex + Diel	151957.60	-119.80
				Sex + Length	152065.90	-11.50
				Sex + Tide trend	152078.40	1.00
				Sex + Temp + Diel	151735.20	-128.70
				Sex + Temp + Length	151858.80	-5.10
				Sex + Temp + Tide trend	151864.00	0.10
				Sex + Temp + Diel + Length	**151730.70**	**-4.50**
				Sex + Temp + Diel + Tide trend	151734.00	-1.20
				Sex + Temp + Diel + Length + Tide trend	151729.30	-1.40
	Generalized	Temp	Temp	Null	150765.00	0.00
				Sex	150607.40	-157.60
				Diel	150664.10	-100.90
				Temp	150689.00	-76.00
				Length	150694.60	-70.40
				Tide trend	150765.50	0.50
				Sex + Temp	150389.40	-218.00

				Sex + Diel	150478.10	-129.30
				Sex + Length	150595.60	-11.80
				Sex + Tide trend	150607.40	0.00
				Sex + Temp + Diel	150253.10	-136.30
				Sex + Temp + Length	150383.80	-5.60
				Sex + Temp + Tide trend	150388.50	-0.90
				Sex + Temp + Diel + Length	150248.30	-4.80
				Sex + Temp + Diel + Tide trend	150250.90	-2.20
				Sex + Temp + Diel + Length + Tide trend	**150245.80**	**-2.50**
				Minimal conventional HMM	151730.70	0.00
				Minimal generalized HMM	150245.80	-1484.90

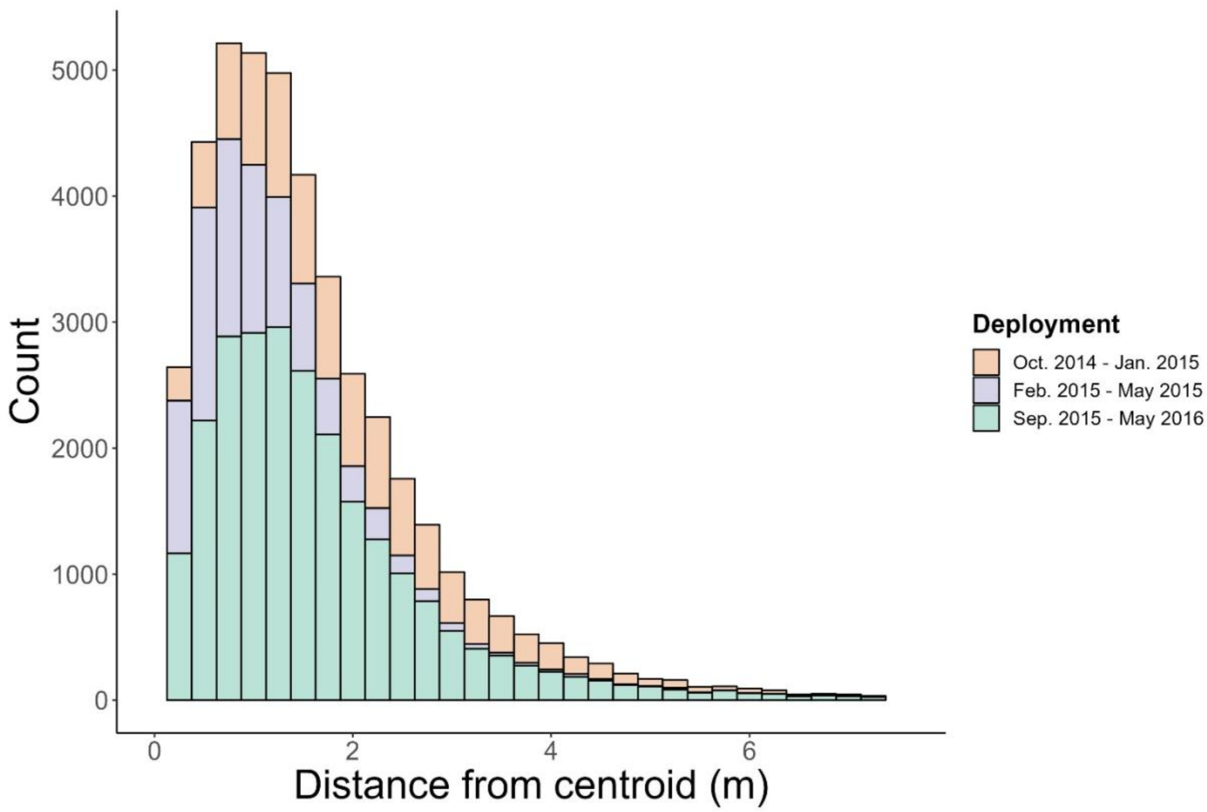

Figure S1: Histogram of the distance of reference tag observations from the centroid of all reference tag observations by deployment period (overlaid). Note that the x-axis is truncated at the 99th percentile across all deployment periods (7.6 m).

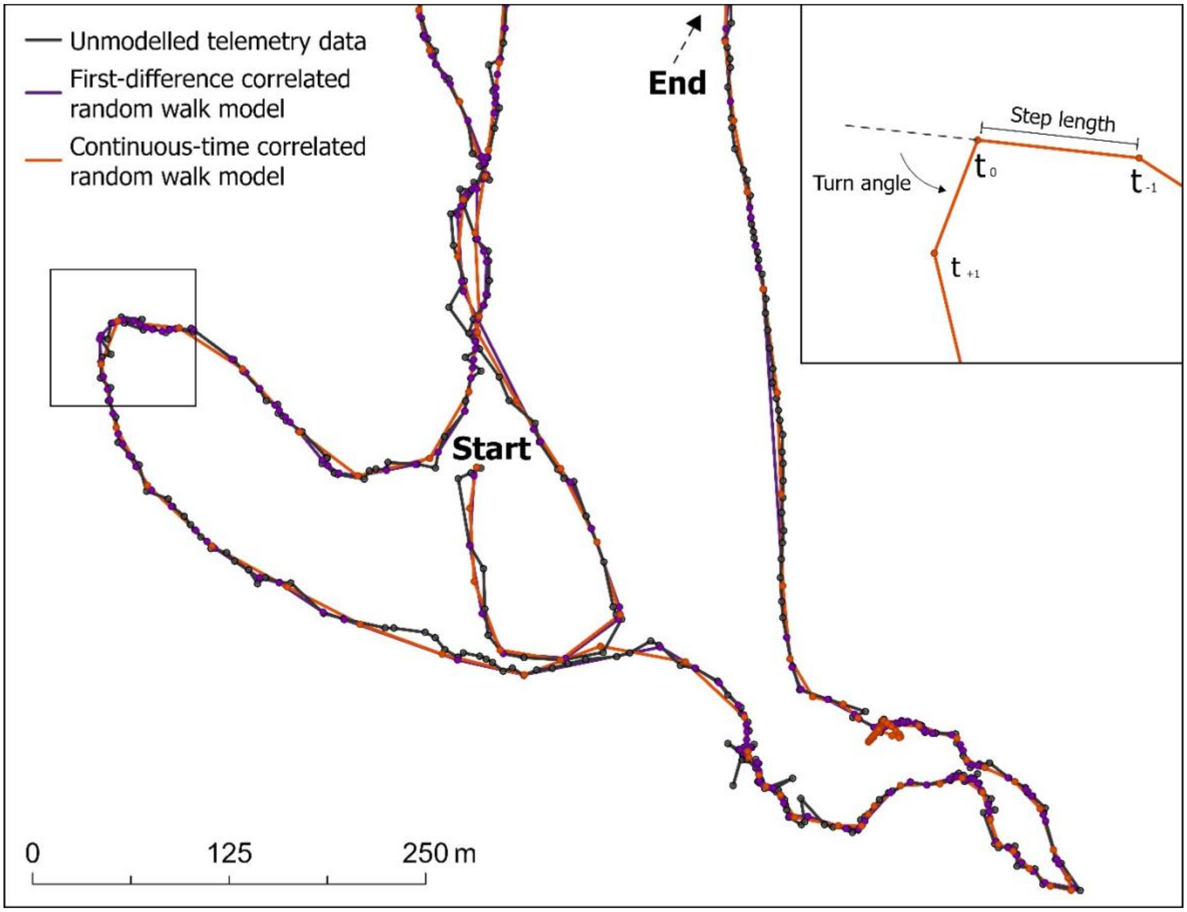

Figure S2: An unmodelled telemetry track segment (black) from a lobster compared to the modelled locations after applying the first-difference correlated random walk model (purple) and the continuous-time correlated random walk model (orange). The inset map illustrates how step lengths (straight-line distance between locations of a fixed temporal interval) and turn angles (the angle measured between t_{-1}, t_0 and t_{+1}) were calculated.

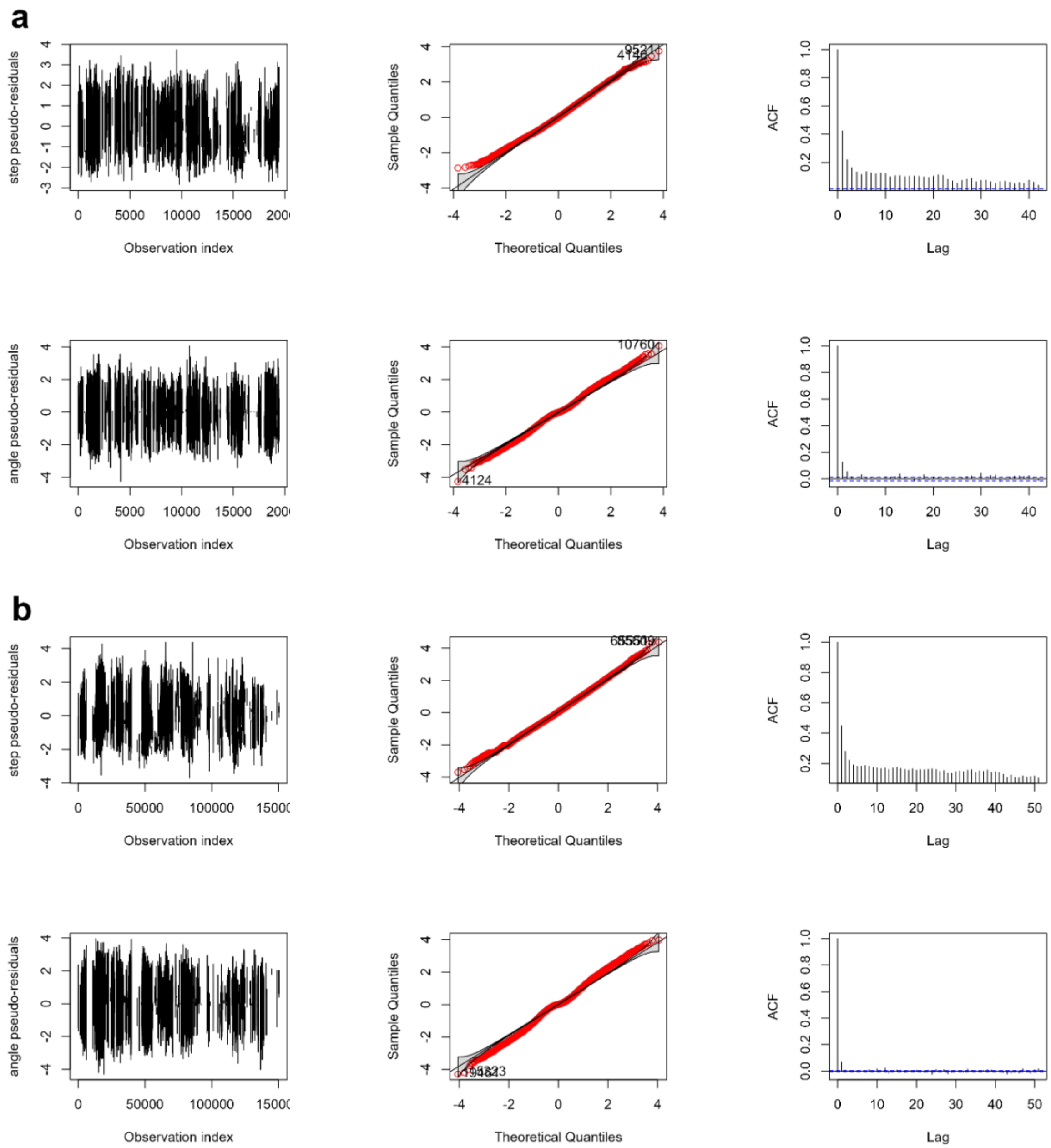

Figure S3: Pseudo-residual plots of time-series, qq-plots, and sample autocorrelation function (ACF) for the short- (a) and long- (b) term American lobster momentuHMM models.

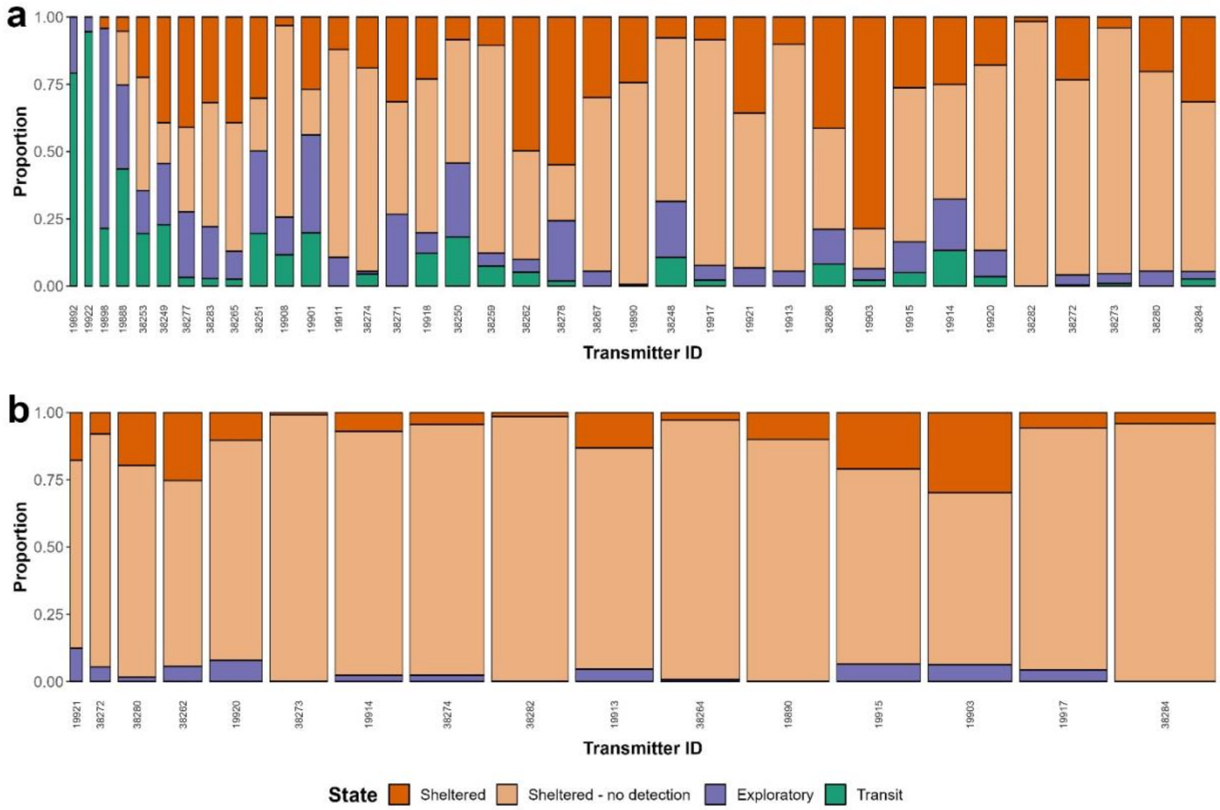

Figure S4: Proportion of time spent by individual American lobster in each behavioral state for short-term (a) and long-term (b) datasets. Bar width is proportional to the number of detections for each individual included in the model by dataset. Note that each individual is a separate column and while individuals are labelled on the x-axis by transmitter ID, this label is not key to the reader's understanding of the figure.

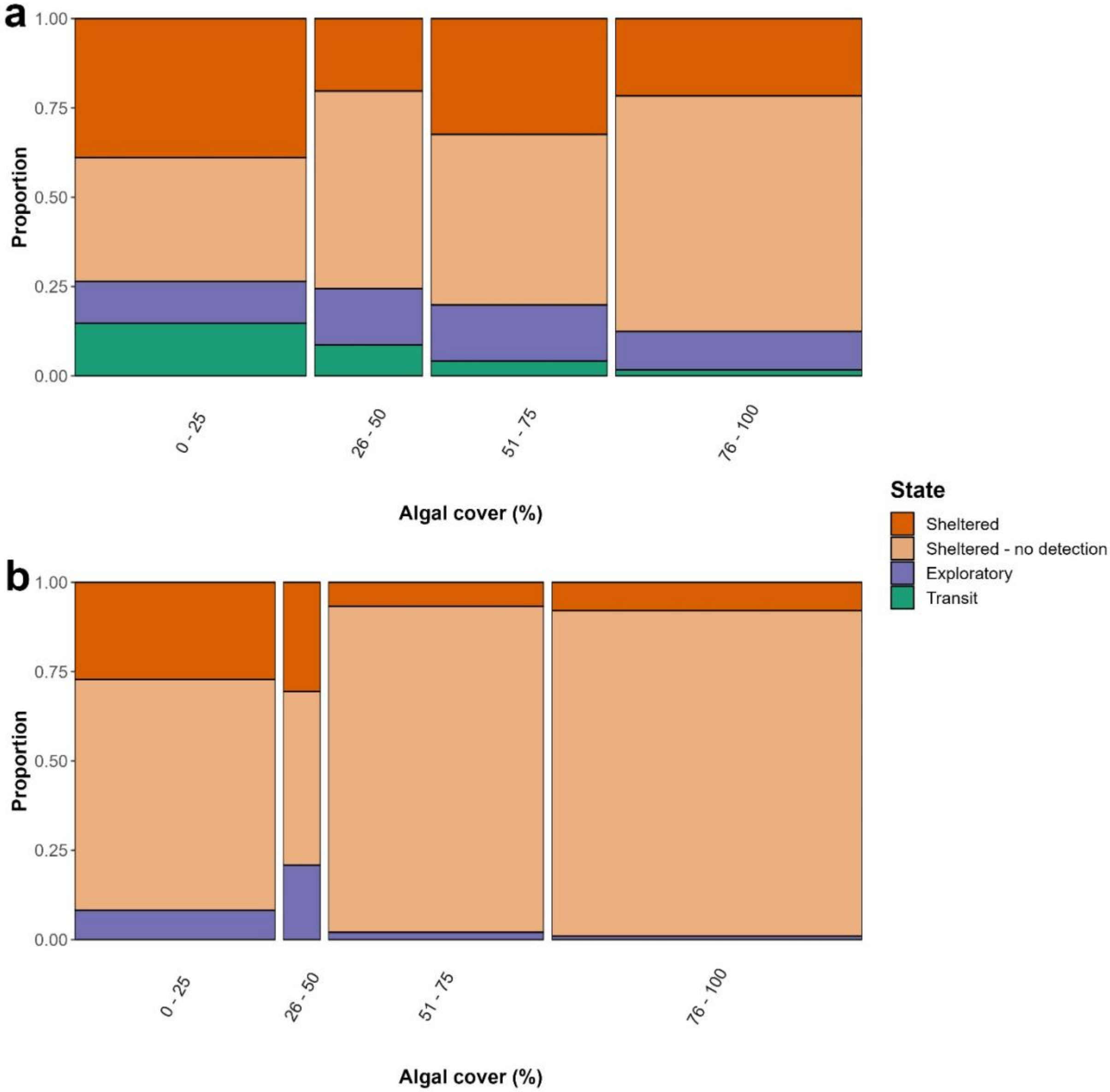

Figure S5: Proportion of observations classified as each behavioural state across algal cover. Results from short- (a) and long- (b) term data sets are presented with bar width proportional to the number of detections in each algal class for that dataset.

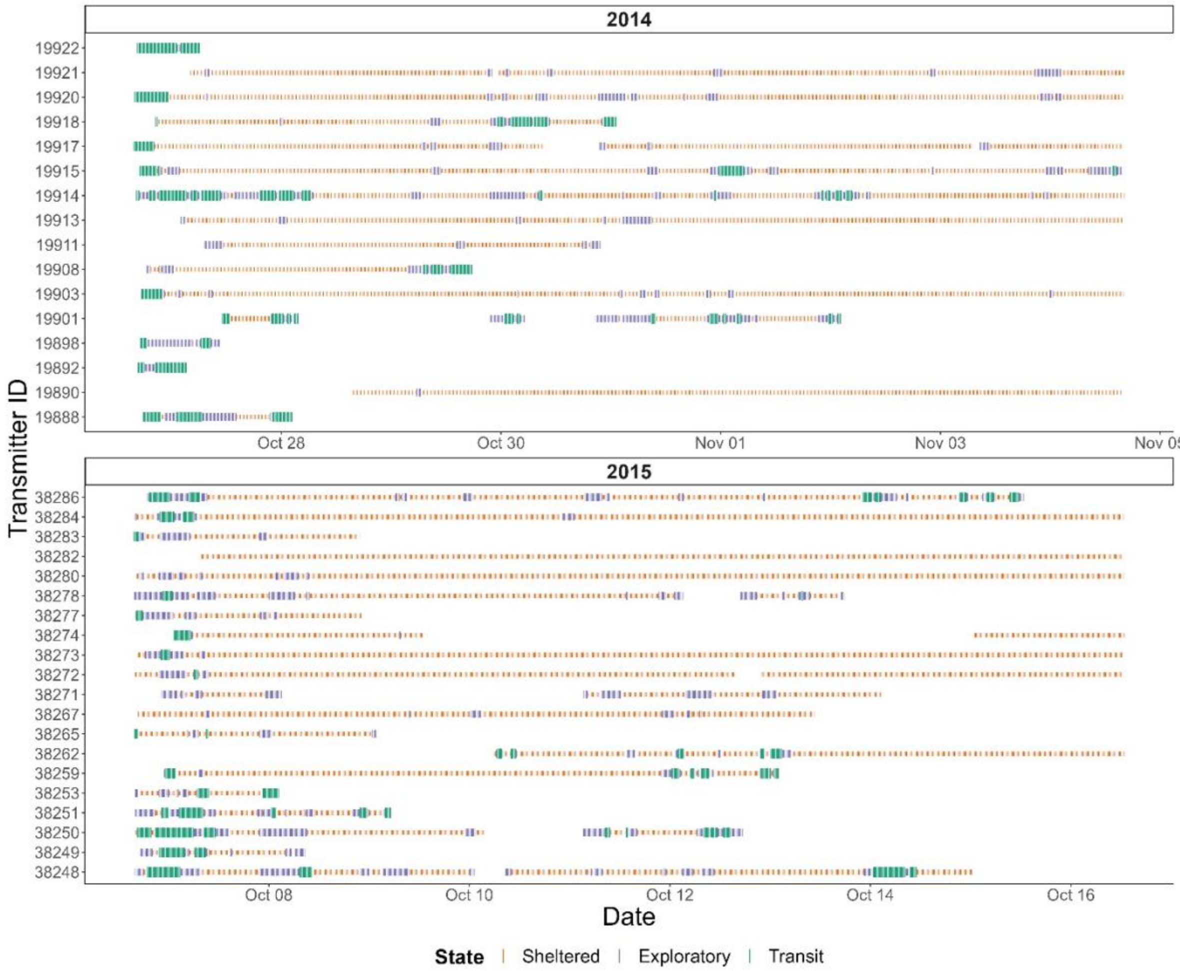

Figure S6: Sequence of state classified movement tracks for the first 10-days post release by year. States are represented by lines of differing lengths for clarity. States are represented by lines of differing lengths in addition to colour for clarity.

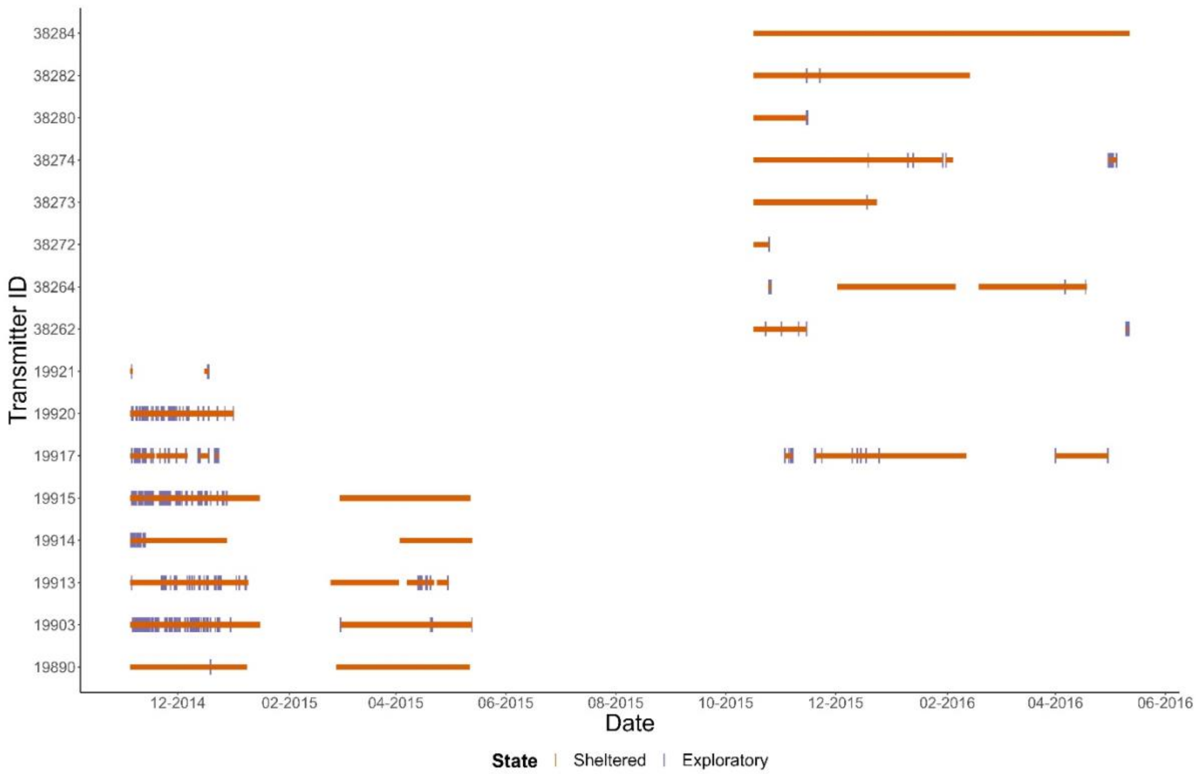

Figure S7: Sequence of state classified movement tracks for individuals included in the long-term analysis. States are represented by lines of differing lengths in addition to colour for clarity.

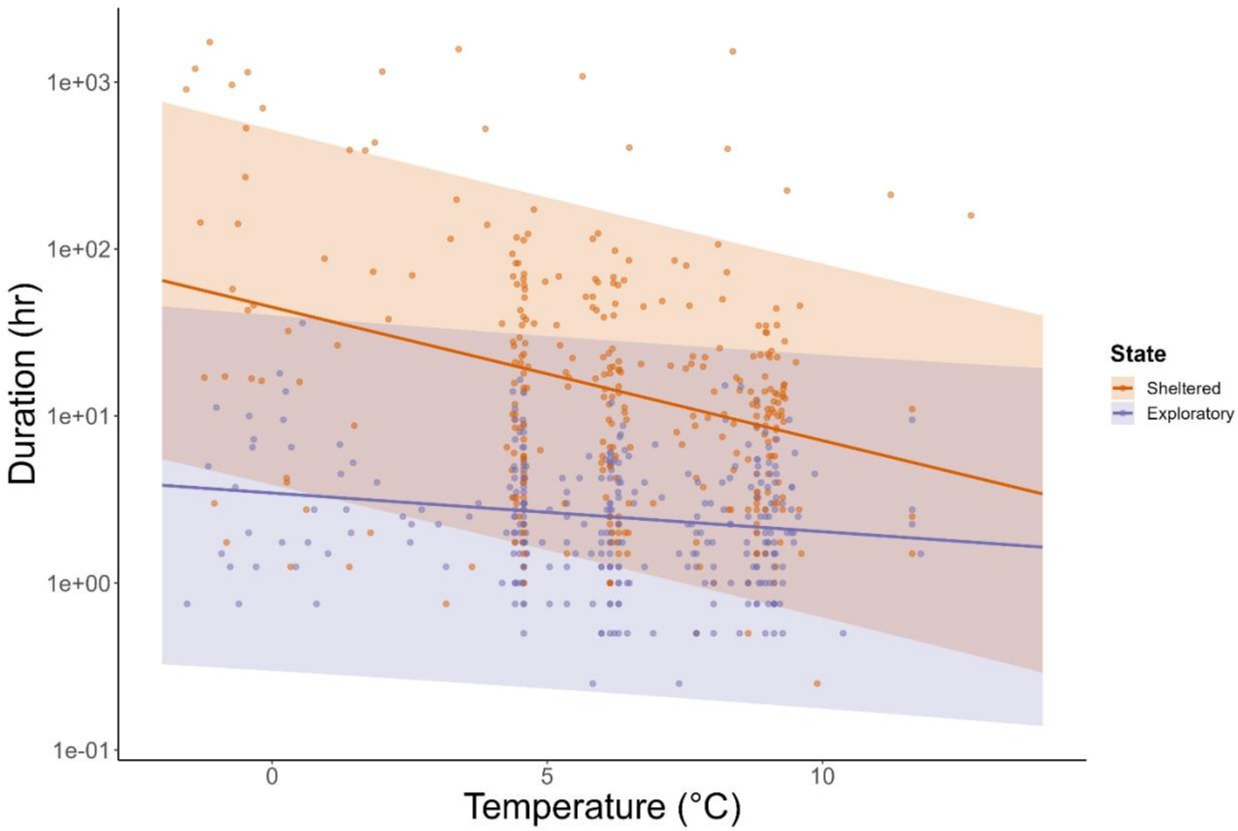

Figure S8: Duration of lobster behavior (Sheltered and Exploratory) states across the temperature range of the long-term dataset. A linear mixed effects model was used to model the effects of mean temperature and state (and their interaction) on duration in a state. A random effect of transmitter ID was included and only IDs with 5 or more data points were included. Duration was log-transformed to improve model fit and the distribution of residuals. Lines show model predictions and shading shows 95% confidence intervals.