The following supplement accompanies the article

Seasonal sea ice dynamics drive movement and migration of juvenile bearded seals *Erignathus barbatus*

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Marine Ecology Progress Series 600: 223–237 (2018)

Supplement 1: Details on Movement Simulations

Control locations for the resource selection function (RSF) analysis were generated by movement simulations. Simulations proceeded by first estimating movement parameters and their probability distributions using a GLMM (velocity and turn angle and covariates affecting these parameters) and then simulating movement based on these parameters. These simulations could have been created by directly simulating from underlying correlated random walk (CRW) in the sSSM, however, we needed to remove the switching aspect of the CRW and add a southerly drift / bias to the simulations in order to create biologically representative control locations. Moreover, a model to estimate these parameters and simulate pseudotracks from them in this system was already available as described in Cameron et al. (2018).

The simulation methods were designed for temporally irregular relocation data – See Cameron et al. (2018) for their original implementation on irregular Argos relocations. The regular time steps produced by sSSM location estimates do not require this accommodation, so the specific aspects of the fitting and simulation described in Cameron et al. (2018) that handle irregularity were removed as they were unneeded. Moreover, our purpose for this simulation was to create control locations for an RSF analysis and for that purpose produced suitable controls (see Fig. 1).

Simulating movements per the methods described in Cameron et al. (2018) using sSSM fitted locations rather than raw Argos affected the bearings and turn angles from which we simulated. The transition probabilities from one of the eight bearing classes to the next for males are given in Table S1 – the equivalent table for females is nearly identical and not shown. Notice that the rows sum to 1. In Table S1 temporal autocorrelation can be seen in the high values along the transition matrix's diagonal, which encodes the probability of remaining in the current heading in the following move. The transition matrix among the eight bearing classes described in Cameron et al. (2018) also shows higher values along the matrix diagonal, which results from autocorrelation in the bearded seals' movement. However, the diagonal elements here are much larger than the diagonal elements in Cameron et al. (2018), and the off-diagonal elements smaller. In Cameron et al. (2018), Argos error still contaminates this matrix; while here Argos error is much better accounted by the sSSM which reveals a more highly autocorrelated movement process, so the diagonal elements we estimate are larger. Simulating from this more autocorrelated movement process, with data that has less contamination with Argos error, results in longer step lengths and smaller turn angles, and the resulting pseudotracks cover larger areas than the pseudotracks used in Cameron et al. (2018).

Except for the differences noted above, simulations proceeded as described in Cameron et al. (2018).

Table S1. Estimated bearing transition matrix for male bearded seals. The transition matrix for females is nearly identical. Note the higher transition probabilities along the diagonal of the matrix, these encode the movement process autocorrelation.

		To Bearing							
		0	45	90	135	180	225	270	315
From Bearing	0	0.651	0.113	0.034	0.022	0.026	0.025	0.034	0.095
	45	0.093	0.663	0.123	0.030	0.023	0.027	0.021	0.020
	90	0.022	0.113	0.652	0.111	0.036	0.024	0.023	0.018
	135	0.016	0.028	0.109	0.662	0.124	0.026	0.015	0.019
	180	0.022	0.016	0.024	0.089	0.717	0.097	0.019	0.017

References

Cameron MF, Frost KJ, Ver Hoef JM, Breed GA, Whiting AV, Goodwin J, Boveng PL. (2018) Habitat selection and seasonal movements of young bearded seals (*Erignathus barbatus*) in the Bering Sea. PloS one 13(2):e0192743.