

Title	Discrete-space continuous-time models of marine mammal exposure to Navy sonar
Authors	Jones-Todd, Charlotte M.;Pirodda, Enrico;Durban, John W.;Claridge, Diane E.;Baird, Robin W.;Falcone, Erin A.;Schorr, Gregory S.;Watwood, Stephanie;Thomas, Len
Publication date	2021-10-15
Original Citation	Jones-Todd, C. M., Pirodda, E., Durban, J. W., Claridge, D. E., Baird, R. W., Falcone, E. A., Schorr, G. S., Watwood, S. and Thomas, L. (2021), 'Discrete-space continuous-time models of marine mammal exposure to Navy sonar', Ecological Applications. doi: 10.1002/eap.2475
Type of publication	Article (peer-reviewed)
Link to publisher's version	10.1002/eap.2475
Rights	© 2021, John Wiley & Sons, Inc. This is the peer reviewed version of the following item: Jones-Todd, C. M., Pirodda, E., Durban, J. W., Claridge, D. E., Baird, R. W., Falcone, E. A., Schorr, G. S., Watwood, S. and Thomas, L. (2021), 'Discrete-space continuous-time models of marine mammal exposure to Navy sonar', Ecological Applications, doi: 10.1002/eap.2475, which has been published in final form at https://doi.org/10.1002/eap.2475 . This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Use of Self-Archived Versions
Download date	2024-05-19 02:08:49
Item downloaded from	https://hdl.handle.net/10468/12112



University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Supporting Information: Jones-Todd, C. M., E. Pirotta, J. W. Durban, D. E. Claridge, R. W. Baird, E. A. Falcone, G. S. Schorr, S. Watwood, and L. Thomas. Discrete-space continuous-time models of marine mammal exposure to Navy sonar. *Ecological Applications*.

Appendix S4. Likelihood

This section derives the negative log-likelihood discussed in Section [Discrete-space continuous-time Markov model](#). The transition probability matrix is given by $\mathbf{P}(t)$, where each element $p_{rs}(t)$ is the probability that, given an individual is currently in state r , they will be in state s at time t in the future. This transition probability matrix can be calculated by taking the matrix exponential of the scaled transition intensity matrix as follows:

$$\mathbf{P}(t) = \text{Exp}(t\mathbf{Q}).$$

The likelihood, $L(\mathbf{Q})$, is calculated as the product, over all individuals and all transitions, of the probabilities that individual k is in state $S(t_{j+1})$ at time t_{j+1} given they were in state $S(t_j)$ at time t_j , evaluated at time $t_{j+1} - t_j$ (for $j = 1, \dots, n_k$):

$$L(\mathbf{Q}) = \prod_{kj} L_{kj} = \prod_{kj} p_{S(t_j)S(t_{j+1})}(t_{j+1} - t_j).$$

Parameter estimates are obtained via minimization of the negative log-likelihood, $-\log(L(\mathbf{Q}))$.