

# CLIOTOP TASK TEAM 2016-06 ANIMAL MOVEMENT AND PREDICTION - MODELLING ANIMAL BEHAVIOUR IN A CHANGING CLIMATE: ANNUAL REPORT 2016

## Key Activities

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The focus of this group is the development of process-based animal movement models that are biologically reasonable and capable of i) modelling behavioural response in relation to environmental covariates, and therefore ii) predicting animal movements in response to climatic changes. The approaches being developed use large observational animal tracking datasets for estimation and simulation procedures.

The AMP task team met three times during 2016-17:

- **May 23-27<sup>th</sup> 2016 in Hobart**, Australia co-hosted at Institute for Marine and Antarctic Studies, University of Tasmania and CSIRO Oceans and Atmosphere.

*Attendees:* Sophie Bestley (AAD, Aus.), Ian Jonsen (MQU, Aus.), Toby Patterson (CSIRO, Aus.), Theo Michelot (U. Sheffield, UK), Theoni Photopoulou (UCT, South Africa). *Visitors:* Mike Sumner (AAD, Aus.), Simon Wotherspoon (IMAS, Aus.), Ben Raymond (AAD, Aus.).

- **September 12-15<sup>th</sup> 2016 in Copenhagen**, Denmark hosted at AQUA, Danish Technical University. Work continued the subsequent week in Bielefeld, Germany.

*Attendees:* Toby Patterson (CSIRO, Aus.), Theo Michelot (U. Sheffield, UK), Roland Langrock (U. Bielefeld, Germany). *Visitors:* Uffe Thygesen (DTU Aqua, Denmark), Martin Pedersen (DTU Aqua, Denmark).

- **February 28<sup>th</sup> – March 3<sup>rd</sup> 2017 in Hobart**, Australia co-hosted at IMAS and CSIRO O&A.

*Attendees:* Ian Jonsen (MQU, Aus.), Toby Patterson (CSIRO, Aus.), Uffe Thygesen (DTU Aqua, Denmark). *Apologies:* Sophie Bestley (IMAS/CSIRO, Aus.).

The working group Reports for the first workshop in 2016 and the preceding inaugural workshop in 2015 are attached as reference documents.

The focus of the DTU workshop was to i) test further movement model parameterisations, and ii) draft a manuscript detailing the encoding of trip-based animal movement behaviours and demonstrating the capacity for simulation from such a model fitted to observational data.

Efforts at the most recent meeting focussed on advancing candidate models using continuous-space parameterizations in TMB. Specifically investigating a i) random walk with an advection (drift) term on X-Y for implementing an environmental bias, and ii) correlated random walk with a time-varying autocorrelation term (approximating area-restricted search behaviour where correlation is low).

## Funding opportunities and collaboration development

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Funding for TT-related work has been sought under the following programs:

- **Australian Antarctic Science program** – Hawke postdoctoral fellowship proposal (Project No. 4467 in 2016/17 application round) submitted 12<sup>th</sup> July 2016 (S. Bestley). Budget total request for 2y is **\$AUD 197,061**: \$177,584 (salary), \$19,477 (support) plus an additional co-contribution from Macquarie Univ. \$20,000. Announcement still pending.
- **Australian Research Council** – DECRA fellowship proposal DE180100828 submitted 22<sup>nd</sup> March 2017 (S. Bestley). Budget total request for 3y is **\$AUD 402,575**: \$298,107 (salary), \$104,468 (support) plus an additional co-contribution from Univ. Tasmania for salary \$99,415 and support \$30,000.
- **Australian Research Council** – Discovery project proposal DP180102269 submitted March 2017 (I. Jonsen, R. Harcourt, J. Matthiopoulos, F. Roquet). Budget total request for 3y is **\$AUD 416,980**: \$367,922 (post-doc salary), \$49,058 (support) plus an additional co-contribution from Macquarie Univ. \$89,046.
- **Australian Research Council** – Endeavour Research Fellowship submitted 30<sup>th</sup> June 2016; to be re-submitted May 2017 (T. Photopoulou). Budget total request for 6 months is **\$AUD 24,000**.

Collaboration development and synergies were discussed at a meeting of CLIOTOP Task Team TT2016-03 *Dynamic Ocean Management and Seasonal Forecasting for Pelagic Ecosystems*, hosted at CSIRO O&A attended 8<sup>th</sup> February 2017.

*Attendees:* Alistair Hobday, Jason Hartog, Paige Eveson (all CSIRO), Kylie Scales (Univ. Sunshine Coast, Aus.).  
*Visitors:* Toby Patterson (CSIRO), Sophie Bestley (IMAS/CSIRO), Uffe Thygesen (DTU Aqua, Denmark).

## Conferences, workshops for presenting TT activities

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The TT workshop agendas have typically involved short presentations to recap and update group activities, and related material, but have mainly focussed on methods development. Presentations of TT activities to wider audiences are anticipated over the coming year at:

- **XII<sup>th</sup> SCAR Biology Symposium**, 10–14<sup>th</sup> July 2017 Leuven, Belgium – Abstract submitted 28<sup>th</sup> February (I. Jonsen, S. Bestley et al.) “Fast inference of behavioural processes underlying marine predator movement and habitat usage”
- **6<sup>th</sup> Biologging Symposium**, 25–29<sup>th</sup> September 2017 Lake Constance, Germany – Abstracts due 31<sup>st</sup> May

## Publications

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The first publication relating to CLIOTOP Task Team work has been submitted to *Ecology* (30<sup>th</sup> October 2016, revised and resubmitted 14<sup>th</sup> March 2017) and is available as a public e-print online:

- Michelot T, Langrock R, Bestley S, Jonsen ID, Photopoulou T & Patterson TA (2016) Estimation and simulation of foraging trips in land-based marine predators. *arXiv preprint arXiv:1610.06953v2*.

## CLIOTOP funds expenditure

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The 2016 CLIOTOP funds were used to support early- and mid-career researcher attendance at AMP workshops. This included USD\$1136.50 allocated towards travel in May by Theo Michelot (PhD student) and Theoni Photopoulou (postdoctoral fellow). The CLIOTOP allocation was also leveraged against a substantial contribution from Macquarie University (\$AUD 6813; I. Jonsen) so that we completely covered all flights, food and accommodation for T. Michelot, T. Photopoulou and I. Jonsen. The remaining funds USD\$863.50 partially supported domestic travel for workshop participants (originally planned Hobart-Sydney [T. Patterson, S. Bestley] ultimately reissued Sydney-Hobart [I. Jonsen] in February due to family commitments of other participants [U. Thygesen]).

## Plans for 2017-18

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Over the next 6-12 months the Task Team priorities will include:

- Finalise extension of the trip-based hidden Markov models to include external covariates, with exploration for both ice and pelagic foraging animals
- Pursue the habitat electivity approach, and through this
- Work to establish connectivity to the climate model projections via the virtual machine infrastructure already built for the team
- Draft manuscript detailing the TMB approaches
- Initiate coordination with CLIOTOP TT2016-05
- Deliver presentations highlighting task team activities to international audiences