

# Théo Michelot

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## EMPLOYMENT

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| <b>Assistant professor in Statistics</b><br>Dalhousie University, Halifax, Canada   | <i>Since 2022</i> |
| <b>Lecturer in Statistics</b><br>University of St Andrews, UK   | <i>2022</i>       |
| <b>Postdoctoral research fellow</b><br>University of St Andrews, UK<br><i>Development of flexible continuous-time stochastic processes with applications in ecology</i> | <i>2019–2021</i>  |

## EDUCATION

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| <b>PhD in Statistics</b><br>University of Sheffield, UK<br><i>Stochastic models of animal movement and habitat selection</i> | <i>2016–2019</i> |
| <b>MSc in Mathematical and Software Engineering</b><br>INSA de Rouen, France   | <i>2012–2015</i> |
| INSA de Lyon, France   | <i>2010–2012</i> |

## PUBLICATIONS

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25. **Michelot, T.** (in press). hmmTMB: hidden Markov models with flexible covariate effects in R. *Journal of Statistical Software*. Preprint: arXiv:2211.14139.
24. Klappstein, N., **Michelot, T.**, Fieberg, J., Pedersen, E., & Flemming, J. M. (2024). Step selection analysis with non-linear and random effects. *Methods in Ecology and Evolution*, 15, pp. 1332–1346.
23. Invernizzi, E., **Michelot, T.**, Popov, V., Ng, N., Macqueen, E., Rouviere, A., Webster, M., & Sasaki, T. (2024). Identifying cues for self-organized nest wall-building behaviour in the rock ant, *Temnothorax rugatulus*, using hidden Markov models. *Animal Behaviour*. DOI: 10.1016/j.anbehav.2024.01.008.
22. **Michelot, T.**, Klappstein, N.J., Potts, J.R., Fieberg, J. (2024). Understanding step selection analysis through numerical integration. *Methods in Ecology and Evolution*. 15, pp. 24–35.
21. **Michelot, T.**, Glennie, R., Quick, N., Thomas, L., Harris, C.M. (2023). Continuous-time modelling of behavioural responses in animal movement. *Annals of Applied Statistics*. 17 (4), pp. 3570–3588.
20. Klappstein, N.J., Thomas, L., **Michelot, T.** (2023). Flexible hidden Markov models for behaviour-dependent habitat selection. *Movement Ecology*. 11 (30), DOI: 10.1186/s40462-023-00392-3.
19. Glennie, R., Adam, T., Leos-Barajas, V., **Michelot, T.**, Photopoulou, T., & McClintock, B.T. (2023). Hidden Markov models: pitfalls and opportunities in ecology. *Methods in Ecology and Evolution*. 14 (1), pp. 43–56.
18. Klappstein, N.J., Potts, J.R., **Michelot, T.**, Pilfold, N.W., Börger, L., Lewis, M.A., Derocher, A.E. (2022) Energy-based step selection analysis: modelling the energetic drivers of animal movement and habitat use. *Journal of Animal Ecology*, 91 (5), pp. 946–957.

17. **Michélot, T.**, Glennie, R., Harris, C., Thomas, L. (2021). Varying-coefficient stochastic differential equations with applications in ecology. *Journal of Agricultural, Biological and Environmental Statistics*, 26 (3), pp. 446-463.  
**Best 2020 paper in JABES.**
16. Connors, M., **Michélot, T.**, Heywood, E., Orben, R.A., Phillips, R., Vyssotski, A., Shaffer, S.A., Thorne, L. (2021). Hidden Markov models reveal major animal movement modes from multi-sensor tags: a case study of four albatross species. *Movement Ecology*, 9 (7), DOI: 10.1186/s40462-021-00243-z.
15. Runde, B.J., **Michélot, T.**, Bacheler, N.M., Shertzer, K.W. and Buckel, J.A. (2020). Assigning fates in telemetry studies using hidden Markov models: an application to deepwater groupers released with descender devices. *North American Journal of Fisheries Management*, 40, pp. 1417–1434.
14. **Michélot, T.**, Blackwell, P.G., Chamaillé-Jammes, S., Matthiopoulos, J. (2020). Inference in MCMC step selection models. *Biometrics*, 76, pp. 438-447.  
**Selected for Young Biometrician Award 2021 (honourable mention).**
13. Farhadinia, M.S., **Michélot, T.**, Johnson, P.J., Hunter, L.T.B., MacDonald, D.W. (2020). Understanding decision making in a food-caching predator using hidden Markov models. *Movement Ecology*, 8 (9), DOI: 10.1186/s40462-020-0195-z.
12. Spangenberg, M., Serrouya, R., Dickie, M., DeMars, C., **Michélot, T.**, Boutin, S., Wittmann, M.J. (2019). Slowing down wolves to protect boreal caribou populations: a spatial simulation model of linear feature restoration. *Ecosphere*, 10 (10), DOI: 10.1002/ecs2.2904.
11. **Michélot, T.**, Gloaguen, P., Blackwell, P.G., Étienne, M.P. (2019). The Langevin diffusion as a continuous-time model of animal movement and habitat selection. *Methods in Ecology and Evolution*, 10 (11), pp. 1894-1907.
10. Bacheler, N. M., **Michélot, T.**, Cheshire, R. T., Shertzer, K. W. (2019). Fine-scale movement patterns and behavioral states of gray triggerfish *Balistes capriscus* determined from acoustic telemetry and hidden Markov models. *Fisheries Research*, 215, pp. 76-89.
9. **Michélot, T.**, Blackwell, P.G. (2019). State-switching continuous-time correlated random walks. *Methods in Ecology and Evolution*, 10 (5), pp. 637–649.
8. **Michélot, T.**, Blackwell, P.G., Matthiopoulos, J. (2019). Linking resource selection and step selection models for habitat preferences in animals. *Ecology*, 100 (1), DOI: 10.1002/ecy.2452.
7. Grecian, W.J., Lane, J., **Michélot, T.**, Wade, H., Hamer, K.C. (2018). Understanding the ontogeny of foraging behaviour: insights from combining marine predator bio-logging with satellite-derived oceanography in hidden Markov models. *Journal of the Royal Society Interface*, 15 (143), DOI: 10.1098/rsif.2018.0084.
6. McClintock, B., **Michélot, T.** (2018). momentuHMM: R package for generalized hidden Markov models of animal movement. *Methods in Ecology and Evolution*, 9 (6), pp. 1518-1530.
5. **Michélot, T.**, Langrock, R., Bestley, S., Jonsen, I.D., Photopoulou, T., Patterson, T.A. (2017). Estimation and simulation of foraging trips in land-based marine predators. *Ecology*. 98 (7), pp. 1932–1944.
4. Langrock, R., Kneib, T., Glennie, R., **Michélot, T.** (2017). Markov-switching generalized additive models. *Statistics and Computing*. 27 (1), pp. 259–270.
3. **Michélot, T.**, Langrock, R., Patterson, T.A. (2016). moveHMM: An R package for analysing animal movement data using hidden Markov models. *Methods in Ecology and Evolution*, 7 (11), pp. 1308–1315.

2. **Michélot, T.**, Langrock, R., Kneib, T., King, R. (2016). Maximum penalized likelihood estimation in semiparametric capture-recapture models. *Biometrical Journal*, 58, pp. 223–239.
1. Langrock, R., **Michélot, T.**, Sohn, A., Kneib, T. (2015). Semiparametric stochastic volatility modelling using penalized splines. *Computational Statistics*, 30, pp. 517–537.

## PREPRINTS

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**Michélot, T.** (2024) Multiscale modelling of animal movement with persistent dynamics. *arXiv preprint*. arXiv:2406.15195.

Leos-Barajas, V., **Michélot, T.** (2018). An introduction to animal movement modeling with hidden Markov models using Stan for Bayesian inference. *arXiv preprint*. arXiv:1806.10639.

## IN PREPARATION

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Storey, E., **Michélot, T.** Scale dependence in hidden Markov models of animal movement.

Kim, D., Mertes, K., **Michélot, T.**, Stabach, J.A., Fieberg, J. Detecting diseases from animal movement using Hidden Markov models.

Larue, B., Farr, J., ..., **Michélot, T.**, ..., Hebblewhite, M. Inferring behavioral states from tracking data with hidden Markov models – A validation study using GPS video-camera collars.

Santos Neto, C., Dwyer, R., **Michélot, T.**, Cristescu, R. Land uses and urbanization shape movement behaviours of an endangered arboreal mammal.

## SOFTWARE

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I have developed several software packages for the R programming language, including:

- **hmmTMB**: Hidden Markov models with non-parametric and random effects. Available on CRAN: [cran.r-project.org/package=hmmTMB](https://cran.r-project.org/package=hmmTMB). Lead developer and maintainer.
- **moveHMM**: Analysis of animal movement data with hidden Markov models. Available on CRAN: [cran.r-project.org/package=moveHMM](https://cran.r-project.org/package=moveHMM). Lead developer and maintainer.
- **momentuHMM**: Analysis of multivariate ecological data with hidden Markov models (extension of moveHMM). Available on CRAN: [cran.r-project.org/package=momentuHMM](https://cran.r-project.org/package=momentuHMM). Co-developer.
- **smoothSDE**: Varying-coefficient stochastic differential equations. Available on Github: [github.com/TheoMichélot/smoothSDE](https://github.com/TheoMichélot/smoothSDE). Lead developer and maintainer.

## BOOK CHAPTERS

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Antinori P., **Michélot T.**, Lescuyer P., Müller M., Acosta-Martin A.E. (2019) Detection of unknown chemical adduct modifications on proteins: from wet to dry laboratory In: Evans C., Wright P., Noirel J. (eds), *Mass Spectrometry of Proteins Methods in Molecular Biology*, vol 1977. Humana Press, New York, NY.

## TEACHING

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### Lead instructor

- STAT3460 Intermediate Statistical Theory, Dalhousie University 2024, 2025
- STAT3450 Statistical Learning with R, Dalhousie University 2024, 2025
- STAT4370 Stochastic Processes, Dalhousie University 2023, 2024
- STAT1060 Introductory Statistics for Science and Health Sciences, Dalhousie University 2023
- MT5758 Multivariate Analysis, University of St Andrews 2022

### Guest lecturer

- MT4113 Computing in Statistics, University of St Andrews *Fall 2019*
- Ecological Modelling, University of Lisbon *Fall 2019*

### Teaching training

*Fall 2019*

Academic Staff Development Programme, University of St Andrews

- Assessment and feedback (half-day workshop)
- Effective lecturing (half-day workshop)

### Workshop co-instructor

*Topics: Hidden Markov models, ecological data analysis*

- One-day workshop in Swansea, UK *July 2024*
- One-day remote workshop (University of Porto) *February 2024*
- One-day remote workshop (International Statistical Ecology Conference) *June 2022*
- Two-day workshop in St Andrews, UK *August 2017*
- Three-day workshop in Mossel Bay, South Africa *March 2016*

### Tutorial demonstrator and marker

*2016–2018*

University of Sheffield

- MAS113 Introduction to Probability and Statistics (first year)
- MAS275 Probability Modelling (second year)
- MAS223 Statistical Inference and Modelling (second year)
- MAS6002 Statistical Laboratory (MSc)

## STUDENT SUPERVISION

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### PhD students

Margo Paris (Dalhousie U., with Joanna Mills Flemming) *Since September 2024*  
Topic: *Statistical models for integrating marine animal movement data into fisheries stock assessment*

### MSc students

Joseph Barss (Dalhousie U., with Joanna Mills Flemming) *Since September 2023*  
Topic: *Spatiotemporal modelling for fisheries*

Emma Storey (U. of St Andrews) *May–August 2022*  
Topic: *Scale dependence in hidden Markov models of animal movement*

Tom Morgan (U. of St Andrews) *May–August 2022*  
Topic: *Modelling the effect of financial market on bitcoin volatility*

### MSc research placements

Carlina Feldmann (U. of St Andrews, with Theoni Photopoulou) *October–November 2019*  
Topic: *Spatially-explicit models of animal movement for acoustic detection data*

Hugo Hervé (U. of St Andrews, with Len Thomas and Richard Glennie) *June–August 2019*  
Topic: *Simulation study of multiple imputation techniques for the application of hidden Markov models to irregular and noisy telemetry data*

### Honours dissertations

Mark McTaggart (Dalhousie U.) *Winter 2024*  
Topic: *Exploring model selection in animal movement hidden Markov models*

Mairi McHale (U. of St Andrews, with David Borchers) 2019–2020  
Topic: *Analysis of snow leopard movement data using hidden Markov models*

### Student examination

Aurélien Nicosia (U. Laval, Department of Mathematics and Statistics) October 2024  
External examiner for PhD thesis: *General multistate models for the analysis of animal movement*

Bantu Halam (U. of Cape Town, Department of Statistical Sciences) September 2019  
External examiner for MSc thesis: *Mining a large shopping database to predict where, when, and what consumers will buy next*

## GRANTS AND AWARDS

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**NSERC Discovery Grant** 2023–2028  
“*Modelling animal movement and habitat selection across scales*”  
\$135,000

**NSERC Discovery Launch Supplement** 2023  
\$12,500

**Best paper of the year in JABES**  
“*Varying-coefficient stochastic differential equations with applications in ecology*” (Michelot et al., 2021)

**Young Biometrician Award – honourable mention** 2021  
For “*Inference in MCMC step selection models*” (Michelot et al., 2020)  
International Biometric Society (British and Irish Region) and Fisher Memorial Trust

**Best student talk award** 2016  
International Statistical Ecology Conference

## PRESENTATIONS

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*Modèles multi-échelles pour les déplacements d’animaux*  
Invited seminar at Université de Laval, Québec, Canada. October 2024.

*Multiscale modelling of animal movement with underdamped dynamics*  
Talk at the International Statistical Ecology Conference, Swansea, UK. July 2024.  
Invited talk at the annual meeting of the Statistical Society of Canada, St John’s, Canada. June 2024.

*Analysing animal movement and behaviour in R*  
Invited remote workshop for University of Porto, Portugal. February 2024.  
Invited workshop at Memorial University of Newfoundland, St John’s, Canada. November 2023.

*Flexible hidden Markov models in ecology and the R package hmmTMB*  
Invited seminar at Memorial University of Newfoundland, St John’s, Canada. November 2023.  
Invited talk at CANSSI/OTN early-career workshop, Halifax, Canada. November 2023.  
Invited webinar for the Journal of Statistical Theory and Practice, online. November 2023.  
Recording available online.

*Towards a mechanistic understanding of animal movement*  
Invited discussion leader at the Gordon Research Seminar on Movement Ecology, Bargga, Italy. May 2023.

*Multiscale models of animal space use: from small-scale movement to large-scale distributions*  
Poster at the Gordon Research Conference on Movement Ecology, Bargga, Italy. June 2023.  
Remote invited seminar for the BioMove research group. March 2023.

*Flexible stochastic differential equations for animal movement*

Invited talk at the International Conference in Statistics and Data Science, Florence, Italy. December 2022.

*Varying-coefficient stochastic differential equations*

Invited talk at the JABES showcase of the International Biometric Conference, online. October 2022.

Invited talk at the Joint Statistical Meeting, online. August 2022.

*Detecting behavioural responses from movement data using stochastic differential equations*

Talk at the International Statistical Ecology Conference, online. June 2022.

*Multiscale models of animal movement and space use*

Remote seminar for Dalhousie University, Halifax, Canada. February 2022.

*Introduction to analysing animal movement data in R*

Invited webinar for Ecological Forecasting Initiative & Ecological Society of America. February 2022.

Recording available online.

*hmmTMB: hidden Markov models with non-parametric and random effects*

Talk at the meeting of the National Centre for Statistical Ecology, online. June 2021.

*Time-varying diffusion processes in movement ecology*

Talk at the virtual International Statistical Ecology Conference, online. June 2020.

*Linking scales of animal movement using statistical samplers*

Invited seminar at the University of Alberta, Edmonton, Canada. March 2020.

*Behavioural response studies of beaked whales using accelerometer data and diffusion models*

Talk at the British Ecological Society conference, Belfast, UK. December 2019.

*Spline-based diffusion models and application to accelerometer data*

Invited seminar at the University of Glasgow, UK. November 2019.

Seminar at the University of St Andrews, UK. November 2019.

*Hidden Markov models of animal movement and behaviour*

Invited seminar at the University of Lisbon, Portugal. November 2019.

Invited talk at the congress of Soc. Portuguesa de Estatística, Amarante, Portugal. November 2019.

*Modelling animal movement and habitat selection across scales*

Invited talk at the annual meeting of the BES movement ecology group, Sheffield, UK. July 2019.

*The Langevin diffusion as a model of animal movement and habitat selection*

Talk at the meeting of the National Centre for Statistical Ecology, Edinburgh, UK. June 2019.

*Modelling animal movement and habitat selection across scales*

Invited seminar at the School of Biosciences of the University of Cardiff, UK. March 2019.

*Analysing telemetry data with hidden Markov models*

Invited seminar at the Duke University Marine Lab, Beaufort, USA. March 2019.

*Do animals move like statistical samplers?*

Talk at the Research Students' Conference in Statistics and Probability, Sheffield, UK. July 2018.

*Markov chain Monte Carlo as a model of animal movement and space use*

Talk at the International Statistical Ecology Conference, St Andrews, UK. July 2018.

*moveHMM and momentuHMM – Analysing animal movement in R*

Invited tutorial at the moving2gather meeting, Montpellier, France. December 2017.

*Can animals do MCMC? Linking resource selection and step selection models*

Poster at the Bio-logging symposium, Konstanz, Germany. September 2017.

*From movement to space use*

Flash talk at the BES movement ecology group meeting, London, UK. July 2017.

*momentuHMM: an R package for the analysis of general telemetry data using hidden Markov models*

Talk at the EURING meeting, Barcelona, Spain. July 2017.

*Can animals do MCMC? Integrating resource selection and step selection*

Talk at the meeting of the National Centre for Statistical Ecology, Canterbury, UK. June 2017.

*Analysing animal movement data with moveHMM – Conservation action plan for the wild haggis*

Talk at the International Statistical Ecology Conference, Seattle, USA. June 2016.

### **Best student talk award**

*Multistate Ornstein-Uhlenbeck processes for modelling animal movement*

Talk at the Research Students' Conference in Probability and Statistics, Dublin, Ireland. June 2016.

*moveHMM: an R package for modelling animal movement with hidden Markov models*

Seminar at the Australian Antarctic Division, Hobart, Australia. June 2016.

Seminar at the Sea Mammal Research Unit, St Andrews, UK. November 2015.

*A statistical introduction to animal movement modelling*

Talk at the German Statistical Week, Hamburg, Germany. September 2015.

## **SERVICE**

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### **Associate Editor**

*Since 2021*

*Journal of Statistical Theory and Practice*

### **Reviewer**

*Advances in Statistical Analysis, Annals of Applied Statistics, Biometrics, Bulletin of Mathematical Biology, Ecography, Ecological Applications, Ecological Monographs, Ecology, Ecology and Evolution, Ecology Letters, Journal of Agricultural, Biological, and Ecological Statistics, Journal of Animal Ecology, Journal of the Royal Statistical Society Series C, Journal of Statistical Theory and Practice, Landscape Ecology, Mathematical Biosciences, Methods in Ecology and Evolution, Movement Ecology, Nature Ecology & Evolution, Plos One, Scientific Reports, Statistics and Probability Letters.*

### **Early career researcher representative**

*2019–2022*

Executive committee of the National Centre for Statistical Ecology, UK

### **Seminar organiser**

Dalhousie Statistics seminar series

*Since 2022*

National Centre for Statistical Ecology seminar series

*2021–2022*

## **OTHER SKILLS**

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### **Programming**

R (including Rcpp, Stan, TMB), C++

### **Tools**

git, L<sup>A</sup>T<sub>E</sub>X, R development tools (devtools, unit testing, profiling, documentation)

### **Languages**

French, English