

Ecography

**ECOG-02445**

Guillera-Arroita, G. 2016. Modelling of species distributions, range dynamics and communities under imperfect detection: advances, challenges and opportunities. – Ecography doi: [10.1111/ecog.02445](https://doi.org/10.1111/ecog.02445)

**Supplementary material**

## Appendix 1 – Literature cited in the summary diagram (fig. 4)

- Bled, F., Royle, J.A. & Cam, E. (2011) Hierarchical modeling of an invasive spread: the Eurasian collared-dove *Streptopelia decaocto* in the United States. *Ecological Applications*, **21**, 290-302.
- Chandler, R.B., Royle, J.A. & King, D.I. (2011) Inference about density and temporary emigration in unmarked populations. *Ecology*, **92**, 1429-1435.
- Dail, D. & Madsen, L. (2011) Models for Estimating Abundance from Repeated Counts of an Open Metapopulation. *Biometrics*, **67**, 577-587.
- Dorazio, R.M. & Royle, J.A. (2005) Estimating size and composition of biological communities by modeling the occurrence of species. *Journal of the American Statistical Association*, **100**, 389-398.
- Dorazio, R.M., Connor, E.F. & Askins, R.A. (2015) Estimating the Effects of Habitat and Biological Interactions in an Avian Community. *Plos One*, **10**
- Dorazio, R.M., Royle, J.A., Söderström, B. & Glimskär, A. (2006) Estimating species richness and accumulation by modeling species occurrence and detectability. *Ecology*, **87**, 842-854.
- Dorazio, R.M., Kéry, M., Royle, J.A. & Plattner, M. (2010) Models for inference in dynamic metacommunity systems. *Ecology*, **91**, 2466-2475.
- Garrard, G.E., Bekessy, S.A., McCarthy, M.A. & Wintle, B.A. (2008) When have we looked hard enough? A novel method for setting minimum survey effort protocols for flora surveys. *Austral Ecology*, **33**, 986-998.
- Guillera-Arroita, G., Morgan, B.J.T., Ridout, M.S. & Linkie, M. (2011) Species occupancy modeling for detection data collected along a transect. *Journal of Agricultural, Biological, and Environmental Statistics*, **16**, 301-317.
- Guillera-Arroita, G., Ridout, M.S., Morgan, B.J.T. & Linkie, M. (2012) Models for species-detection data collected along transects in the presence of abundance-induced heterogeneity and clustering in the detection process. *Methods in Ecology and Evolution*, **3**, 358-367.
- Hardin-Waddle, J., Dorazio, R.M., Walls, S.C., Rice, K.G., Beauchamp, J., Schuman, M.J. & Mazzotti, F.J. (2010) A new parameterization for estimating co-occurrence of interacting species. *Ecological Applications*, **20**, 1467-1475.
- Hines, J.E., Nichols, J.D., Royle, J.A., MacKenzie, D.I., Gopaldaswamy, A.M., Samba Kumar, N. & Karanth, K.U. (2010) Tigers on trails: Occupancy modeling for cluster sampling. *Ecological Applications*, **20**, 1456–1466.
- Hooten, M.B., Wikle, C.K., Dorazio, R.M. & Royle, J.A. (2007) Hierarchical spatiotemporal matrix models for characterizing invasions. *Biometrics*, **63**
- Johnson, D.S., Conn, P.B., Hooten, M.B., Ray, J.C. & Pond, B.A. (2013) Spatial occupancy models for large data sets. *Ecology*, **94**, 801–808.

- Joseph, L.N., Elkin, C., Martin, T.G. & Possingham, H.P. (2009) Modeling abundance using N-mixture models: the importance of considering ecological mechanisms. *Ecological Applications*, **19**, 631-642.
- Kendall, W.L., Hines, J.E., Nichols, J.D. & Grant, E.H.C. (2013) Relaxing the closure assumption in occupancy models: staggered arrival and departure times. *Ecology*, **94**, 610-617.
- Kéry, M. & Royle, J.A. (2009) Inference about species richness and community structure using species-specific occupancy models in the National Swiss Breeding Bird survey *Modeling demographic processes in marked populations* (ed. by D.L. Thomson, E.G. Cooch and M.J. Conroy). Springer.
- Kéry, M., Royle, J.A., Plattner, M. & Dorazio, R.M. (2009a) Species richness and occupancy estimation in communities subject to temporary emigration. *Ecology*, **90**, 1279-1290.
- Kéry, M., Dorazio, R.M., Soldaat, L., Strien, A.v., Zuiderwijk, A. & Royle, J.A. (2009b) Trend estimation in populations with imperfect detection. *Journal of Applied Ecology*, **46**, 1163-1172.
- MacKenzie, D.I., Bailey, L.L. & Nichols, J.D. (2004) Investigating species co-occurrence patterns when species are detected imperfectly. *Journal of Animal Ecology*, **73**, 546-555.
- MacKenzie, D.I., Nichols, J.D., Seamans, M.E. & Gutiérrez, R.J. (2009) Modeling species occurrence dynamics with multiple states and imperfect detection. *Ecology*, **90**, 823-835.
- MacKenzie, D.I., Bailey, L.L., Hines, J.E. & Nichols, J.D. (2011) An integrated model of habitat and species occurrence dynamics. *Methods in Ecology and Evolution*, **2**, 612-622.
- MacKenzie, D.I., Nichols, J.D., Hines, J.E., Knutson, M.G. & Franklin, A.B. (2003) Estimating site occupancy, colonization, and local extinction when a species is detected imperfectly. *Ecology*, **84**, 2200-2207.
- MacKenzie, D.I., Nichols, J.D., Lachman, G.B., Droege, S., Royle, J.A. & Langtimm, C.A. (2002) Estimating site occupancy rates when detection probabilities are less than one. *Ecology*, **83**, 2248-2255.
- Martin, J., Royle, J.A., MacKenzie, D.I., Edwards, H.H., Kéry, M. & Gardner, B. (2011) Accounting for non-independent detection when estimating abundance of organisms with a Bayesian approach. *Methods in Ecology and Evolution*, **2**, 595-601.
- Mattsson, B.J., Zipkin, E.F., Gardner, B., Blank, P.J., Sauer, J.R. & Royle, J.A. (2013) Explaining local-scale species distributions: relative contributions of spatial autocorrelation and landscape heterogeneity for an avian assemblage. *Plos One*, **8**, e55097.
- Miller, D.A., Nichols, J.D., McClintock, B.T., Grant, E.H.C., Bailey, L.L. & Weir, L.A. (2011) Improving occupancy estimation when two types of observational error occur: non-detection and species misidentification. *Ecology*, **92**, 1422-1428.
- Miller, D.A.W., Nichols, J.D., Gude, J.A., Rich, L.N., Podruzny, K., Hines, J.E. & Mitchell, M.S. (2013) Determining occurrence dynamics when false positives occur: estimating the range dynamics of wolves from public survey data. *PLoS One*, **8**, e65808.

- Nichols, J.D., Hines, J.E., MacKenzie, D.I., Seamans, M.E. & Gutiérrez, R.J. (2007) Occupancy estimation and modeling with multiple states and state uncertainty. *Ecology*, **88**, 1395-1400.
- Nichols, J.D., Bailey, L.L., O'Connell Jr., A.F., Talancy, N.W., Campbell Grant, E.H., Gilbert, A.T., Annand, E.M., Husband, T.P. & Hines, J.E. (2008) Multi-scale occupancy estimation and modelling using multiple detection methods. *Journal of Applied Ecology*, **45**, 1321-1329.
- Ovaskainen, O., Hottola, J. & Siitonen, J. (2010) Modeling species co-occurrence by multivariate logistic regression generates new hypotheses on fungal interactions. *Ecology*, **91**, 2514-2521.
- Ovaskainen, O., Roy, D.B., Fox, R. & Anderson, B.J. (2016a) Uncovering hidden spatial structure in species communities with spatially explicit joint species distribution models. *Methods in Ecology and Evolution*, n/a-n/a.
- Ovaskainen, O., Abrego, N., Halme, P. & Dunson, D. (2016b) Using latent variable models to identify large networks of species-to-species associations at different spatial scales. *Methods in Ecology and Evolution*, n/a-n/a.
- Pollock, L.J., Tingley, R., Morris, W.K., Golding, N., O'Hara, R.B., Parris, K.M., Vesk, P.A. & McCarthy, M.A. (2014) Understanding co-occurrence by modelling species simultaneously with a Joint Species Distribution Model (JSDM). *Methods in Ecology and Evolution*, **5**, 397-406.
- Richmond, O.M.W., Hines, J.E. & Beissinger, S.R. (2010) Two-species occupancy models: a new parameterization applied to co-occurrence of secretive rails. *Ecological Applications*, **20**, 2036-2046.
- Royle, J.A. (2004a) N-mixture models for estimating population size from spatially replicated counts. *Biometrics*, **60**, 108-115.
- Royle, J.A. (2004b) Modeling abundance index data from anuran calling surveys. *Conservation Biology*, **18**, 1378-1385.
- Royle, J.A. (2004c) Generalized estimators of avian abundance from count survey data. *Animal Biodiversity and Conservation*, **27**, 375-386.
- Royle, J.A. (2006) Site occupancy models with heterogeneous detection probabilities. *Biometrics*, **62**, 97-102.
- Royle, J.A. & Nichols, J.D. (2003) Estimating abundance from repeated presence-absence data or point counts. *Ecology*, **84**, 777-790.
- Royle, J.A. & Link, W.A. (2005) A general class of multinomial mixture models for anuran calling survey data. *Ecology*, **86**, 2505-2512.
- Royle, J.A. & Link, W.A. (2006) Generalised site occupancy models allowing for false positive and false negative errors. *Ecology*, **87**, 835-841.
- Stanley, T.R. & Royle, J.A. (2005) Estimating site occupancy and abundance using indirect detection indices. *Journal of Wildlife Management*, **69**, 874-883.

- Tyre, A.J., Tenhumberg, B., Field, S.A., Niejalke, D., Parris, K. & Possingham, H.P. (2003) Improving precision and reducing bias in biological surveys: estimating false-negative error rates. *Ecological Applications*, **13**, 1790-1801.
- van der Burg, M.P., Bly, B., VerCauteren, T. & Tyre, A.J. (2011) Making better sense of monitoring data from low density species using a spatially explicit modelling approach. *Journal of Applied Ecology*, **48**, 47-55.
- Webster, R.A., Pollock, K.H. & Simons, T.R. (2008) Bayesian spatial modeling of data from avian point count surveys. *Journal of Agricultural Biological and Environmental Statistics*, **13**, 121-139.
- Wenger, S.J. & Freeman, M.C. (2008) Estimating species occurrence, abundance, and detection probability using zero-inflated distributions. *Ecology*, **89**, 2953-2959.
- Yamaura, Y., Andrew Royle, J., Kuboi, K., Tada, T., Ikeno, S. & Makino, S.i. (2011) Modelling community dynamics based on species-level abundance models from detection/nondetection data. *Journal of Applied Ecology*, **48**, 67-75.
- Yamaura, Y., Royle, J., Shimada, N., Asanuma, S., Sato, T., Taki, H. & Makino, S.i. (2012) Biodiversity of man-made open habitats in an underused country: a class of multispecies abundance models for count data. *Biodiversity and Conservation*, **21**, 1365-1380.