- **Why is Zonation useful?** Zonation can link species distribution modelling directly to quantitative reserve planning. Zonation includes species-specific connectivity responses, natural weighting of species and several unique analysis options. It can analyse relatively large data sets in reasonable time. The analysis is deterministic and its main results can be summarized in a map and a graph.

- **Where does data for Zonation come from?** Observed or predicted occurrence of features or coverage of habitat type. Typically one would enter one grid per species (or whatever biodiversity feature). Each cell would have either an observation of population size at that location, or a probability of occurrence or abundance predicted using a statistical habitat model.

- **What is new in Zonation v. 3.0?** New analysis features allow, for example, ecological community-level analyses, balancing of alternative land uses, landscape condition and retention, multi-feature connectivity and analyses across multiple administrative regions.

- **What limitations does the software have?** Zv3 has fewer limitations than Zv2. Zv3 is multithreading 64 bit software, which makes it fast and allows it to process large data set on computers running 64 bit Windows.

- **What does Zonation presently not do?** It does not work with vector-based units. It only allows a limited set of interactive planning analyses.

- **Where can I get Zonation?** Download the free software from Biodiversity Conservation Informatics Group's web pages: http://www.helsinki.fi/bioscience/consplan. The package includes user manual and tutorial.

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Zonation references

Important basic Zonation analyses

Moilanen, A., Franco, A.M.A., Early, R., Fox, R., Wintle, B.A. and C.D. Thomas 2005. Prioritising multiple-use landscapes for conservation: methods for large multi-species planning problems. *Proc. R. Soc. B*, 272: 1885-1891.

Moilanen, A. 2007. Landscape zonation, benefit functions and target-based planning: Unifying reserve selection strategies. *Biological Conservation,* 134: 571-579.

Moilanen, A., Kujala, H. and J. Leathwick. 2009. The Zonation framework and software for conservation prioritization. Pp. 196-210 in Moilanen, Wilson and Possingham (Eds.), Spatial Conservation Prioritization, OUP, UK.

Leathwick, J.R., Moilanen, A., Ferrier, S. and K. Julian. 2010. Complementarity-based conservation prioritization using a community classification, and its application to riverine ecosystems. *Biological Conservation*, 143, 984-991.

Moilanen, A., Anderson, B.J., Eigenbrod, F., Heinemeyer, A., Roy, D.B., Gillings, S., Armsworth, P.R., Gaston, K.J., and C.D. Thomas. 2011. Balancing alternative land uses in conservation prioritization. *Ecological Applications*, 21: 1419-1426.

Moilanen, A. and A. Arponen. 2011. Administrative regions in conservation: balancing local and global priorities in spatial planning. *Biological Conservation*, 144: 1719-1725.

Moilanen, A., Leathwick, J.R. and J.M. Quinn. 2011. Spatial prioritization of conservation management. *Conservation Letters*, 4: 383-393.

Accounting for distributional uncertainty

Moilanen, A., Wintle, B.A., Elith, J. and M. Burgman 2006. Uncertainty analysis for regional-scale reserve selection. *Conservation Biology*, 20: 1688-1697.

Generating reserve network aggregation

Moilanen, A. and B.A. Wintle. 2007. The boundary-quality penalty: a quantitative method for approximating species responses to fragmentation in reserve selection. *Cons. Biol.*, 21: 355-364.

Moilanen, A., Leathwick, J. and J. Elith. 2008. A method for spatial freshwater conservation prioritization. *Freshw. Biol.*, 53: 577-592.

Lehtomäki, J., Tomppo, E., Kuokkanen, P. Hanski, I., and A. Moilanen. 2009. Applying spatial conservation prioritization software and high-resolution GIS data to a national-scale study in forest conservation. *Forest Ecology and Management*, 258: 2439-2449.

Illustrative applications

Kremen, C., Cameron, A., Moilanen, A., Phillips, S., Thomas, C.D. et al. 2008. Aligning conservation priorities across taxa in Madagascar, a biodiversity hotspot, with high-resolution planning tools. *Science,* 320: 222-226.

Leathwick, J.R., Moilanen, A., Francis, M., Elith, J., Taylor, P. Julian, K. and T. Hastie. 2008. Novel methods for the design and evaluation of marine protected areas in offshore waters. *Cons. Lett.*, 1: 91-102.

Thomson, J.R., Moilanen, A., McNally, R., and P. Vesk. 2009. Where and when to revegetate: a quantitative method for scheduling landscape reconstruction. *Ecological Applications*, 19: 817-828.

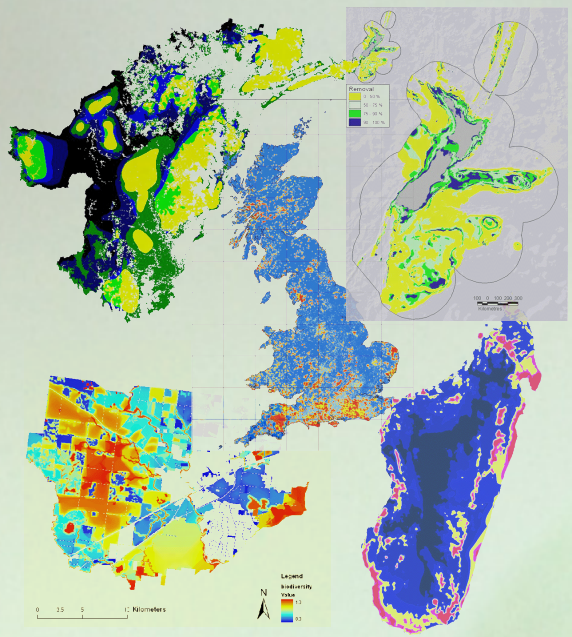
Gordon, A., Simondson, D., White, M., Moilanen, A., and S.A. Bekessy. 2009. Integrating conservation planning and landuse planning in urban landscapes. *Landscape and Urban Planning*, 91: 183-194.

Carroll, C., Moilanen, A., and J. Dunk. 2010. Optimizing resilience of reserve networks to climate change: multispecies conservation planning in the Pacific North-West USA. *Global Change Biology*, 16: 891-904.

Spatial conservation planning framework and software

ZONATION

Version 3.0
available since November 2011



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Zonation is a framework and software for spatial conservation prioritization; it is a decision support tool for conservation planning. Zonation identifies areas important for retaining habitat quality and connectivity for multiple species, habitats or ecosystems, indirectly aiming at species' long-term persistence. The computational strategy of Zonation can be characterized as *maximal retention of weighted, range size normalized (rarity corrected) feature richness*. Zonation produces a *complementarity-based priority ranking*. The operation of Zv3 is explained in a 300 page comprehensive manual.

Zonation produces a hierarchical prioritization of the landscape based on the occurrence levels of features in sites (grid cells). It iteratively removes the least valuable remaining cell, accounting for connectivity and generalized complementarity in the process. The output of Zonation can be imported into GIS software for further analysis. Zonation can be run on very large data; Zv3 can process landscapes with up to ~50 million grid cells with effective data.

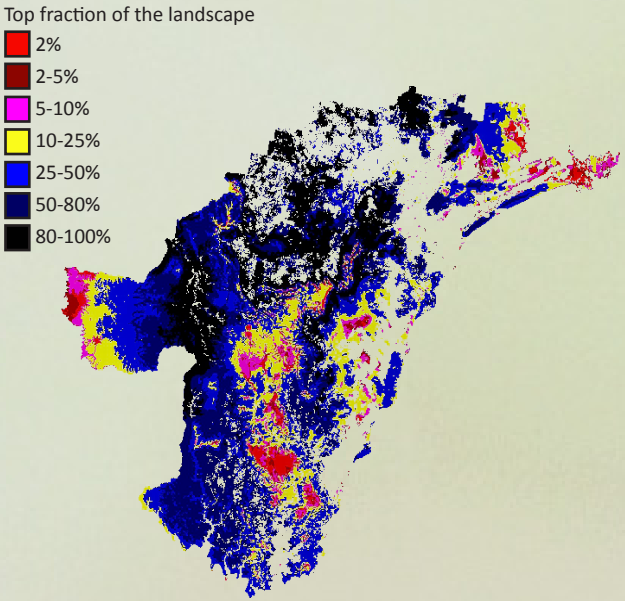

Fig. 1. First main Zonation output: A visualization of the hierarchical priority ranking of the landscape. Areas have been zoned to graded colours based on their priority rank, with highest priorities shown in red. The priority ranking also supports expansion of conservation area networks, target-based systematic conservation planning, or identification of ecologically low-value areas for alternative land uses.

Basic analyses

- Identification of optimal reserve areas
- Identification of reserve area expansions
- Identification of areas for alternative land uses
- Target-based planning
- Multiple alternatives for how conservation value is aggregated across features and across the landscape

Input data includes

- Large-scale high-resolution grids with
  - Presence/absence -data
  - Probabilities of occurrence
  - Abundance/density/coverage -data
- Point occurrence data
- Planning unit layers
- Cost and mask layers

Features

- Species/feature weighting (prioritization)
- Connectivity methods
  - Distribution Smoothing
  - Boundary Quality Penalty
  - Boundary Length Penalty
  - Directed freshwater connectivity
  - Species interactions
  - Matrix connectivity (**NEW** in 3.0)
- Uncertainty analysis aiming at robust conservation decisions
- Combined ecological community level and species level analysis (**NEW** in 3.0)
- Priority ranking balancing needs of alternative land uses (**NEW** in 3.0)
- Landscape condition and retention analysis (**NEW** in 3.0)
- Prioritization across multiple administrative regions with different priorities (**NEW** in 3.0)

Zonation v.3.0 software

- New GUI
- New manual
- Now allows analysis of very large data

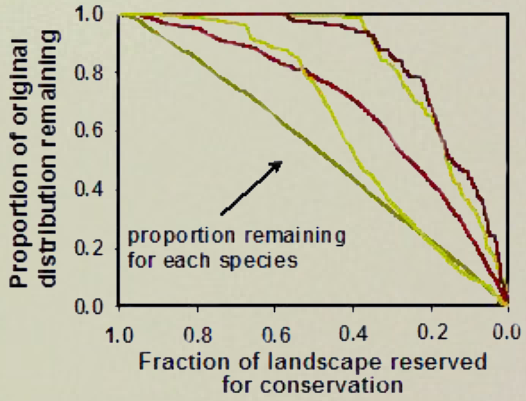

Fig. 2. Second main Zonation output: Zonation produces detailed information about the decrease in species distributions as landscape is lost.

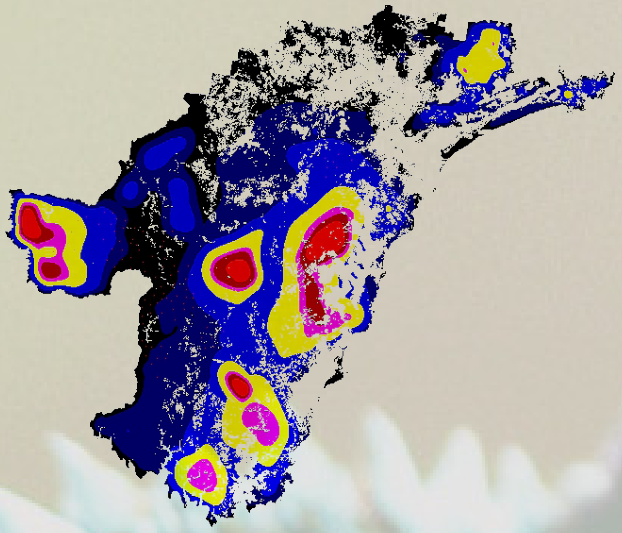

Fig. 3. Connectivity is a fundamental variable of spatial ecology. Zonation includes multiple ways of dealing with connectivity in a feature-specific manner. One of them is called distribution smoothing, which converts local habitat quality to habitat density, providing a measure of connectivity (above). The boundary quality penalty is another aggregation method, transferring connectivity effects from habitat models to Zonation. Zonation also includes directed connectivity for freshwater systems.

The example area here is a 120 * 140 km2 region in eastern Australia. The data includes 7 priority fauna species and a 649 * 555 grid at 200 m cell resolution (courtesy of Dr. Brendan Wintle, University of Melbourne, and the Hunter Region Organization of Councils, HROC).
Background pictures: Evgeniy Meyke.
Layout: Heini Kujala, Camilla Ekblad, Laura Meller, Aija Kukkala and Atte Moilanen.