

CV Rainer M. Krug

PERSONAL DETAILS

Name	Rainer M. Krug
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E-mail	Rainer@krugs.de
Date of birth	12 April 1968
Civil status	married, one daughter

QUALIFICATIONS

Postgraduate

- 2008 PhD in Conservation Ecology**, Stellenbosch University, South Africa
Thesis Title: Modelling seed dispersal in restoration and biological invasion.
- 1997 MSc Conservation Biology**, University of Cape Town, South Africa
Thesis topic: The Genetic Diversity in a Founded Population of the African buffalo (*Syncerus caffer*): an example of an Artificial Bottleneck.
- 1995 Diplom (MSc equivalent) in Physics**, Philips-Universität Marburg, Germany
Thesis Title: Der Einfluss von Habitat Heterogenität auf die mittlere Überlebensdauer von Populationen (The influence of habitat heterogeneity on the mean survival time of populations)
Subjects for oral examination: Experimental Physics, Theoretical Physics, Ecological Modelling, Biology

Undergraduate

- 1992 Vor-Diplom (BSc equivalent) in physics**, Philips-Universität Marburg, Germany
Subjects for oral examination: Experimental Physics, Theoretical Physics, Mathematics, Chemistry.

POSITIONS HELD

10/2016 – 12/2016	Laboratoire Ecologie, Systematique et Evolution, Paris Sud Researcher
08/2015 – 09/2015	Laboratoire Ecologie, Systematique et Evolution, Paris Sud Postdoctoral Researcher
11/2014 – 12/2014	Laboratoire Ecologie, Systematique et Evolution, Paris Sud Postdoctoral Researcher
09/2013 – 11/2013	Laboratoire Ecologie, Systematique et Evolution, Paris Sud Postdoctoral Researcher
08/2011 – 12/2016	DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University Research Associate
06/2008 – 06/2008	DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University Postdoctoral Research Fellow, hosted by Prof. Dave Richardson.
06/2007 – 06/2008	Plant Conservation Unit, University of Cape Town Postdoctoral Research Fellow, hosted by Prof. Timm Hoffman.

AREAS OF INTEREST AND EXPERTISE

Ecological Modelling; statistical computing; combined modelling and experimental approaches; invasive species management; spatial pattern analysis; decision support; open source tools

My research interest and focus is on 1) spatial modeling and analysis of pattern and processes and their integration with field experiments and observations, ranging from population (local) to ecosystem (regional) scale, 2) the impact of change (climate change, human impacts, alien spread, ...) and conscious human actions (management) on these pattern and ultimately on the function of these ecosystems and ecosystem services, and 3) the use of models in decision support of the management of natural resources.

During my research career I have developed and used different types of models, ranging from individual based models, over hybrid models using individual based approaches together with grid based elements, to pure grid based models. The systems studied ranged from populations and communities on the local scale to community dynamics (e.g. grassland - shrubland dynamics, two biocontrol species one invasive species system, spread of three alien invasive species) on the local scale and spread simulations of individual species on the national scale under different climate change scenarios. Most of my research included different management scenarios in the form of alien plant management actions.

Nearly all the simulation and analysis tools I use (and used) are Open Source software (R, GRASS GIS, QGIS). This provides the flexibility to develop the

simulation models and analysis protocols without additional costs, distribute them freely and to enable others (scientists as well as implementing agencies like nature conservation agencies) to use and evaluate the code without limitations and without having to purchase specific software, i.e. reproducible research. Reproducible research includes for me to use scripts in analysis and generation of graphs and to make these as well as the simulation models available (as far as funder conditions allow this).

RESEARCH PROJECTS

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|--------------------------|--|
| 10/2016 – present | Literature Analysis of Scenarios and Models on Global scale (Laboratoire Ecologie, Systematique et Evolution, Paris Sud). |
| 08/2015 – 09/2015 | Analyze measured vertical wind profiles to improve the performance of a forest growth model (CASTANEA) in regards to energy balance (Laboratoire Ecologie, Systematique et Evolution, Paris Sud). |
| 11/2014 – 12/2014 | Develop proof of concept for assessing multi species forest community productivity (Laboratoire Ecologie, Systematique et Evolution, Paris Sud). |
| 09/2013 – 11/2013 | Adapt the framework developed to simulate the alien spread in the Western Cape for management of invasive alien species in the Drakensberg in Southern Africa (Laboratoire Ecologie, Systematique et Evolution, Paris Sud). |
| 2008 – 2012 | <p>DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University</p> <p>Investigating the temporal dynamics and the spread of biocontrol agents and their host plants on a landscape scale using a GIS based ecological simulation model, as well a non-spatial approach to understand diverse aspects of the interaction between biocontrol agent and host plant and how these interactions influence the effectiveness of biocontrol agents in halting the spread of invasive species. Results from the project were used to inform implementing agencies and are communicated in the form of contributions to a handbook.</p> <p>Modelling the spread of alien species in the Western Cape with the aim of optimising the alien management strategies. This project included aspects ranging from using an Analytical Hierarchical Process to capture and quantify the subjective decision making process of prioritizing, translating this into a spatial simulation model, developing a spatial-temporal simulation model which included fire, alien plant management, different dispersal vectors (wind, water, birds) and to use high performance computing infrastructure (cluster) to run the simulations and to develop a package for R to compare the different resulting prioritisation maps spatially.</p> <p>Investigating the spread of invasive species under different climate change scenarios. This involved developing the spread models (population based as well as probabilistic) which included climatic suitability maps to project the observed distribution under different climate change scenarios to identify risk areas and to assess the invasive potential of these species.</p> <p>Assessing the viability of pine plantations under different (and changing) fire regimes using a basic modelling approach.</p> |

- 2008 – 2012** Investigating the temporal dynamics and the spread of biocontrol agents and their host plants on a landscape scale using a GIS based ecological simulation model. Results from the project were used to inform implementing agencies and are communicated in the form of contributions to a handbook (**DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University**).
- Modelling the spread of alien species in the Western Cape with the aim of optimising the alien management strategies. Using an Analytical Hierarchical Process to capture and quantify the subjective decision making process, translating this into a spatial simulation model which included fire, alien plant management and different dispersal vectors (wind, water, birds) modules and to use high performance computing infrastructure (cluster) for simulations (**DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University**).
- Investigating the spread of invasive species under different climate change scenarios (**DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University**).
- Assessing the viability of pine plantations under different (and changing) fire regimes using a basic modelling approach (**DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University**).
- 2007 – 2008** Analyzing the population dynamics of *Aloe pillansii*, a tree aloe, with focus on the recruitment events and their reconstruction (**Plant Conservation Unit, University of Cape Town**).
- 2000 – 2007** Modelling the role of seed dispersal in restoration and biological invasion, and investigating factors influencing the spread of a species. using a rule-based simulation models based on data and experts opinions (**Conservation Ecology and Entomology department, Stellenbosch University**).
- 1996 – 1997** Investigated the genetic heterogeneity of three populations of African Buffalo using microsatellites (**Percy FitzPatrick Institute of African Ornithology, University of Cape Town**).
- 1995 – 1995** Development of an individual based simulation model focussing on the effect of habitat use on the mean survival time of populations (**Department of Physics, Philipps-Universität Marburg**).

ADDITIONAL SKILLS

- Computer**
- Operating System** Expert Linux user; advanced Mac and Windows user
 - Programming Languages** Extensive experience in programming in R, Delphi / Pascal; user of L^AT_EX; basic usage of C
 - Programs** Extensive experience in R, GRASS; Daily Emacs user; MS Office programs / Libre Office; basic experience of QGIS and Arc-GIS
- Language**
- German** native language
 - English** reading, writing and speaking fluent
 - French** reading, writing and speaking fair

GRANTS

- 2009 – 2010** NRF Freestanding Postdoctoral Fellowship
- 1999 – 2000** Deutscher Akademischer Austauschdienst (DAAD: German Academic Exchange Service) grant to conduct fieldwork for PhD at Gobabeb, Namibia.
- 1996 – 1997** Deutscher Akademischer Austauschdienst (DAAD: German Academic Exchange Service) grant to attend MSc in Conservation Biology course at UCT.

TEACHING EXPERIENCE

- Postgraduate teaching** "Introduction to True Basic", a one-week introductory course to the ecological modelling module as part of the MSc Conservation Biology at the University of Cape Town. For the same course, I assisted in lecturing the module "Ecological Modelling" for three years.
- Seven week course including assignments on models in ecology as part of the BWE 424 course in the Department of Conservation Ecology, as well as additional lectures on models in ecology, and I regularly assisted in teaching Leslie Matrix modelling in a module on sustainable harvesting.
- I taught six practicals for the Population and Conservation Ecology undergraduate course at the Stellenbosch University.
- Student supervision** During my PhD I co-supervised an MSc student who investigated seed dispersal in Renosterveld by conducting seed trapping experiments.
- Block course** R introductory R block courses to students from postgraduate to postdoctoral level (between 2 and 3 days)
- Other teaching** Involved in conducting the Tygerberg Olympiad, a project for grade nine to eleven learners, in which they are taught aspects ranging from ecological, legal, archeological aspects concerning the region (Tygerberg). At the end, they are expected to give a short presentation and prizes are handed out.

OTHER EXPERIENCE

During my time at the desert research station Gobabeb (1997 2000), I was involved in conducting participatory workshops with the local communities on fog harvesting and sustainable use of the nara fruit.

PUBLICATIONS

Peer-reviewed Journals

- Krug, R. M., Richardson, D. M., apr 2014. Modelling the effect of two biocontrol agents on the invasive alien tree *Acacia cyclops* — Flowering, seed production and agent survival. *Ecological Modelling* 278, 100–113.
- URL <http://dx.doi.org/10.1016/j.ecolmodel.2014.01.028><http://linkinghub.elsevier.com/retrieve/pii/S0304380014000714><http://www.sciencedirect.com/science/article/pii/S0304380014000714>

- Krug, R. M., Roura-Pascual, N., Richardson, D. M., jul 2010. Clearing of invasive alien plants under different budget scenarios: using a simulation model to test efficiency. *Biological Invasions* 12 (12), 4099–4112.
URL <http://www.springerlink.com/index/E342L4008P462563.pdf><http://www.springerlink.com/content/e342l4008p462563>
- Le Maitre, D. C., Krug, R. M., Hoffmann, J. H., Gordon, A. J., Mgidi, T. N., 2008. *Hakea sericea*: Development of a model of the impacts of biological control on population dynamics and rates of spread of an invasive species. *Ecological Modelling* 212 (3–4), 342–358.
URL <http://www.sciencedirect.com/science/article/pii/S0304380007006059>
- Marques, A., Pereira, H. M., Krug, C., Leadley, P. W., Visconti, P., Januchowski-Hartley, S. R., Krug, R. M., Alkemade, R., Bellard, C., Cheung, W. W. L., Christensen, V., Cooper, H. D., Hirsch, T., Hoft, R., van Kolck, J., Newbold, T., Noonan-Mooney, K., Regan, E. C., Rondinini, C., Sumaila, U. R., Teh, L. S., Walpole, M., oct 2014. A framework to identify enabling and urgent actions for the 2020 Aichi Targets. *Basic and Applied Ecology* 15 (8), 633–638.
URL <http://www.sciencedirect.com/science/article/pii/S1439179114001261><http://linkinghub.elsevier.com/retrieve/pii/S1439179114001261><http://dx.doi.org/10.1016/j.baae.2014.09.004>
- Privett, S. D. J., Krug, R. M., Forbes, G., Gaertner, M., sep 2014. Wild flower harvesting on the Agulhas Plain, South Africa: Impact of harvesting intensity under a simulated commercial harvesting regime for two re-seeding and two re-sprouting fynbos species. *South African Journal of Botany* 94, 270–275.
URL <http://linkinghub.elsevier.com/retrieve/pii/S025462991400129X><http://www.sciencedirect.com/science/article/pii/S025462991400129X>
- Richardson, D., Iponga, D., Roura-Pascual, N., Krug, R., Milton, S., Hughes, G., Thuiller, W., 2010. Accommodating scenarios of climate change and management in modelling the distribution of the invasive tree *Schinus molle* in South Africa. *Ecography* 33 (July), 1049–1061.
URL <http://onlinelibrary.wiley.com/doi/10.1111/j.1600-0587.2010.06350.x/full>
- Roura-Pascual, N., Bas, J. M., Thuiller, W., Hui, C., KRUG, R. M., Brotons, L., 2009a. From introduction to equilibrium: reconstructing the invasive pathways of the Argentine ant in a Mediterranean region. *Global Change Biology* 15 (9), 2101–2115.
URL <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2009.01907.x/full>
- Roura-Pascual, N., Krug, R. M., Richardson, D. M., Hui, C., apr 2010. Spatially-explicit sensitivity analysis for conservation management: exploring the influence of decisions in invasive alien plant management. *Diversity and Distributions* 16 (3), 426–438.
URL <http://www.sciencemag.org/content/312/5781/1715><http://onlinelibrary.wiley.com/doi/10.1111/j.1472-4642.2010.00659.x/full><http://doi.wiley.com/10.1111/j.1472-4642.2010.00659.x>
- Roura-Pascual, N., Richardson, D. M., Chapman, R. A., Hichert, T., Krug, R. M., 2011. Managing biological invasions: charting courses to desirable futures in the Cape Floristic Region. *Regional Environmental Change* 11 (2), 311–320.
- Roura-Pascual, N., Richardson, D. M., Krug, R. M., Brown, A., Chapman, R. A., Forsyth, G. G., Le Maitre, D. C., Robertson, M. P., Stafford, L., van Wilgen, B. W., Wannenburgh, A., Wessels, N., 2009b. Ecology and management of alien plant invasions in South African fynbos: accommodating key complexities in objective decision making. *Biological Conservation* 142, 1595–1604.
- Singer, A., Johst, K., Banitz, T., Fowler, M. S., Groeneveld, J., Gutiérrez, A. G., Hartig, F.,

Krug, R. M., Liess, M., Matlack, G., Meyer, K. M., Pe'er, G., Radchuk, V., Voinopol-Sassu, A.-J., Travis, J. M., dec 2015. Community dynamics under environmental change: How can next generation mechanistic models improve projections of species distributions? Ecological Modelling in press.

URL <http://dx.doi.org/10.1016/j.ecolmodel.2015.11.007><http://linkinghub.elsevier.com/retrieve/pii/S0304380015005281>

Book Chapters

Hui, C., Krug, R. M., Richardson, D. M., 2011. Fifty Years of Invasion Ecology: The Legacy of Charles Elton. Wiley-Blackwell, Oxford, Ch. Models spr, pp. 329–343.

Krug, C. B., Krug, R. M., 2007. Old fields: Dynamics and restoration of abandoned farmland. Island Press / Society for Ecological Restoration, Washington, Ch. Restoratio.

Maertens, B., Henle, K., Kuhn, W., Krug, R. M., Johst, K., Grosse, W.-R., Wissel, C., 1996. Species Survival in Fragmented Landscapes. In: Settele, J., Margules, C., Poschlod, P., Henle, K. (Eds.), Species Survival in Fragmented Landscapes. Vol. 35 of The GeoJournal Library. Springer Netherlands, Dordrecht, pp. 241–247.

URL <http://link.springer.com/10.1007/978-94-009-0343-2>

Marques, A., Krug, C., Regan, E., Bowles-Newark, N., Burgess, N., Visconti, P., Walpole, M., Tittensor, D., Pereira, H., Leadley, P., Krug, R. M., 2014. Integrated Analysis of the 2020 Strategic Goals: Time Lags, Indicators and Interactions. In: Leadley, P., Krug, C., Alkemade, R., Pereira, H., U.R., S., Walpole, M., Marques, A., Newbold, T., Teh, L., van Kolck, J., Bellard, C., Januchowski-Hartley, S., Mumby, P. (Eds.), Progress towards the Aichi Biodiversity Targets: An Assessment of Biodiversity Trends, Policy Scenarios and Key Actions. Secretariat of the Convention on Biological Diversity, Montreal, Canada., Ch. 21, pp. 441–467.

Conference proceedings

Krug, C. B., Krug, R. M., Midoko Iponga, D., Walton, B. A., Milton, S. J., Newton, I. P., Farley, N., Shiponeni, N. N., 2004a. Restoration of West Coast Renosterveld: facilitating the return of a highly threatened vegetation type. In: Arianoutsou, M., Papanastasis, V. P. (Eds.), Ecology, Conservation and Management of Mediterranean Ecosystems. Proceedings of the 10th International Conference on Mediterranean Ecosystems, April 25 – May 1, 2204, Rhodes, Greece. Millpress, Rotterdam, pp. 1–12.

Krug, R. M., Johst, K., Wissel, C., Maertens, B., 1996. Wirkung der räumlichen Heterogenität innerhalb eines Habitats auf die mittlere Überlebensdauer einer Zauneidechsen-Population. Verhandlungen der Gesellschaft fuer Oekologie 26, 447–454.

Krug, R. M., Krug, C. B., Midoko Iponga, D., Walton, B. A., Milton, S. J., Newton, I. P., Farley, N., Shiponeni, N. N., 2004b. Reconstructing West Coast Renosterveld: past and present ecological processes in a Mediterranean shrubland of South Africa. In: Ecology, Conservation and Management of Mediterranean Ecosystems. Proceedings of the 10th International Conference on Mediterranean Ecosystems, April 25 – May 1, 2204, Rhodes, Greece. No. 1999. pp. 1–12.

Krug, R. M., Roura-Pascual, N., Richardson, D. M., 2009. Prioritising areas for the management of invasive alien plants in the CFR: different strategies, different priorities? South African Journal of Botany 75 (2), 408–409.

Roura-Pascual, N., Krug, R. M., Richardson, D. M., 2009. Identifying priority areas for the management of invasive alien plants in the Cape Floristic Region. In: South African Journal of Botany. Vol. 75. p. 439.

Conference presentations Only first author, except invited keynote presentations

- Krug, R. M., 1997. Population size, sample size and Microsatellites. Meeting of the Zoological Society of Southern Africa, Cape Town, South Africa.
- Krug, R. M., 2007. Two Approaches — same Answer? UCT Conference on Biomathematics in Africa, Cape Town, South Africa.
- Krug, R. M., 2011. Spatial modelling with the R-GRASS Interface. The R User Conference, University of Warwick, Coventry, UK.
- Krug, R. M., 2013. Bringing Science to Management: using Simulation- and Scenario-Based Approaches to Guide Decision Making in Invasive Species Management — one tool which can do both. INTECOL - Into the Next 100 Years, London, UK.
- Krug, R. M., Farley, N., Midoko-Iponga, D., Newton, I. P., Shiponeni, N., Walton, B. A., Milton, S. J., 2004. Reconstructing Ecological Processes in West Coast Renosterveld: The Grazers, the Fires and the Humans. Fynbos Forum, Langebaan, South Africa.
- Krug, R. M., Le Maitre, D. C., 2006. An alien invasive species, an agent and experts: A case study of hakea spread and two seed feeding biocontrol agents. UCT Conference on Biomathematics in Africa, Cape Town, South Africa.
- Krug, R. M., Milton, S. J., 2002. Pattern in Vegetation Dynamics: Identification and Application in Modelling Restoration of Old Fields in West Coast Renosterveld. Fynbos Forum 14th – 16th, Rawsonville, South Africa.
- Krug, R. M., Richardson, D. M., 2011. Biocontrol Agents, Aliens and Eneregy. Fynbos Forum: Fynbos and Human Heritage, Still Bay, South Africa.
- Krug, R. M., Richardson, D. M., Le Maitre, D. C., 2012. The Impact of two biological control agents at the landscape scale: implications for management. Fynbos Forum, Port St. Francis, South Africa.
- Krug, R. M., Roura-Pascual, N., Richardson, D. M., 2009a. Prioritising areas for the management of invasive alien plants in the CFR: different strategies, different priorities? 25th Annual Conference of the South African Association of Botanists, Stellenbosch, South Africa.
- Krug, R. M., Roura-Pascual, N., Richardson, D. M., 2009b. Towards More Efficient Management of Invasive Alien Plants in the Cape Floristic Region: Optimising the Priorities. 10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi 10), Stellenbosch, South Afrtica.
- Krug, R. M., Roura-Pascual, N., Richardson, D. M., 2009c. Towards more efficient management of invasive alien plants: Spatial prioritisationse. Diversitas Open Science Conference 2 - Biodiversity and Society, Understanding Connections, Adapting to Change, Cape Town, South Africa.
- Krug, R. M., Roura-Pascual, N., Richardson, D. M., 2009d. Towards more Eficent Management of Invasive Alien Plants (AIPs): Spatial Prioritisation. Fynbos Forum, Bredarsdorp, South Africa.
- Krug, R. M., Roura-Pascual, N., Richardson, D. M., 2016. From Scenarios over Models to Management — Alien Spread Management. International Conference on Scenarios and Models of Biodiversity and Ecosystem Services in Support of Decision Making, Montpellier, France.
- Krug, R. M., Rushworth, I., 2012. Optimising the Use of and Motivating for Funding - one tool which can do both. Ezemvelo KZN Wildlife Symposium on Contemporary Conservation Practice, Howick, South Africa.
- Krug, R. M., Wiegand, T., Milton, S. J., 2003. Optimal Patch Size for Restoration of Renosterveld? A Seeds View. Fynbos Forum, Hartebos, South Africa.

Rushworth, I., Krug, R. M., 2016. Integrating Scenarios and Models into Ecosystem Management: an example from the Maloti-Drakensberg Park World Heritage Site, South Africa. International Conference on Scenarios and Models of Biodiversity and Ecosystem Services in Support of Decision Making, Montpellier, France.

Software Packages

Krug, R. M., Eddelbuettel, D., 2009. earthmovdist: Wrapper to the Emd-L1 library by Haibin Ling and Kazunori Okada.
URL <http://earthmovdist.r-forge.r-project.org/>

Guest lectures

Krug, C. B., Krug, R. M., 2004. West Coast Renosterveld: Ökologische Prozesse und Restaurierung (West Coast Renosterveld: Ecological Processes and Restoration).

Krug, R. M., 2004. Ecological Modelling — A Taxonomy.

Krug, R. M., 2013. Bringing Science to Management: using Simulation- and Scenario-Based Approaches to Guide Decision Making in Invasive Species Management — one tool which can do both. Helmholtz Zentrum für Umweltforschung, UFZ Halle.