CV Rainer M. Krug

Personal Details

Name Rainer M. Krug

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Year of birth 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

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 – **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

Spatial modelling of pattern and processes on regional to local scale

I am interested in ecological modelling, particularly ecological modelling and its integration and interaction with field experiments and data. My main interest lies in the field of processes and pattern description and analysis which processes cause pattern and how pattern influence the processes. These pattern and processes can range from population to ecosystem levels.

More specifically, I am interested in the functioning of ecosystems and the dynamics of populations and communities which processes and disturbances are essential in maintaining the dynamics? How do they react to changes in e.g. the frequency or intensity of these processes? Which processes and disturbances are essential in maintaining certain pattern in the system? Which role does dispersal play in the maintenance of these systems?

To answer these questions, it is important to combine field work with ecological simulation models of different complexity in all stages of the project from the planning of the experiments to the analysis of the field data and the identification of important parameter and processes.

Scenarios and Models on local scales

The combined usage of scenarios and models is a very powerful approach to assess impacts of changes on properties of the simulated system, like ecosystem health and functioning or ecosystem services. The main focus of research involving Scenarios and Models has been on global and regional scale and aimed ad policy. But the local scale is missing which gives a wide range of very interesting research topics and problems. These include scaling from global and regional to local as on local scale different processes have to be included; local dynamics which can link global scenarios (e.g. climate change) to effects on the local scale for populations, communities and ecosystems; addressing of management questions in the context of different budget scenarios as well as

environmental (e.g. climate change) and social scenarios (population growth or change in behaviour);

Linking and implementing simulation models in management and policy

Essential is for me the close integration of theoretical models and field work and field data. Models can help to plan experiments, determine sample sizes needed, simplifying experiments. Field experiments can enhance and simplify models and validate results obtained in ecosystem models. These simplified but valid models can be used to address conservation and policy related questions.

To link management into the models developed to be able to provide applicable feedback to managers, is an important aspect for me, as well as the close co-operation with managers during all phases of the project. This approach, coupled with a close co-operation with field biologists, makes it possible, that the results of the projects are not only scientifically interesting, but also have an impact on the management practices.

Using open source tools to develop models

All my simulation models and analysis use only Open Source software. This includes R for analysis and writing my simulations, GRASS and QGIS as GIS programs, which I also use in my simulations (GRASS). This approach of only using Open Source software, provides the flexibility to develop the simulation models and analysis protocols, 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 purchased specific software.

In addition, the use of open source tools and making the code of the models available enables reproducible research in a way that the same data can be analysed using the same scripts again at a later stage.

To make my research even more reproducible and transparent, I started using virtualisation technologies (Docker) to have the complete analysis and simulation environment in one container (including operating system) which can be re-used anytime a re-analysis of the same or new data becomes necessary.

Research

08/2015 – 09/2015 **Laboratoire Ecologie, Systematique et Evolution, Paris Sud**

Analyze measured vertical wind profiles to improve the performance of a forest growth model (CASTANEA) in regards to energy balance.

11/2014 – 12/2014 **Laboratoire Ecologie, Systematique et Evolution, Paris Sud**

Develop proof of concept for assessing multi species forest community productivity. This was done in co-operation with

09/2013 – 11/2013 **Laboratoire Ecologie, Systematique et Evolution, Paris Sud**

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. This included adding of new species and modification of processes parameter. The final product was a framework for further development.

2008 – 2012 **DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University**

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.

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.

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.

Assessing the viability of pine plantations under different (and changing) fire regimes using a basic modelling approach.

2008 – 2012 DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University

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.

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.

Investigating the spread of invasive species under different climate change scenarios.

Assessing the viability of pine plantations under different (and changing) fire regimes using a basic modelling approach.

2007 – 2008 Plant Conservation Unit, University of Cape Town

Analyzing the population dynamics of *Aloe pillansii*, a tree aloe, with focus on the recruitment events and their reconstruction.

2000 – 2007 Conservation Ecology and Entomology department, Stellenbosch University

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.

1996 – 1997 **Percy FitzPatrick Institute of African Ornithology, University of Cape Town**

Investigated the genetic heterogeneity of three populations of African Buffalo using microsatellites

GIS based conservation planning exercise in which species presence absence data was used to identify areas most relevant for conservation.

Participated in analysis of the financial value of the Good Hope Environmental Education Centre.

1995 – 1995 **Department of Physics, Philipps-Universität Marburg** Developin of a simulation model focussing on the effect of habitat use on the mean survival time of populations. In co-operation with a biologist who was involved in the planning of the project and in the formulation of the questions.

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 LaTeX; 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 home language

English reading, writing and speaking fluent

French reading, writing and speaking fair

Grants

2009 – 2010 NRF Freestanding Postdoctoral Fellowship awarded

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

1997 – 2007 "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.

2004 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.

In addition, I taught six practicals for the Population and Conservation Ecology undergraduate course at the Stellenbosch University.

During my PhD I co-supervised an MSc student who investigated seed dispersal in Renosterveld by conducting seed trapping experiments.

2007, 2008 and 2009 R introductory R block courses to students from postgraduate to postdoctoral level (between 2 and 3 days each).

2008 and 2009 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 prices 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.2014.01.028http://linkinghub.elsevier.com/retrieve/pii/S0304380014000714http://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.pdfhttp://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/S1439179114001261http://linkinghub.elsevier.com/retrieve/pii/S1439179114001261http://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/S025462991400129Xhttp://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/312/5781/1715http://onlinelibrary.wiley.com/doi/10.1111/j.1472-4642.2010.00659.x/fullhttp://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.2015.11.007http://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 raeumlichen Heterogenitaet innerhalb eines Habitats auf die mittlere Ueberlebensdauer 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 Eficient 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.