

# CV Rainer M. Krug

## PERSONAL DETAILS

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<b>Year of birth</b>	1968
<b>Civil status</b>	married, one daughter

## QUALIFICATIONS

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### 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.

## TODO RESEARCH

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2015 – TODO Castanea

11/2014 – TODO Forest Productivity I was involved in a project assessing the

09/2013 – 11/2013 TODO

2010 – **DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University**

Spatial and temporal dynamics of biocontrol agents and their target species on a landscape scale and implications for alien invasive species management .

The project investigates 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. This study will enable us 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. This understanding enables us to devise release- and relocation-strategies for the biocontrol agent(s) that minimise the effort involved and at the same time maximises the impact of the biocontrol agent. Results arising from the project will be used to inform implementing agencies and will be communicated in the form of guidelines and workshops.

2008 – 2011 **DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University**

Spatial as well as non-spatial and temporal dynamics of selected biocontrol agents and their hosts. The study addresses the dynamics resulting from a single biocontrol agent based on the dispersal ability of the agent, as well as the dynamics resulting from the introduction of multiple biocontrol agents.

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 prioritising, 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.

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. I have developed rule-based simulation models based on data collected in the field and experts estimates to predict the rate of spread of a species depending on dispersal ability, competition experienced in establishment, and the effects of biocontrol agents.

**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. It included, among others, questionnaires to tourists and schools concerning their willingness of paying to visit the centre.

**1995 – 1995**    **Department of Physics, Philipps-Universität Marburg** Developed simulation model focussing on the effect of habitat use on the mean survival time of populations. This research was conducted in co-operation with a biologist who was involved in the planning of the project and in the formulation of the questions. Building a simulation model of the population investigated provided important insights in the importance of different habitat types for the survival and conservation of the species.

## WORK EXPERIENCE

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**08/2011 –**                      Research Associate at the NRF-DST Centre of Excellence for Invasion Biology.

**06/2008 – 06/2008**        Postdoctoral Research Fellow at the NRF-DST Centre of Excellence for Invasion Biology, hosted by Prof. Dave Richardson.

**06/2007 – 06/2008**        Postdoctoral Research Fellow at the Plant Conservation Unit, University of Cape Town, hosted by Prof. Timm Hoffman, and at the DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch University, hosted by Prof. Dave Richardson.

## ADDITIONAL SKILLS

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**Computer**    **Operating System** Expert user and basic Linux administrator; advanced Windows user

**Programming Languages** Extensive experience in programming in R, Delphi / Pascal; basic understanding and usage of C

**Programs** Extensive experience in R, GRASS; Office programs; LyX / L<sup>A</sup>T<sub>E</sub>X for writing; basic experience of Arc-GIS

**Language**    **German** home language  
**English** reading, writing and speaking fluent  
**French** reading, writing and speaking fair

## GRANTS

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**1996 – 1997**    Deutscher Akademischer Austauschdienst (DAAD: German Academic Exchange Service) grant to attend MSc in Conservation Biology course at UCT.

**1999 – 2000**    Deutscher Akademischer Austauschdienst (DAAD: German Academic Exchange Service) grant to conduct fieldwork for PhD at Gobabeb, Namibia.

**2009 – 2010**    NRF Freestanding Postdoctoral Fellowship awarded

## TODO AREAS OF INTEREST AND EXPERTISE

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I am interested in theoretical ecology, 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.

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 related questions.

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.

My PhD focused on the role of seed dispersal in restoration and biological invasion, the effects of alien vegetation on the establishment of indigenous species and the effects of biocontrol agents on the spread of invasive species. This involved developing rule-based simulation models reflecting the seed dispersal and plant distributions observed in the field, and making predictions of the spread of species under different scenarios. The model was written in Delphi.

A recent research focus was on population dynamics and reconstructing the age structure of populations of *Aloe pillansii*, spatial dynamics of alien invasive plants and the interaction with different management strategies, including biocontrol. My latest projects (spatial and temporal dynamics) combine the field of ecological modelling with spatial statistics, as the development of simulation models as well as the comparison of different spatial pattern is essential to them.

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 practises.

In the field of statistics, I am interested in resampling methods and I employed a bootstrapping approach in the analysis of seed dispersal data. Data arising from the simulations are all analysed in the statistical package R, using a range of different functions and modules. I have written numerous scripts in R to aid with data analysis and presentation. I also wrote a package for R implementing the Earth Movers Distance based on an implementation in C++ by Haibin Ling and Kazunori Okada.

All my simulation models and analysis use only Open Source software. This includes Linux as the operating system of choice, 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 the code without limitations and without having to purchased specific software.

## TEACHING EXPERIENCE

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From 1997 – 2007, I taught the module “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.

In 2004, I taught a 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.

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

In 2008 and 2009 I was 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

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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.

In addition to the standard software, I do have experience in different GIS applications (ArcGIS, ArcView, GRASS, QGIS), R (extensive usage for analysis and programming of simulations, basic development of packages), the programming language Delphi (used as the modelling language for my PhD) and Turbo Pascal (used for my MSc in Physics), Open Office. I have extensive experience in Linux and I am strongly in favour of using Open Source instead of proprietary software.

## PUBLICATIONS

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### 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. Survival of the sand lizard (*Lacerta agilis* Linnaeus, 1758) (Sauria, Lacertidae) in relation to habitat quality and heterogeneity. *Species Survival in Fragmented Landscapes* (ISBN 079 234 2399), 241–247.

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 für Ökologie* 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, 2004, 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.

### 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.