CV Rainer M. Krug

Personal Details

Name	Rainer M. Krug
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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

03/2017 – present **Department of Evolutionary Biology and Environmental Studies, University Zürich**

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.

Other Positions / Roles

2017 – 2019	IPBES Chapter Scientist of the chapter 4 of the IPBES Global Assessment
2019 – present	Expert Member of the **IPBES Knowledge and Data Task Force**, nominated by Switzerland.
2021	Member of Policy Network on Environment (PNE), Intersessional workstream of the Internet Governance Forum (IGF)

Areas of Interest and expertise

Keywords open source tools; data and metadata management; ecological modelling; statistical computing; combined modelling and experimental approaches; invasive species management; spatial pattern analysis; decision support

Research My current focus of work is in the field of data management, metadata management, workflows and data archival. Recent activities include development of a framework for continuous data analysis and archival which is used by an ongoing project (moved from development into usage and maintenance stage); development of data management guidelines for our working group (ongoing), development of a domain specific metadata scheme to make entering and useful metadata as easy as possible for the researcher while at the same providing all the information needed for a useful re-use of the archived data; management of the large scale literature review of the IPBES Global Assessment Chapter 4, including data collection, quality control, analysis, graphing and archival (finalising).

My previous research interest and focus is on 1) spatial modelling 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 mod-

els, 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.

All the simulation and analysis tools I use (and nearly all of the ones I used) are Open Source software (R, GRASS GIS, QGIS). This provides the flexibility to develop the simulation models and analysis protocols and pipelines without additional costs, distribute them freely and to enable others (scientists as well as other implementing agencies and usrs) to use and evaluate the code without limitations and without having to purchased 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).

IT During my research activities I obtained a broad expertise in programming in different languages, linking these through e.g. scripting to into automated process and data work flows, setting up and usage of virtual computing platforms (most recently S3IT Science Cloud) including docker, and virtual machines, setting up and maintenance of small MySQL and sqlite databases as well as SAMBA servers and trouble shooting of a wide variety of software as well as hardware problems. In addition, I maintain number of R packages for internal as well as public usage.

Since I started in Zürich, a substantial part of my work involved research support, ranging from informal discussion on how workflows and scripts could be improved in regards to speed and data management / reproducibility aspects, designing and writing R packages to simplify or automate workflows up to designing workflows which use different computing platforms to the actual management of research data to finally submitting it to Zenodo for long term preservation.

During my career I was using different operating systems (in chronological order Windows, Linux, Mac) and obtained Expert knowledge of each. My daily OS is Mac and Linux.

Data Management In my role as an elected expert member of the Knowledge and Data Task Force of IPBES, I was leading the development of the first IPBES data management policy as well as, at the moment, leading the revision and continuing review of the policy to include aspects not included in traditional data management policies such as aspects specifically related to indigenous and local knowledge. In addition, I am involved in the development of educational material to facilitate the implementation of the policy, drafting of a data management vision for IPBES, and other activities concerning data management.

In my work in the Policy Network on Environment (PNE) (Internet Governance Forum) I successfully promoted the FAIR use of data (Findable, Accessible, Interoperable and Reusable) as well as the CARE principles (Collective benefits, Authority of control, Responsibility and Ethics) to be included in the recommendations. Caused by the overall positive acceptance of the report, it was decided to continue the work in a Dynamic Coalition (https://www.intgovforum.org/en/content/dynamic-coalitions) which I am part in establishing it.

Research Projects

- Development of an R package for running a simulation reproducible as well as support for graphing of the results.
- Development and maintenance of an automatic data preparation and pre-processing pipeline to extract from regularly measured data and movies (every second day) research ready as well as preservation ready data (open formats). The whole pipeline is implemented in a completely reproducible way (open code, docker, makefiles).
- Development of a data management strategy for our research group and of tools to facilitate the provision and improve the quality of metadata.
- Predictions in Chaotic systems
- Management of the Literature Analysis (**IPPBES Global Assessment Chapter 4**) and the generated data and the Excel Database in a reproducible way for archiving as well as graphing of the results.
- Analyse measured vertical wind profiles to improve the performance of a forest growth model (CASTANEA) in regards to energy balance
- Modelling temporal and spatial dynamics of a range of different different alien species, alien control agents and management strategies
- Optimising alien invasive plant management through modelling of temporal and spatial modelling
- Modelling the role of seed dispersal in restoration and biological invasion

Additional skills

Computer	**Operating System** Expert Linux and Mac user; advanced Windows user
	Programming Languages Extensive experience in programming in R, Delphi / Pascal; basic usage of C and LaTeX
	Programs Extensive experience in R, GRASS, bash; Daily BBEdit user; Apple office programs; MS Office programs; basic experience of QGIS and ArcGIS
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.

Publications

Data publication are not included. For an autogenerated list of the all publications see https://orcid.org/0000-0002-7490-0066

Peer-reviewed Journals

Krug, R.M., Petchey, O.L., 2021. Metadata Made Easy: Develop and Use Domain-Specific Metadata Schemes by following the dmdScheme approach. Ecology and Evolution 11, 9174–9181. doi:10.1002/ece3.7764.

Krug, R.M., Richardson, D.M., 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. doi:10.1016/j.ecolmodel.2014.01.028.

Krug, R.M., Roura-Pascual, N., Richardson, D.M., 2010. Clearing of invasive alien plants under different budget scenarios: Using a simulation model to test efficiency. Biological Invasions 12, 4099–4112. doi:10.1007/s10530-010-9827-3.

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, 342–358. doi:10.1016/j.ecolmodel.2007.11.011.

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., 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., 2014. A framework to identify enabling and urgent actions for the 2020 Aichi Targets. Basic and Applied Ecology 15, 633–638. doi:10.1016/j.baae.2014.09.004.

Martinez-Harms, M.J., Gelcich, S., Krug, R.M., Maseyk, F.J.F., Moersberger, H., Rastogi, A., Wambugu, G., Krug, C.B., Spehn, E.M., Pascual, U., 2018. Framing natural assets for advancing sustainability research: Translating different perspectives into actions. Sustainability Science doi:10.1007/s11625-018-0599-5.

Privett, S., Krug, R., Forbes, G., Gaertner, M., 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. doi:10.1016/j.sajb.2014.06.015.

Richardson, D.M., Iponga, D.M., Roura-Pascual, N., Krug, R.M., Milton, S.J., Hughes, G.O., 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, 1049–1061. doi:10.1111/j.1600-0587.2010.06350.x.

Roura-Pascual, N., Bas, J.M., Thuiller, W., Hui, C., Krug, R.M., Brotons, L., 2009. From introduction to equilibrium: Reconstructing the invasive pathways of the Argentine ant in a Mediterranean region. Global Change Biology 15, 2101–2115. doi:10.1111/j.1365-2486.2009.01907.x.

Roura-Pascual, N., Krug, R.M., Richardson, D.M., Hui, C., 2010. Spatially-explicit sensitivity analysis for conservation management: Exploring the influence of decisions in invasive alien plant management: Sensitivity analysis of decision-support models. Diversity and Distributions 16, 426–438. doi:10.1111/j.1472-4642.2010.00659.x.

Roura-Pascual, N., Richardson, D.M., Arthur Chapman, R., Hichert, T., Krug, R.M., 2011. Managing biological invasions: Charting courses to desirable futures in the Cape Floristic Region. Regional Environmental Change 11, 311–320. doi:10.1007/s10113-010-0133-5.

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., 2009. Ecology and management of alien plant invasions in South African fynbos: Accommodating key complexities in objective decision making. Biological Conservation 142, 1595–1604. doi:10.1016/j.biocon.2009.02.029.

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., 2016. Community dynamics under environmental change: How can next generation mechanistic models improve projections of species distributions? Ecological Modelling 326, 63–74. doi:10.1016/j.ecolmodel.2015.11.007.

Book Chapters

Hui, C., Krug, R.M., Richardson, D.M., 2010. Modelling Spread in Invasion Ecology: A Synthesis, in: Richardson, D.M. (Ed.), Fifty Years of Invasion Ecology. Wiley-Blackwell, Oxford, UK, pp. 329–343.

Krug, C.B., Krug, R.M., 2007. Restoration of old fields in Renosterveld : A case study in a Mediterranean-type shrubland of South Africa, in: Cramer, V.A., Hobbs, R.J. (Eds.), Old Fields: Dynamics and Restoration of Abandoned Farmland. Island Press, Washington. The Science and Practice of Ecological Restoration.

Maertens, B., Henle, K., Kuhn, W., Krug, R., Jost, 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, in: Species Survival in Fragmented Landscapes. Springer Netherlands, Dordrecht, pp. 241–271.

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., pp. 441–467.

Conference proceedings

Krug, C.B., Krug, R.M., Iponga, D.M., Walton, B.A., Milton, S.J., Shiponeni, N.N., 2004a. Restoration of West Coast Renosterveld: Facilitating the return of a highly threatened vegetation type , 12.

Krug, R., Roura-Pascual, N., Richardson, D., 2009. Prioritising areas for the management of invasive alien plants in the CFR: Different strategies, different priorities? South African Journal of Botany 75, 408–409. doi:10.1016/j.sajb.2009.02.072.

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 .

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. Ecology, Conservation and Management of Mediterranean Ecosystems. Proceedings of the 10th International Conference on Mediterranean Ecosystems, April 25 – May 1, 2204, Rhodes, Greece. , 1–12.

Roura-Pascual, N., Krug, R., Richardson, D., 2009. Identifying priority areas for the management of invasive alien plants in the Cape Floristic Region. South African Journal of Botany 75, 439. doi:10.1016/j.sajb.2009.02.161.

Conference presentations Only first author, except invited keynote presentations

Krug, R., Roura-Pascual, N., Richardson, D., 2009a. Prioritising areas for the management of invasive alien plants in the CFR: Different strategies, different priorities? South African Journal of Botany 75, 408–409. doi:10.1016/j.sajb.2009.02.072.

Krug, R.M., a. Bringing Science to Management: Using Simulation- and Scenario-Based Approaches to Guide Decision Making in Invasive Species Management — one tool which can do both.

Krug, R.M., b. Population size, sample size and Microsatellites.

Krug, R.M., 2007. Two Approaches — same Answer?

Krug, R.M., 2011. Spatial modelling with the R-GRASS Interface.

Krug, R.M., Le Maitre, D.C., Richardson, D.M., 2012. The Impact of two biological control agents at the landscape scale: Implications for management.

Krug, R.M., Petchey, O.L., 2019a. MetaData can be easy!

Krug, R.M., Petchey, O.L., 2019b. MetaData made easy!

Krug, R.M., Richardson, D.M., 2011. Biocontrol Agents, Aliens and Energy.

Krug, R.M., Roura-Pascual, N., Richardson, D.M., 2009b. Towards more efficient management of invasive alien plants: Spatial prioritisationse.

Krug, R.M., Roura-Pascual, N., Richardson, D.M., 2009c. Towards more Eficient Management of Invasive Alien Plants (AIPs): Spatial Prioritisation.

Krug, R.M., Roura-Pascual, N., Richardson, D.M., 2016. From Scenarios over Models to Management — Alien Spread Management.

Le Maitre, D.C., Krug, R.M., 2006. An alien invasive species, an agent and experts: A case study of hakea spread and two seed feeding biocontrol agents.

Milton, S.J., Krug, R.M., 2002. Pattern in Vegetation Dynamics: Identification and Application in Modelling Restoration of Old Fields in West Coast Renosterveld.

Milton, S.J., Krug, R.M., Newton, I.P., Farley, N., Midoko-Iponga, D., Shiponeni, N., Walton, B.A., . Reconstructing Ecological Processes in West Coast Renosterveld: The Grazers, the Fires and the Humans.

Milton, S.J., Wiegand, T., Krug, R.M., 2003. Optimal Patch Size for Restoration of Renosterveld? A Seeds View.

Roura-Pascual, N., Richardson, D.M., Krug, R.M., 2009. Towards More Efficient Management of Invasive Alien Plants in the Cape Floristic Region: Optimising the Priorities.

Rushworth, I., Krug, R.M., 2012. Optimising the Use of and Motivating for Funding - one tool which can do both.

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.

Software Packages

Krug, R.M., Eddelbuettel, D., . Earthmovdist: Wrapper to the Emd-L1 library by Haibin Ling and Kazunori Okada.

Krug, R.M., Petchey, O.L., 2019a. dmdScheme: An r Package for Working with Domain Specific MetaData Schemes. doi:10.5281/zenodo.3581970.

Krug, R.M., Petchey, O.L., 2019b. emeScheme: A Package for Working with Ecological Microbial Experimental MetaData. Zenodo. doi:10.5281/zenodo.1544945.

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.