

A photograph of a penguin, likely a Cape penguin, standing on a sandy beach. The penguin has a white body with a prominent black band across its chest and a black cap with a white stripe. It is looking slightly to the right. The background is a bright, sandy beach with some sparse vegetation.

Centre for Statistics in Ecology, Environment and Conservation Report 2015

University of Cape Town

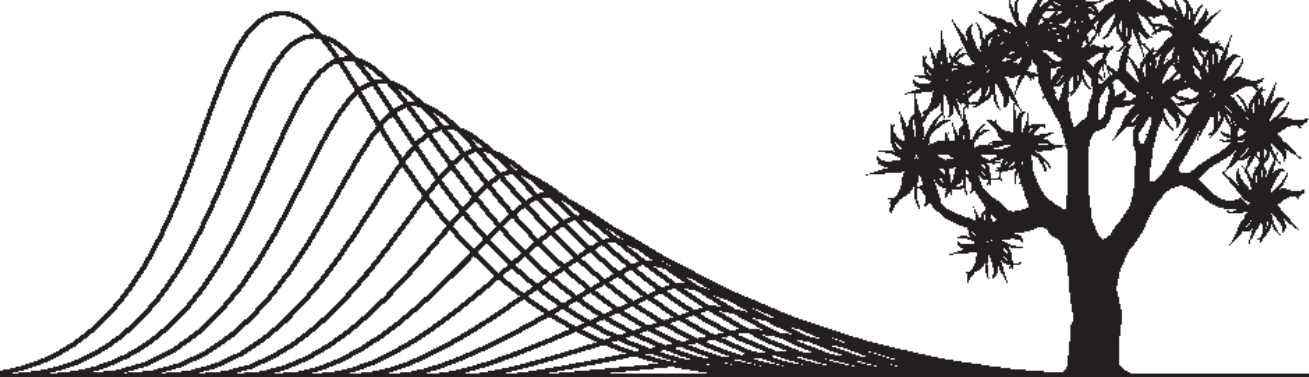


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SEEC - Statistics in Ecology, Environment and Conservation

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1. Summary

1.1 Summary

The Centre for Statistics in Ecology, the Environment and Conservation (SEEC) was founded in January 2014 with the aim to bring together statisticians and ecologists to work on pressing environmental problems. 2015 was the second year of existence for the group, which consisted of 19 academic core members, 12 postdocs, 12 PhD students and 7 MSc students. Our research led to 41 publications in peer-reviewed international journals, and we raised \sim R 3.5 Mio of funding, mostly in the form of postdoctoral fellowships and student bursaries from various sources. We hold regular research meetings and an annual student symposium. A large proportion of the academics' time is also spent teaching at various levels. We feel that we have had a successful year and the group has been recognised as a source of sound research as shown by the publication outputs and the various collaborations within UCT, nationally and internationally. Nevertheless, we feel that we still have a lot of underused potential for further synergies within the group and the challenge for the coming years will be to bring this potential to bear on some of the most important ecological and environmental problems.

1.2 Our goals

- To be the leading group in statistical ecology and environmental analytics within South Africa
- To provide a hub connecting statisticians and biological / environmental scientists to ensure that the most important environmental questions are addressed with cutting edge statistical methods
- To develop methods that link data analysis and modelling into the conservation planning and management process

1.3 The team

1.3.1 Core team

Fitsum Abadi	University of the Witwatersrand
Res Altwegg	UCT, Statistical Sciences (director)
Laura Blamey	UCT, Biological Sciences
David Borchers	University of St Andrews, SEEC Honorary Research Associate (HRA)
Allan Clark	UCT, Statistical Sciences
Jonathan Colville	South African National Biodiversity Institute, SEEC HRA
Greg Distiller	UCT, Statistical Sciences
Ian Durbach	UCT, Statistical Sciences
Birgit Erni	UCT, Statistical Sciences
Astrid Jarre	UCT, Biological Sciences
Sue Kuyper	UCT, Administrator
Iain MacDonald	UCT, Actuarial Sciences
David Maphisa	South African National Biodiversity Institute, SEEC HRA
Guy Midgley	Stellenbosch University
Peter Ryan	UCT, Biological Sciences
Jasper Slingsby	South African Environmental Observation Network, SEEC HRA
Les Underhill	UCT, Biological Sciences
Melvin Varughese	UCT, Statistical Sciences
Vernon Visser	UCT, Statistical Sciences
Henning Winker	South African National Biodiversity Institute, SEEC HRA

1.3.2 Advisory board

SEEC has an advisory board consisting of Bob Scholes (University of the Witwatersrand), John Donaldson (South African National Biodiversity Institute), Francesca Little (UCT, HOD Statistical Sciences), Anusuya Chinsamy-Turan (UCT, HOD Biological Sciences, 2015), Muthama Muasya (UCT, HOD Biological Sciences, 2016), Anton Le Roex (UCT, Dean of the Science Faculty).

1.3.3 Postdocs

Yahkat Barshep	Biological Sciences
Raquel Garcia	Statistical Sciences
Tess Gridley	Statistical Sciences
Sanet Hugo	Statistical Sciences
Natasha Karenyi	Statistical Sciences
Silvia Mecenero	University of the Western Cape <i>and</i> South African National Biodiversity Institute
Theoni Photopoulou	Statistical Sciences
Chevonne Reynolds	Biological Sciences
Francis Strobbe	Statistical Sciences <i>and</i> South African National Biodiversity Institute
Petra Sumasgutner	Biological Sciences
Kate Watermeyer	Biological Sciences
Florian Weller	Biological Sciences

1.3.4 Postgraduate students

PhD

Gordon Botha	Statistical Sciences
Marc Burman	Biological Sciences
Allan Clark	Statistical Sciences
Greg Distiller	Statistical Sciences
Greg Duckworth	Statistical Sciences
Dorine Jansen	Statistical Sciences, handed in Feb 2016
David Maphisa	Statistical Sciences, graduated December 2015
Alecia Nickles	Statistical Sciences
Chris Oosthuizen	University of Pretoria
Etienne Pienaar	Statistical Sciences
Kim Stevens	Biological Sciences
Zingfa Wala	Biological Sciences

MSc

Francois Becker	Statistical Sciences
Danielle Boyd	Statistical Sciences
Jessie Berndt	Biological Sciences, graduated June 2015
Francisco Cervantes Peralta	Statistical Sciences
Yolokazi Galada	Biological Sciences
Kyle Lloyd	Biological Sciences, handed in Feb 2016
Ariella Rink	Statistical Sciences

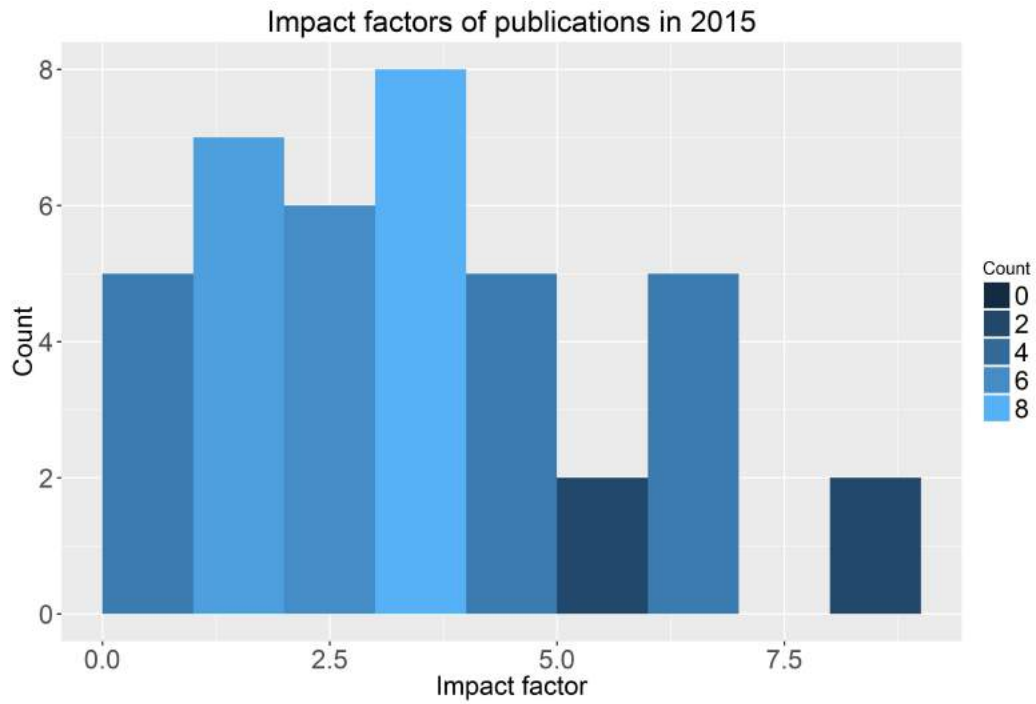


2. Research

We have broad research interests at the intersection between statistics and ecology / environmental sciences, with decision support as an overarching theme. Nature conservation and using biodiversity sustainably requires complex decisions to be made on incomplete information, and under other types of uncertainty. We believe that the best way to tackle important problems in this field is through collaboration between scientists with broad interest and expertise along the axes from good system knowledge to pure statistics and mathematical modelling. SEEC has now existed for two years and most of our research outputs still reflect projects that were initiated before SEEC became an official research group. Our challenge over the coming years will be to bring our expertise to bear on projects that draw on the strengths of several group members to achieve goals that none of us would have been able to do in isolation.

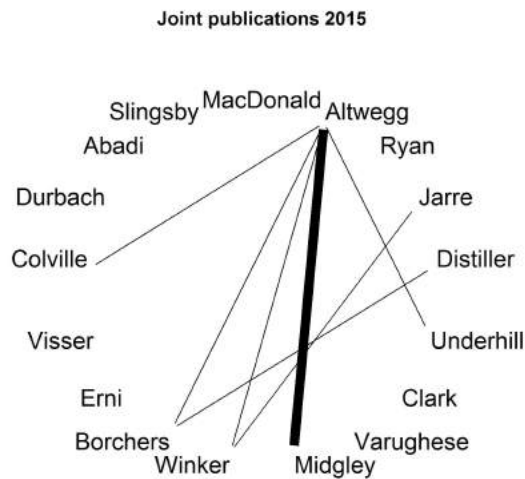
2.1 Research performance

SEEC members published an impressive 41 publications in 2015 (See the publications list at the end of this report). A number of these publications were in high impact journals such as *Global Change Biology*, *Methods in Ecology and Evolution* and *Global Ecology and Biogeography*. The figure below shows SEEC publications for 2015 and their associated impact factors. The median impact factor of these publications was a relatively high 3.234.



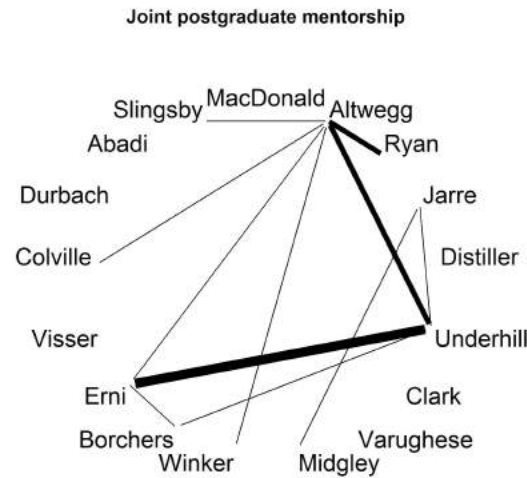
2.2 Co-publication

As a measure of current collaboration within the core team, we plotted 2015 publications that were co-authored between SEEC core members. In the figure below, each line between team member’s names represent joint publications. The thin lines are one publication; the thick line represents two publications.



2.3 Co-supervision

Similarly, we plotted co-supervision of postgraduate students (MSc and PhD). Thin lines connecting team member's names indicate joint supervision of one student; intermediate lines represent co-supervision of two students and the thick line represents co-supervision of three students.



2.4 SEEC student symposium 2015

The 2015 SEEC student symposium was held at the UCT Research Office at Cormack House in Mowbray on Friday 16 October, and was well attended by postgraduate students, postdoctoral researchers, staff, and a few visitors. The symposium is intended to give SEEC postgraduate students and postdocs experience in conference presentation, and an opportunity to discuss their work.

Res Altwegg opened the event, and highlighted the objectives of SEEC – to bring together field ecologists, statistical ecologists and mathematical statisticians and to promote collaborative research and supervision. SEEC's vision is to produce world-class relevant and useful research that is statistically and ecologically sound.

The talks all highlighted the importance of using appropriate statistical tools to describe ecological systems. The impact of ecological research on environmental management decisions and policy development – particularly on the key issues of rapid climate change, land use change and loss of biodiversity – depends on the quality of the research process, from start to end – hypotheses, sampling and data, analytical methods, results and synthesis.

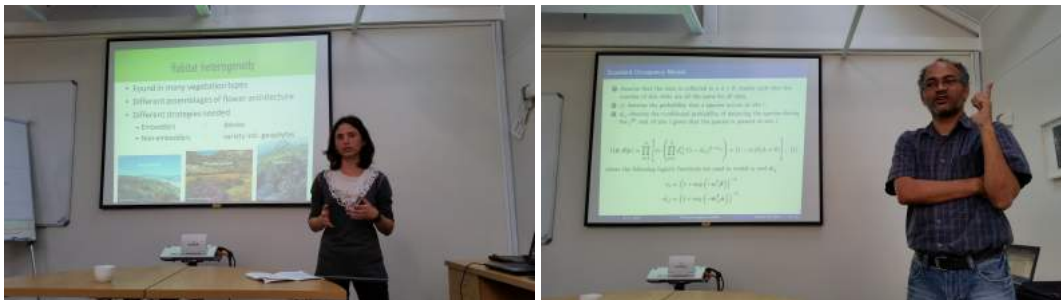
The scope of the talks highlighted these objectives, and covered all aspects of the research process. Subjects included:

- The role of grazing and fire in grassland management in South Africa
- Pair-bonding dynamics in wandering albatross populations
- Geelbek (cape salmon) population spatial dynamics in relation to commercial fishing
- The impacts of protected areas on common bird species
- The range and populations of the rare and threatened Rose's mountain toadlet in the Table Mountain National Park

- The effects of climate change on barn swallows (long-distance Palearctic migrants) in South Africa
- Sexual and natural selection as drivers of diversity in monkey beetles
- Continuous-time spatial capture-recapture models
- Approximate Bayesian methods for occupancy models.

Studies in all stages of academic progress were presented, from early-stage Master's and PhD projects to theses and post-doc papers in various degrees of completion. Michael Schaub of the Swiss Ornithological Institute closed the symposium with a highly interesting plenary talk discussing his work on modelling immigration dynamics in bird populations.

There was time for questions after each talk and lively discussion during the breaks. This second SEEC symposium built on the success of the first symposium held at Kirstenbosch in 2014, and we look forward to the next one. Special thanks go to Sue Kuyper for planning and coordinating the event, venue and catering.



2.5 SEEC members activities during 2015

Greg Distiller

My primary research goal for 2015 has been to complete my PhD which is on continuous-time spatially explicit capture-recapture (secr) models. I have reached the end of the actual research and aim to write everything up by early 2016. In addition, I (together with my supervisor Prof David Borchers) have had a paper accepted for publication in *Ecology and Evolution* that outlines how the continuous-time secr framework leads to a proper likelihood for single-catch traps that has proven elusive when using the traditional discrete-time models.

David Borchers

My research over the past year has focussed on developing distance sampling and spatial capture-recapture methodology. Distance sampling methods have been developed to (i) use times-to-detection to deal with responsive movement prior to detection (manuscript submitted to *Biometrics*), (ii) deal with stochastic animal availability (paper in *Biometrics*), and (iii) develop a general modelling framework for distance sampling that includes random effects (paper in *JABES*). I also did a review of estimation methods when detection at distance zero is less than certain (paper in *Methods in Ecology and Evolution*). Spatial capture-recapture method developments include (i) (with Greg Distiller) a method to deal with single-catch traps (paper in *Ecology and Evolution*), (ii) deriving a general framework for acoustic spatial capture-recapture surveys (paper in *Methods in Ecology and Evolution*), and (iii) developing a new, more efficient Bayesian inference method for spatial and other capture-recapture methods (paper to *Annals of Applied Statistics*). Current work includes (1)

developing spatial modelling methods for use with distance sampling and spatial capture-recapture data, using integrated nested Laplace approximation, (2) developing methods of dealing with recapture uncertainty on capture-recapture surveys, and (3) developing methods for density estimation of marine mammals and birds from aerial video survey data. Current projects include estimation from camera-trap data of jaguars in Belize, leopards in the Kruger Park and rats in New Zealand, from acoustic surveys of frogs in the Western Cape and gibbons and green peafowl in Southeast Asia, from shipboard surveys of dolphins and whales in the eastern tropical Pacific, and aerial surveys of harbour porpoise in the North Sea and of beluga whales off west Greenland.

Birgit Erni

I continued working on methods for estimating trends in time series (water bird counts, environmental time series), using state-space models, particle filters, dynamic factor analysis. My second ongoing research project is maintenance of the R moult package and collaboration with researchers studying moult in birds.

Jasper Slingsby

While I have a lot on the go at the [SAEON Fynbos Node](#), and various students and postdocs at UCT and Stellenbosch University, my personal goals for 2015 have been honing my skills in handling and analysing spatial data in R. More and more of the projects I am involved in have a spatial component and it is increasingly desirable to be able to handle and analyse spatial data in a single workflow without jumping between software packages etc. For those interested, I have posted a basic [Primer for Handling Spatial Data](#) on RPubS.

Jonathan F. Colville

In 2015, I completed the first year of my five-year NRF Research Career Advancement Fellowship. This fellowship is researching the patterns of diversity and distribution of South African insects and plants. During 2015, regional datasets for insects and plants have been collated and geo-statistical methods (Mecenero et al. 2015) have been used to produce species probability distributions for tens of thousands of species of insects and plants. These distributions are now being mapped and analysed to assess hotspots of diversity, their biogeographic structure, and their congruence with other biotic groups. A large part of 2015 was spent on field collecting trips in Namaqualand, collecting insect material and experimental data for post-graduate students and for phylogenetic analyses.

Allan Clark

During the course of the year I have developed Variational Bayes methods that could be used to approximate the posterior distributions of the parameters of various spatial occupancy models. The bulk of my time however has been spent on revising a paper that lays the ground work for how these approximations could be done for a single season occupancy model. In the paper we explore how good the approximations are as well as how good the approximations are when approximating the predictive distributions of the proportion of occupied sites (PAO). Lastly, I've also developed a method to account for random effects in the occupancy process as well as accounting for false positives in occupancy model data sets.

Theoni Photopoulou

2015 was a busy year with lots of loose ends finally coming together. My main aim for this year was to publish as much as possible. I made good progress on my two movement ecology projects, as well as a couple of little side projects on marine mammals from my collaboration with Peter Best from the Mammal Research Institute of the University of Pretoria. I was successful in acquiring funding from the Marine Alliance for Science and Technology Scotland (MASTS) for a research visit to two Scottish universities. This facilitated fruitful collaboration with three experts at the Universities of St Andrews and Glasgow, over the space of a three-month period. During my visits I worked on the modelling aspect of my movement ecology projects. First, I visited Drs Len Thomas and Roland Langrock (now Professor at the University of Bielefeld, Germany) at CREEM, St Andrews, where I worked on hidden Markov models for raptor flight behaviour with data from black eagles (*Aquila verreauxii*). After that, I visited Prof Jason Matthiopoulos at IBAHC, Glasgow, where I made progress on an existing project for developing a mechanistic model for diving in air-breathing divers, with diving data from elephant seals (*Mirounga* spp.). This year I published two papers (Photopoulou et al. 2015a, 2015b), had one paper rejected, which I will rework and resubmit, and I currently have one paper in review. There were no major conferences in 2015 that were relevant to my research but I gave three talks, one of which a webinar, as part of my research visit.

Natasha Karenyi

My research focusses on the use of relatively new statistical methods on existing marine biodiversity data in an effort to more efficiently analyse such data. In 2015 I focussed on producing two manuscripts using multi-species site occupancy models to determine the impact of sampling process on observed species richness-depth relationships and on conservation targets. In addition, I presented my research at the Statistics in Ecology and Environmental Management (SEEM) Conference in Queenstown, New Zealand, where I learnt of some new techniques available for the analyses of multivariate data. I have been working through one of these models, finite mixture models, to apply it to a marine benthic macrofauna dataset in order to test surrogates for biodiversity. Finally, I became involved in a research project entitled the Benthic Trawl Exclusion Experiment which monitors the recovery of a previously trawled area. In this project I am responsible for monitoring the benthic macrofauna.

Florian Weller

My work has focused almost entirely on the Penguin Pressure Model. The model was expanded and updated based on feedback from work group members, fully adapted to Dyer Island, and a programme of tests and simulations was run to investigate comparative pressure impacts and management priorities. After being chewed over for a goodly time, the manuscript was rejected by Ecological Modelling for being too technical. To bundle the technical parts of the resulting manuscript, and create an accessible documentation of ongoing model evolution, model documentation was then reworked based on the TRACE framework (Grimm et al., Ecological Modelling 2014 (280)); the manuscript was re-submitted and is currently under review at EcolMod. In the meantime, the model is being further developed, with current priorities being a) adaptation to Dassen Island, based on input from the Penguin Pressure Model Working Group, and b) development of a scenario builder mode that will allow breaking up parameter ranges into cases/regimes and combine them into scenario series. No conference participation was possible this year, but I did manage to take part in three workshops including the SEEC-organized Integrated Population Management workshop in October.

Francis Strobbe

In the second half of 2015 I started exploring ways to create an on-line communications tool for mobilising the Coordinated Waterbird Counts (CWAC) data. The aim is to create a web application to monitor progress or loss in biodiversity of waterbirds in South African wetland areas. This involved defining the specifications needed for building web services (APIs) in JSON, adapting the R code to get the data from the CWAC database by using a JSON parser and sketching out the web interface, with key features and technologies used. I am funded through a SANBI Postdoctoral Fellowship.

Ian Durbach

My main work in 2015 was contributing to a project constructing probabilistic projections of baseline carbon dioxide and other greenhouse gas emissions for South Africa to 2050. My involvement was primarily co-ordinating the collection of probabilistic projections of key drivers of energy demand using expert elicitation, and assisting with subsequent simulation of trajectories of potential greenhouse gas emissions. The novel aspect of the elicitation was the assessment of probabilistic projections, rather than point forecasts. The results were submitted as a report to the United Nations Environmental Program, two papers (one on the expert elicitation procedure and one on the subsequent modelling and results; submitted), and an R package *elicitation* (available on github). I presented the work at the MCDM (Society for Multicriteria Decision Making) conference in Hamburg in August.

Francois Becker

My main research goal for 2015 has been to progress significantly in my Masters thesis, which has a spatial modelling component as well as a capture-recapture modelling component. I hope to integrate these into a risk assessment for a toad species (Rose's mountain toad) under critical threat of extinction, which aims to inform the management of the species and the habitat it occupies. I have successfully completed the first round of spatial modelling and ground-truthing, as well as obtained the first population size estimates for the species, revealing that it may be in more trouble than previously supposed. Further multi-species integrated spatial modelling is still being discussed and developed, which aims to show which environmental factors might be affecting amphibian community assemblage, even in the absence of the main species being modeled.

Gordon Botha

My research this year included a gap analysis on Wandering Albatross research from each of the three main breeding colony island groups (Marion, Kerguelen and South Georgia) and the curation of thirty years of observational capture-mark-recapture data for three colonies (ringing and breeding data). From the gap analysis, I identified voluntary partner switching and carry-over effects as my main focus area and have fit a series of multi-state models to start investigating these effects, with some promising preliminary results.

Alecia Nickless

The primary goals of my research are to investigate the method of Bayesian inverse modelling approach to estimating CO₂ fluxes for South Africa at regional and sub-regional scales, and to obtain the first estimates of CO₂ fluxes for the City of Cape Town using this method. Two years of atmospheric measurements CO₂ measurements were obtained at sites around the City of Cape Town (Robben Island and Hangklip, together with the CO₂ record at Cape Point GAW Station).

These CO₂ concentrations, together with a detailed inventory of anthropogenic CO₂ emissions for the City and surrounding areas, and high resolution estimates of NEE and NEP from the CABLE land-atmosphere exchange model, are used to obtain the best estimates of CO₂ fluxes at 1km x 1km spatial resolution during the period of atmospheric measurement. An optimal network design, based on the Bayesian inverse modelling approach, for South Africa has been obtained for the placement of new atmospheric monitoring sites for CO₂ to optimise the amount of information available for the estimation of sources and sinks.

Laura Blamey

I currently hold a 5 year Research Career Advancement fellowship from the NRF and I completed my first year of this fellowship in June 2015. My research focuses on marine coastal systems, looking specifically at spatial and temporal changes in these systems related to fishing and climate change. In 2015 I joined the GULLS project as part of the South African ecosystem modelling team and I have been working on developing a SEA-MICE model (Socio-Ecological Adaptations Model of Intermediate Complexity for Ecosystems) for an area along the south-western Cape coast, as well as updating and expanding my previous MICE model. In 2016 my main aim is to work on both these models, as well as collaborate on various papers dealing with local indigenous knowledge, ecosystem change and climate change. In 2015 I was awarded an NRF rating as well as funding to attend the Species on the Move 2016 conference in Hobart, Tasmania, where I will present a paper on marine species that have undergone shifts in the southern Benguela nearshore. This will be followed by a research visit to CSIRO, Brisbane to continue work on the MICE and SEA-MICE models.

Sanet Hugo

I spent the year 2015, the second year of my NRF Innovation postdoctoral fellowship, working on two studies that depend on data from the second Southern African Bird Atlas Project (SABAP2). I am currently preparing these two studies for submission to scientific journals and for presentation at international conferences during 2016. One of the goals for SABAP2 is to continue collating data indefinitely to provide a valuable long-term bird species distribution database. Therefore, I examined the possible causes and consequences of substantial spatial sampling bias in SABAP2 that may cause distorted views of species distributions. Such a study is needed to assist atlas coordinators and volunteers in their future sampling endeavours, and to ensure that the database is used to its full potential. Further, I focused on specific regions within South Africa with high data quality and high levels of human activity, to study bird species' responses to urban and cultivated areas. This study advances our understanding of how whole communities of interacting bird species use the variety of natural and human-created habitats available at a regional spatial scale.

Vernon Visser

I joined SEEC in October 2015 after having been working at the Centre for Invasion Biology at Stellenbosch University. As a result, my research focus has until recently focused a great deal on non-native species, particularly invasive grasses. I am particularly interested in the field of biogeography, with much of my research focussing on understanding species distributions, spatial patterns of species richness, and mapping and detecting species at broad spatial scales. During my short time in SEEC in 2015 I ran a course on behalf of SANBI and SEEC on species distribution modelling in R and have been completing research on invasive grasses in South Africa. I have

also been busy with some other research, including on species distribution modelling and I intend spending a lot more time on a review of experimental manipulations of species composition at biome boundaries.

Henning Winker

I am currently leading the Statistical Ecology Unit at the South African National Biodiversity Institute (SANBI). My research in 2015 has focused on a wide range of applications for monitoring of abundance trends, population dynamics, and natural resource management with emphasis on marine and fisheries ecology. These applications included progress in the development of: (1) objective IUCN red listing methods using Bayesian State-Space models, (2) a Monte-Carlo and Bayesian based data poor fisheries assessment method (CMSY), which has been positively reviewed by the FAO, ICES, ICCAT and other global management entities, (3) a novel Bayesian Biomass Dynamics Modelling Framework which has been applied to South Atlantic Blue Shark (ICCAT stock assessment) and regional linefish assessments (DAFF), and (4) the use Generalized Additive Mixed Models (GAMMs) to standardize long-term trends of shore angling species as well as tiger sharks using KwaZulu-Natal Sharks Board data. In addition, I dedicated a substantial amount of effort to (5) elude on the responses of declining penguin populations to island fisheries closures which resulted in a co-authored publication and a series of reports as part of the Penguin Island Closure Technical Task Team. Most recently, I engaged in an international collaboration with statisticians and modelers from NOAA, Seattle, USA, to explore (6) applications of Geostatistical Models with Spatial Factor Analysis with the aim to gain simultaneous inference from spatial correlations and species-community interdependencies. As part of this collaboration, we have also commenced (7) a global meta-analysis across six large marine ecosystems to test for evidence for density-dependent changes in effective population area for 120 marine fishes and (8) to explore applications of geostatistical delta-GLMMs to the South Africa trawl survey dataset to uncouple spatio-temporal dynamics for high priority target and bycatch species. Among this year's highlights was certainly my contribution to conceptual work on strategies for sustainable exploitation of the world's oceans together with some of the most renowned and highest published fisheries ecologists, which resulted in a published review and concept paper on "Minimizing the impacts of fishing". In summary 2015 was busy, and for 2016, I wish to find some more time to focus on my first-author papers.

Res Altwegg

My research in 2015 has focused on understanding the dynamics of species ranges, and how climate change and other drivers might be affecting these. In one project, we used dynamic occupancy models adapted to bird atlas data for analysing patterns and processes in the distributions of bird species in southern Africa between 1987 and 2015. We found both clear legacies of past climatic conditions in the current species assemblages, and evidence that species ranges dynamically changed in apparent reaction to recent bush encroachment and changes in land use. Ranges tended to shift in the same direction as climate but generally lagged behind their changing climatic niche. Range changes led to opportunities for new ecological and evolutionary interactions between brood parasites and their host species. We also found evidence that pairs of closely related species competitively limit the range of one another. Finally, we found that protected areas are critical for the persistence of some species. The bird atlas data also revealed clear shifts in migration phenology of a number of palearctic and intra-African migrants. A second line of research examined the role of climate and

other factors as drivers of population dynamics of elephant seals, toads and various bird species. We found a strong effect of rainfall on survival of Rose's Mountain toad, which is endemic to the Cape peninsula. Rainfall was also a strong driver of sociable weaver population dynamics whereas African reed warblers appeared to react to raising temperatures.

Astrid Jarre

The interdisciplinary group of 12-15 people which I have the privilege to lead and which is hosted by the Department of Biological Sciences, contributes to the 3rd goal of SEEC, "to develop methods that link data analysis and modelling into conservation planning and management processes". It is supported through DST/NRF's South African Research Chair Initiative, as well as regional and international project funding. We are interested in developing decision-making in social-ecological systems under global change. Along the spectrum from rational to emotional decision making, our work focusses on three areas, (i) ecosystem modelling for management strategy evaluation, (ii) methodology for structured decision support, including indicators and modelling with stakeholders, and (iii) transdisciplinary research into marine social-ecological systems under global change. Whereas area (i) is situated in the natural sciences, areas (ii) and (iii) requires inter- and transdisciplinary collaboration, and the group currently has members with backgrounds in social anthropology, history, geography, environmental sciences, marine biology, oceanography, mathematics and computer science. Sabbatical leave during the second half of 2015 made it possible for me to link with colleagues in the US implementing structured decision making in wildlife and fisheries management. Our research highlights during 2015 with particular relevance to SEEC included the completion of Dr Emily McGregor's PhD research into assessing the implementation efficacy of an ecosystem approach to management of the South African sardine-directed fishery, which included the compilation of a knowledge-based tool synthesising a variety of indicators for this purpose, as well as an evaluation of the social learning on system-based management that has occurred in the participatory modelling process that resulted in the synthetic tool. Progress with the penguin pressure model, another participatory model developed by Dr Florian Weller (see personal section in this report) is regarded as an important contribution to the Biodiversity Management Plan - African Penguin by DEA:Oceans and Coast, and Cape Nature as the implementing agency. Whereas reducing pressures created by scarcity of forage fish and oiling are the top management priorities for the Robben Island colony, reducing predation pressure, notably through culling of problem seals, currently are of highest importance for the Dyer Island colony. Dr Kate Watermeyer graduated with a thesis on "ecosystem implications of the recent southward shift in key resources in the southern Benguela", as part of which she developed a novel frame-based model which combines spatial pressures through long-term climate variability and fishing on sardine and anchovy. Her research is an important contribution to the difficult problem of managing one of South Africa's most important fisheries in a changing environment, and in an ecosystem context.



3. Training

To achieve our goals, we need to train people with excellent skills both in statistics and ecology / environmental sciences. We want to attract quantitatively minded biology and environmental- and geographical science students, and statistics students with an interest in ecology / environmental questions. At the moment, biology students only tend to fully appreciate the importance of statistics when they are far into their studies and most of the statistics students come from the commerce side with little interest in ecology and environmental sciences. SEEC members have therefore invested a lot of effort into developing and running courses at the intersection between statistics and ecology, ranging from undergraduate courses to specialised workshops.

3.1 Undergraduate teaching

A number of SEEC members have been very busy developing our 2nd - year statistics course for science students (STA2007) as an online course. Under Birgit Erni's lead, Birgit, Greg Distiller, Theoni Photopoulou and Res Altwegg developed the course, including short videos, notes, online quizzes and assignments, and more. Yahkat Barshep and Greg Duckworth helped with the tutorials. The first run of the online version of this course was a great success. 46 students wrote the exam and we received strongly positive course evaluations. Even though developing and teaching STA2007 is part of our departmental duty, it forms a key building block for achieving a central SEEC goal: to train scientists at the intersection between statistics and ecology / environmental science. We think having developed this course was an important investment in SEEC's future and it should lead to a pool of potential postgraduate students that are well prepared to tackle project in our field. We have already heard from Biology faculty members that they noticed an improvement in the data analysis skills of their undergraduate students.

STA2007 builds on the first-year course STA1007, which Greg Distiller convenes. During that course, students now get introduced to R. Res Altwegg helped with promoting statistics during

practicals of Biology undergraduate courses.

3.2 Workshops

3.2.1 Modelling species distributions

Vernon Visser ran a workshop on behalf of the South African National Biodiversity Institute (SANBI) on species distribution modelling (SDM) in R (with a focus on marine environments). The course provided a theoretical background to SDMs as well as useful R scripts for running SDMs. Vernon has run this course a number of times previously and it has proven extremely popular due to the numerous applications of SDMs in conservation, ecology, and invasion biology (to name a few). Fourteen people took part in the course, with participants ranging from PhD students to civil servants to employees in the private sector working in the marine sector. As an indication of participant's interest in the course, the overall rating of the course was very high (mean score of 8.8 out of 10).



3.2.2 Bayesian Integrated Population Analysis

SEEC organised a workshop on Bayesian integrated population modeling using BUGS and JAGS from 19 to 23 October 2015. The course was taught by Michael Schaub and Marc Kéry from the Swiss Ornithological Institute, Sarah Converse from the US Geological Survey and Res Altwegg from SEEC. We had 26 participants, including 9 from outside Africa (Europe, Australia and South America).



4. Partners

We have a strong network of partners at three levels: within UCT, nationally, and internationally.

4.1 Within UCT

Within UCT, SEEC has close links to a number of other research groups. Res Altwegg holds a research chair with the African Climate and Development Initiative (ACDI). Astrid Jarre is affiliated with the Marine Research Institute (MARE). SEEC core members Peter Ryan and Les Underhill are directors of the Percy FitzPatrick Institute for African Ornithology and the Animal Demography Unit, respectively.

4.2 National

A key partner outside UCT is the **South African National Biodiversity Institute**. Three of their scientists are SEEC core members. A postdoc at SEEC falls within the framework of the establishment of a centre of excellence in biodiversity information driven by SANBI through partner organisations. For this centre of excellence a five years strategy is currently being developed.

South African Environmental Observation Network's Jasper Slingby is a SEEC core member.

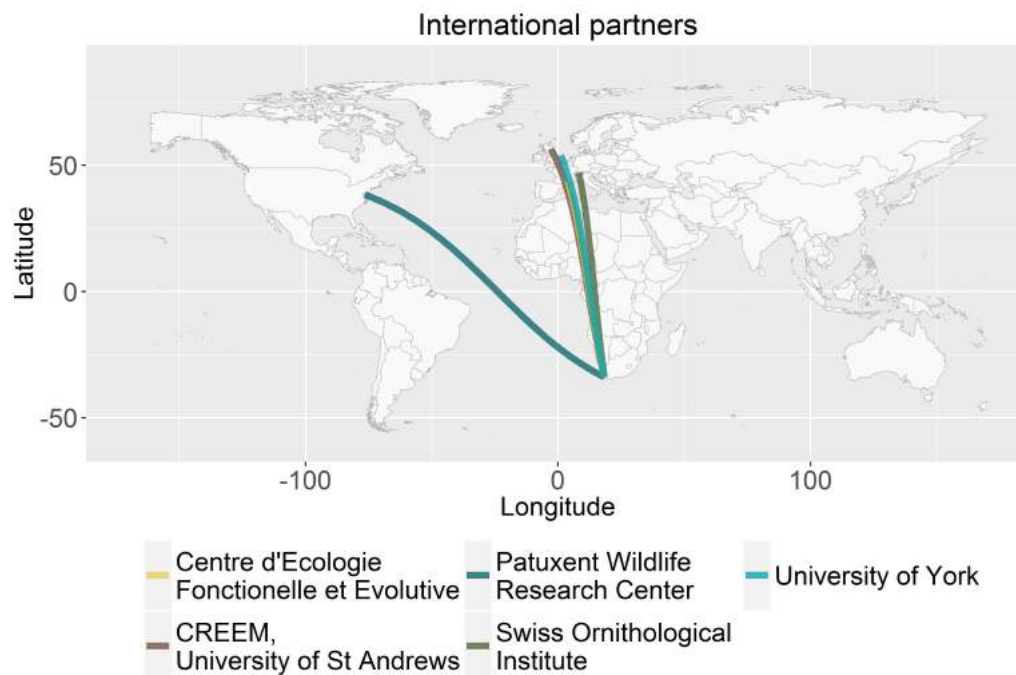
Guy Midgley from **University of Stellenbosch's** Department of Botany and Zoology is a SEEC core member. SEEC has several ongoing collaborations with the **Centre for Invasion Biology** at the University of Stellenbosch.

SEEC members collaborated with Peter Taylor – who holds a South African Research Chair in Biodiversity and Change in the Vhembe Biosphere Reserve at the **University of Venda** – on two grant applications to the National Research Foundation.

We have a grant from the **Applied Centre for Climate and Earth Systems Science (ACCESS)** through the Ecosystems Services and Human Livelihoods theme. We also held discussions about collaborating with ACCESS on training courses in statistics.

We work with key conservation organisations: **Cape Nature**, the **Endangered Wildlife Trust**, and **BirdLife South Africa** on various projects.

4.3 International



Internationally, we collaborate with some of the leading groups in our field. One of them is the **Centre for Research into Ecological and Environmental Modelling (CREEM)** at the University of St Andrews. David Borchers from CREEM is an Honorary Research Associate at SEEC and the main link between the two groups. Under his supervision, Greg Distiller is working towards a joint UCT - St Andrews PhD degree.

We are working scientists from the **Patuxent Wildlife Research Center** of the US Geological Survey. Through a project funded by the NRF's Blue Skies programme, we are working with Jim Nichols on analysing bird atlas data using occupancy models. Sarah Converse visited SEEC in October to teach a workshop on Bayesian Integrated Population Analysis, and to co-convene a symposium on Advances in Design and Analysis for Seabird Demographic Studies at the second International Seabird Conference in Cape Town.

Michael Schaub and Marc Kéry from the **Swiss Ornithological Institute** visited SEEC to teach a workshop on Bayesian Integrated Population Analysis and to share their experience with analysing bird atlas data collected in Switzerland. Michael Schaub gave the key-note address at the SEEC student symposium in October.

We have an ongoing collaboration with the **Centre d'Ecologie Fonctionnelle et Evolutive** at the CNRS Montpellier. We applied for an NRF Protea grant to work with Roger Pradel, Olivier Gimenez, Claire Doutrelant and Rémy Choquet on wildlife demography. Roger visited SEEC in October and gave a two-day workshop at the University of the Witwatersrand.

We have an ongoing collaboration with Colin Beale at the **University of York** on analysing spatial biodiversity data.



5. Funding

- URC Conference Travel Grant awarded to Laura Blamey to attend and present a paper at the Species on the Move conference in Hobart, Tasmania, February 2016.
- Theoni Photopoulou was awarded a MASTS (Marine Alliance for Science and Technology Scotland) Postdoctoral & Early Career Researcher Exchange fund to visit Drs Len Thomas and Roland Langrock at the University of St Andrews, and Prof Jason Matthiopoulos at the University of Glasgow for ten weeks (June - August 2015).
- Ariella Rink was awarded an Oppenheimer Memorial Trust student bursary for funding towards her Masters degree (2015 - 2017).
- Francis Strobbe is funded through a SANBI Postdoctoral Fellowship (2015-16)
- Res Altwegg received funding from the African Climate and Development Initiative.
- Res Altwegg, Birgit Erni, Phoebe Barnard, Guy Midgley and Les Underhill had an NRF Blue Skies grant "Dynamic macroecology for conservation" to study range dynamics using bird atlas data (2012-15).
- Res Altwegg had an NRF Incentive grant.
- Res Altwegg had a grant from the Applied Centre for Climate and Earth Systems Science (ACCESS) as part of theme 5 "Ecosystem Services and Human Livelihoods".
- David Borchers and Res Altwegg received a Mentoring African Research in Mathematics (MARM) grant to collaborate on acoustic spatially explicit capture-recapture methods.
- Raquel Garcia and Res Altwegg received a grant from the NRF Knowledge Interchange and Collaboration programme for Raquel to attend and present at the Species on the Move conference in Hobart, Tasmania, February 2016.
- Various postdocs and students received freestanding fellowships and bursaries that amounted to ~ R2'300'000.- in 2015.



6. Conferences

6.1 Presentations

1. Distiller, G.: *Using continuous-time Spatially Explicit Capture-Recapture (SECR) models to make inference about animal activity*. South African Statistical Association conference, Pretoria, 2015.
2. Blamey, L.K., Branch, G.M., Jarre, A. and É.E. Plaganyi: *Regime shifts in the southern Benguela*. Aquatic Biodiversity and Ecosystems Conference. Liverpool, UK, September 2015.
3. Karenyi, N., K. Sink, R. Nel and R. Altwegg. 2015. *Variable species detection probabilities distort the marine benthic depth-diversity relationship*. Statistics in Ecology and Environmental Monitoring Conference, Queenstown, New Zealand (Oral)
4. Colville, J.F. *Biogeographic patterns of insect diversity across South Africa's Cape biomes*. 6th Annual Diamond Route Research Conference, De Beers Corporate Headquarters, Johannesburg, October 2015.
5. Rink, A., Altwegg, R., Bowie, R.C.K., Colville, J.F. *Sexual selection and habitat heterogeneity – complimentary drivers of diversification in the monkey beetles?* 6th Annual Diamond Route Research Conference, De Beers Corporate Headquarters, Johannesburg, October 2015.
6. Altwegg, R. *Scaling from functional responses to populations dynamics*. Workshop “Functional responses and a tool in invasion biology: current applications and future directions”, Centre for Invasion Biology, Stellenbosch University, South Africa, November 2015.



7. Publication list 2015

- [1] **ALTWEGG, R.**, DE KLERK, H. M., AND **MIDGLEY, G.F.** 2015. Fire-mediated disruptive selection can explain the reseed-resprouter dichotomy in mediterranean-type vegetation. *Oecologia* 177:367–377.
- [2] **BLAMEY, L. K.**, SHANNON, L. J., J., B. J., CRAWFORD, R. J. M., DUFOIS, F., GRIFFITHS, C. L., HUTCHINGS, L., **JARRE, A.**, ROUAULT, M., WATERMEYER, K. E., AND **WINKER, H.** 2015. Ecosystem change in the southern benguela and the underlying processes. *Journal of Marine Systems* 144:9–29.
- [3] **BORCHERS, D.L.** AND LANGROCK, R. Double-observer line transect surveys with markov-modulated poisson process models for overdispersed animal availability. *Biometrics* . DOI: 10.1111/biom.12341. Early view.
- [4] BRADSHAW, P., **J.F. COLVILLE**, AND LINDER, P. 2015. Optimizing regionalisation techniques: Identifying centres of endemism in the extraordinarily endemic-rich Cape floristic region. *PloS One* . DOI: 10.1371/journal.pone.0132538.
- [5] BROMS, K., HOOTEN, M., JOHNSON, D., **ALTWEGG, R.**, AND CONQUEST, L. 2015. Dynamic occupancy models for explicit colonization processes. *Ecology* . DOI: 10.1890/15-0416.1. In press.
- [6] BUCKLAND, S., OEDEKOVEN, C., AND **BORCHERS, D.L.** Model-based distance sampling. *Journal of Agricultural, Biological and Environmental Statistics* . DOI: 10.1007/s13253-015-0220-7. In press.
- [7] BURT, M., **BORCHERS, D.L.**, JENKINS, K., AND MARQUES, T. 2015. Using mark-recapture distance sampling methods on line transect surveys. *Methods in Ecology and Evolution* 5:1180–1191.

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- [8] BUSSIÈRE, E., UNDERHILL, L.G., AND ALTWEGG, R. 2015. Patterns of bird migration phenology in South Africa suggest northern hemisphere climate as the most consistent driver of change. *Global Change Biology* 21:2179–2190.
- [9] DARU, B. H., BANK, M., MAURIN, O., YESSOUFOU, K., SCHAEFER, H., SLINGSBY, J. A., AND DAVIES, T. J. 2016. A novel phylogenetic regionalization of phytogeographical zones of southern Africa reveals their hidden evolutionary affinities. *Journal of Biogeography* 43:155–166.
- [10] DISTILLER, G. AND BORCHERS, D.L. An secr estimator for single-catch traps. *Ecology and Evolution* . DOI: 10.1002/ece3.1748. In press.
- [11] ELLENDER, B., WEYL, O., AND WINKER, H. 2016. Success of a large riverine cyprinid smallmouth yellowfish *Labeobarbus aeneus* in a southern African impoundment. *Fisheries Management and Ecology* 23:44–54.
- [12] FROESE, R., WALTERS, C., PAULY, D., WINKER, H., WEYL, O. L., DEMIREL, N., TSIKLIRAS, A. C., AND HOLT, S. J. Reply to Andersen et al.(2016) “Assumptions behind size-based ecosystem models are realistic”. *ICES Journal of Marine Science: Journal du Conseil* . DOI: 10.1093/icesjms/fsv273. Early view.
- [13] FROESE, R., WALTERS, C., PAULY, D., WINKER, H., WEYL, O. L. F., DEMIREL, N., TSIKLIRAS, A. C., AND HOLT, S. J. 2015. A critique of the balanced harvesting approach to fishing. *ICES Journal of Marine Science* p. DOI: 10.1093/icesjms/fsv122. Early view.
- [14] FROESE R, WINKER H, G. D. 2015. Size still matters. a response to Svedäng (2013): Size matters: *Ne quid nimis*. *Fisheries Research* 164:329–330.
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- [17] JANSEN, D.Y.M., WILSON, A., AND ALTWEGG, R. 2015. Climatic influences on survival of migratory African reed warblers *acrocephalus baeticatus* in South Africa. *Ardea* 103:163–174.
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- [22] MONCRIEFF, G. R., SCHEITER, S., SLINGSBY, J. A., AND HIGGINS, S. I. 2015. Understanding global change impacts on south african biomes using Dynamic Vegetation Models. *South African Journal of Botany* 101:16–23.
- [23] MUTUMI, G. L., JACOBS, D. S., AND WINKER, H. 2016. Sensory drive mediated by climatic gradients partially explains divergence in acoustic signals in two horseshoe bat species, *Rhinolophus swinnyi* and *Rhinolophus simulator*. *PloS ONE* 11:e0148053.
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- [26] OOSTHUIZEN, W. C., BESTER, M. N., ALTWEGG, R., MCINTYRE, T., AND DE BRUYN, P. J. N. 2015. Decomposing the variance in southern elephant seal weaning mass: partitioning environmental signals and maternal effects. *Ecosphere* 6:139.
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- [37] SIMMONS, R. E., KOLBERG, H., BRABY, R., AND **ERNI, B.** 2015. Declines in migrant shorebird populations from a winter-quarter perspective. *Conservation Biology* 29:877–887.
- [38] STEVENSON, B. C., **BORCHERS, D. L.**, **ALTWEGG, R.**, SWIFT, R. J., GILLESPIE, D. M., AND MEASEY, G. J. 2015. A general framework for animal density estimation from acoustic detections across a fixed microphone array. *Methods in Ecology and Evolution* 6:38–48.
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