

# RMA

*The Resource Modeling Association is an international association of scientists working at the intersection of mathematical modeling, environmental science, and natural resource management. We formulate and analyze models to understand and inform the management of renewable and exhaustible resources. We are particularly concerned with the sustainable utilization of renewable resources and their vulnerability to anthropogenic and other disturbances.*

RMA Newsletter

Fall 2016



## *Barcelona Meeting* by John Hearne

**T**he 2017 World Conference on Natural Resource Modeling will be held June 6–9, 2017 in Barcelona, Spain. This year's annual meeting of the Resource Modeling Association (RMA), is being organized by John Hearne with the support and assistance of the RMA, the Pau Costa Foundation, and the Universitat Politècnica de Catalunya (UPC).

Four outstanding scientists will deliver invited plenary talks which cover a broad range of applications of natural resource modeling—forest and fire ecology, fisheries and resource economics, landscape fragmentation and terrestrial ecology, and a management perspective of our modeling. Mark Finney is a Research Forester at the Missoula Fire Sciences Laboratory of the Rocky Mountain

Research Station in the USA. He has developed a number of simulation systems to simulate the growth and impact of wildland fires over large landscape areas. Linda Nøstbakken is a Resource Economist in the Department of Economics at the Norwegian School of Economics. Professor Nøstbakken's research focuses on the optimal management and regulatory enforcement of fisheries.

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# The role of groundwater-dependent ecosystems in groundwater management

by Encarna Esteban<sup>a</sup> & Ariel Dinar<sup>b</sup>

*While the estimated global value of ecosystem services is very significant, the annual loss of ecosystem services value is alarming; especially worrying is the case of aquatic and groundwater-dependent ecosystems (GDEs). We assess the conjunctive management of groundwater and GDEs using a certain type of an ecosystem health function. The results highlight the necessity for a better understanding of GDEs behavior and call for groundwater regulation to protect these resources.*

Constanza et al. [1] estimated the global value of ecosystem services ranging between 125–145 trillion dollars per year; however, the annual loss of ecosystem services value is alarming. A very important type of ecosystems is groundwater-dependent ecosystems (GDEs), which survival relies on groundwater resources.

The increasing pressure on aquifers is largely threatening the survival of several GDEs. While recent economic literature has been based on the general study of groundwater resources [2, 3] the impacts of groundwater overexploitation on the health of GDEs are still scantily analyzed.

<sup>a</sup> Department of Economic Analysis, University of Zaragoza, Spain. (encarnae@unizar.es)

<sup>b</sup> School of Public Policy, University of California, Riverside, CA, USA. (adinar@ucr.edu)

Encarna Esteban

In the case of groundwater, the depletion of the water level generates significant impacts on GDEs. Ecosystems' responses can be different depending on the ecosystem type, which is reflected in their health function [4]. The results of this paper demonstrate that under a linear and continuous ecosystem health function type, groundwater regulation may or may not be necessary. This result clearly calls for a better understanding and need for more information about the ecosystems' behavior. This information is essential to design a proper management policy to protect the ecosystems and their ecological goods and services.

## Optimal groundwater model integrating and ecosystem response function

This study contributes to the existing literature by introducing the GDEs as an additional groundwater user, characterized by a behavioral or health function. The regulator internalizes two externalities: (1) extraction/congestion externality, which is the damage that one user imposes on the other users; and (2) environmental externality, which are the benefits that GDEs provide to society. The environmental externality depends on the type of GDE, which is defined by the ecosystem health function. The impact of groundwater level on the ecosystem generates different ecological status levels depending on the response of the ecosystems to habitat changes. We have focused on a linear and continuous specification representing how habitat modifications alter the behavior of the ecosystems.

A groundwater management problem consists of the maximization of the groundwater users' future income stream. However, users do not normally take into account the benefits provided by the ecosystems (GDEs) and maximize their private benefits minus the costs from groundwater consumption.

$$\begin{aligned} \text{Max } \Pi &= \int_0^{\infty} e^{-rt} \cdot \left[ \frac{1}{2k} \cdot W^2 - \frac{g}{k} \cdot W - (C_0 + C_1 \cdot (S_L - H)) \cdot W \right] dt \\ \text{s. t. } \quad \dot{H} &= \frac{[R + (\alpha - 1)W]}{AS} \quad \text{and} \quad H(0) = H_0 \end{aligned}$$

where  $\Pi$  is the users' total private profit. The model variables are the water extractions ( $W$ ) and the level of the water table ( $H$ ). The users' total revenue ( $1/2k \cdot W^2 - g/k \cdot W$ ) is the area under the inverse irrigation water demand curve (with  $g$  and  $k$  parameters). The total cost of pumping depends on the aquifer depletion ( $S_L - H$ ) or the distance between the elevation of the surface ( $S_L$ ) and the water table level ( $H$ ), with  $C_0$  and  $C_1$  parameters. Additionally, the model is constrained by the hydrological behavior of the aquifer ( $\dot{H}$ ), which is a function of the natural recharge ( $R$ ), the aquifer size ( $AS$ ), and the returned water into the aquifer  $(\alpha - 1) \cdot W$ ; and an initial condition ( $H(0) = H_0$ ).

When the benefits of ecosystems are included, the GDE externality that represents the benefits from the ecosystems services are internalized and become an integral part of the optimization problem.

$$\begin{aligned} \text{Max } SP &= \int_0^{\infty} e^{-rt} \cdot \left[ \frac{1}{2k} \cdot W^2 - \frac{g}{k} \cdot W - (C_0 + C_1 \cdot H) \cdot W \right. \\ &\quad \left. + \xi \cdot (\sigma - \rho \cdot (S_L - H)) \right] dt \\ \text{s. t. } \quad \dot{H} &= \frac{[R + (\alpha - 1)W]}{AS} \quad \text{and} \quad H(0) = H_0 \end{aligned}$$

where  $SP$  represents the problem where GDEs externalities are accounted for. The environmental externality  $\xi \cdot (\sigma - \rho \cdot (S_L - H))$  de-

pends on the economic value per unit of ecosystem status ( $\xi$ ) and the aquifer depletion ( $S_L - H$ ), being  $\sigma$  and  $\rho$  parameters.

By solving these two optimization problems we demonstrate that the internalization of the ecosystem's behavior modifies the optimal paths for both water extractions and water table levels. Depending on the differences between the ecosystem's behavior (namely the slope of the ecosystem's health function) the optimal groundwater management and the optimal policy can be substantially different. Furthermore, policy intervention in groundwater management is justified and necessary when GDEs are highly valuable.

## Empirical application

The theoretical results have been tested in one of the most important aquifers in Spain along with its GDE (Western la Mancha aquifer and Tablas de Daimiel wetland). The large overexploitation of this aquifer during the last fifty years has caused severe impacts on the linked Tablas de Daimiel wetland.

The empirical results illustrate how the inclusion of the environmental externality in the groundwater management problem leads to lower levels of groundwater extractions (Fig. 1). We have performed some sensitivity analysis using a higher economic value of the GDEs (sensitivity analysis 1) and also lower and higher values of the slope of the ecosystem behavior function (sensitivity analysis 2 and 3, respectively). The results show how under some circumstances (sensitivity analysis 1) private users should stop their extractions.

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The inclusion of the GDEs' external-ity also changes the optimal path of the water table level. The results suggest that when ecosystems health functions are internalized optimal water table levels must be higher (Fig. 2). Both the extraction and the water table levels are sensitive to the slope of the ecosystem response function and to the value of the ecosystem. Furthermore, when the value of the ecosystem is high (sensitivity analysis 1) or the function slope is high (sensitivity analysis 3) farmers should pump smaller groundwater quantities to reach higher water table levels.

## Conclusion

The behavior of the GDEs depends on their intrinsic characteristics and their links with the groundwater bodies they rely on. Our theoretical and empirical results suggest that both the economic value of ecosystems and the ecosystem health function slope affect the optimal extraction rates and the optimal water table levels. The results demonstrate both theoretically and empirically the importance of incorporating the environmental external-ity in social analyses. Furthermore, not just ecosystems but also their specific ecosystem functions are necessities for achieving efficient environmental regulations. These results justify the investment in acquiring better knowledge of ecosystem processes and their relationship with the rest of the environment.

## References

- [1] R. Costanza, R. de Groot, P. Sutton, S. van der Ploegh, S.J. Andersson, I. Kubiszewskia, S. Farbere, R.K. Turner. [2014]. *Change in the global value of ecosystem services*. Glob Environ Chang 26, 152–158.
- [2] P. Koundouri [2004]. *Current issues in the economics of groundwater resource management*. Journal of Economic Surveys 18, 703–740.
- [3] J. Roumasset and C.A. Wada [2013]. *A dynamic approach to PES pricing and finance for interlinked ecosystem services: Watershed conservation and groundwater management*. Ecol Econ 87, 24–33.
- [4] M. Scheffer, S. Carpenter, J.A. Foley and B. Walker [2001]. *Catastrophic shifts in ecosystems*. Nature 413, 591–596.

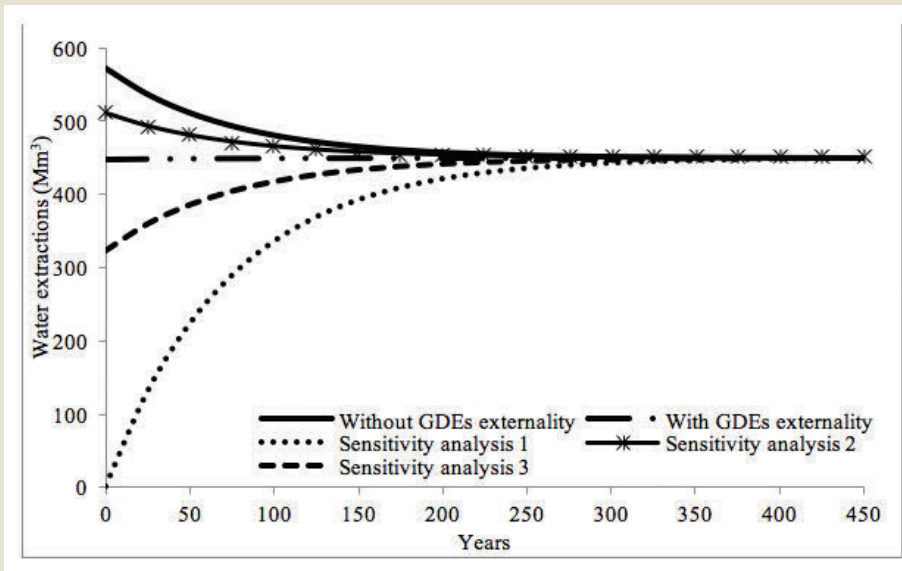


Fig. 1. Optimal path of water extractions in the Western la Mancha aquifer

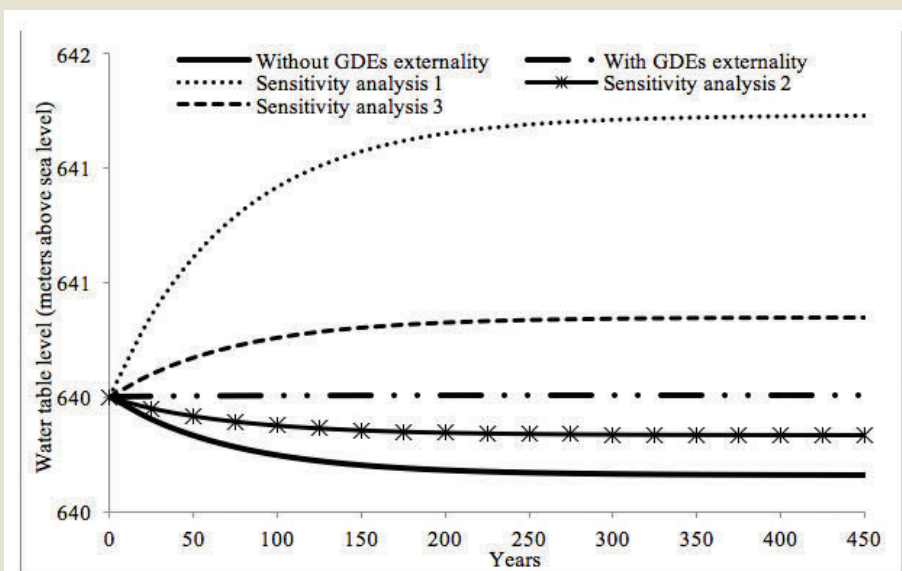


Fig. 2. Optimal path of water table levels in the Western la Mancha aquifer

# Flagstaff Conference Report

by Bob Fray

The 2016 World Conference on Natural Resource Modeling was held at the modern High Country Conference Center in Flagstaff, Arizona, USA, on June 14–17. The conference was supported by Furman University and the Resource Modeling Association and organized by Bob Fray with major assistance from Catherine Roberts. The theme of this year's conference was "Quantitative Modeling of Natural Resources in an Era of Climate Change." The conference was attended by 80 conference participants and their families who came from a dozen different countries.

Four invited speakers addressed the theme of the conference. Shandelle Henson from Andrews University in Michigan and Jim Cushing from the University of Arizona gave a two-part presentation on "The Effects of Climate Change on Marine Birds." Shandelle spoke on "Rising Sea Surface Temperature, Cannibalism, and Reproductive Synchrony," and Jim focused on "Population Dynamics and Evolutionary Outcomes." Graciela Ana Canziani described the ongoing work of the Intergovernmental Science-Policy Platform on Biodiversity, a cooperative program of over 100 governments to assess the state of the planet's biodiversity, its ecosystems and the essential services they provide to society. Hugh Possingham addressed the question "What is the Value of Knowledge?" Admittedly good decisions require data, values and models, but how much data do we need, how good do the models have to be?

The conference began most convivially with the customary opening reception on Tuesday evening, June 14 at the historic Weatherford Hotel in downtown Flagstaff. This was a most en-

joyable occasion, seeing old friends again and meeting many new participants. The next day was filled with contributed talks on forestry, commercial fisheries and species dispersion. This was also the day for the talks by graduate students and the presentations by Shandelle and Jim. On Thursday morning Graciela gave her address along with papers on climate change and riparian species. At noon on Thursday all conference attendees boarded busses for the trip to Grand Canyon National Park for a relaxed afternoon and the conference banquet. The conference ended on Friday with the talk by Hugh and papers on economics, forestry and ecosystems.

The conference excursion to the Grand Canyon was a wonderful occasion with the opportunity to hike into the canyon, along the rim, shop or simply sightsee. That evening the conference banquet was held at the Maswick Lodge in the park. At the banquet the first ever Lamberson Medals were awarded to Encarna Esteban, Erick Zivot and Nina Sidneva. In addition, Betsy Heines received the award for the outstanding student paper. Also, in his usual humorous style, John Hearne, President of RMA, gave his prizes for dubious achievements. The trip concluded with everyone going to the rim of the canyon to watch a gorgeous sunset over the multihued walls and rock formations of one of the planet's most stunning sights.

With its many restaurants and pubs within easy walking distance of the conference center, Flagstaff provided an excellent location for participants to gather for dinner and an evening of social exchange. We all look forward to continuing the close interaction and the scholarly discussions at the next world conference in Barcelona in 2017.



# PRESIDENT'S COLUMN



I am very happy and honored to write this column for the newsletter as the new president of the Resource Modeling Association. I am especially proud to be at the head of an association devoted to the modeling and management of natural resources, ecosystems, socio-ecosystems with the a major interdisciplinary content between ecology, economics, mathematics and computer sciences.

This president's column is first an opportunity for me to send a warm welcome to all new RMA members, especially those that have joined us following the successful conference in Flagstaff.

This is also an opportunity for me to say how grateful I am to John Hearne, Catherine Roberts, Rollie Lamberson, Harry Gorfine, and Bob Fray for the work done during these last years for both the association RMA and our journal *Natural Resource Modeling* (NRM). I hope that they will all remain engaged in the association and continue to actively contribute. I also wish to extend a warm welcome to Shandelle Henson as future NRM editor. My acknowledgements also go to Keith Criddle and Rick Moll for the work done as recent presidents.

My first president's column is also an occasion to recall some general goals for RMA and announce more specific objectives for the future years of our association. My general purpose for the next two years is to reinforce RMA's sustainability and to extend its influence regarding the modeling and management of natural resources, especially renewable resources and ecosystems. In that regard, the next years will offer great opportunities because the need of decision support and quantitative methods,

scenarios, models or theory for environmental challenges and the operationalization of sustainability facing global changes significantly increases. This is exemplified by the creation of the IPBES (International Platform for Biodiversity and Ecosystem Services) and Future Earth, an ambitious initiative launched at the Rio+20 Summit following the promotion by the Science and Technology Alliance for Global Sustainability. In that respect, RMA is well equipped with its interdisciplinary 'DNA' and its scientific objectives related to management and decision support. To foster our scientific impact, we will have to rely on our strengths which are numerous: the annual, international and interdisciplinary conference, the NRM journal, the newsletter, the website, together with the friendliness of the association. However, a 'laissez-faire' strategy would be risky. In that respect, I will pay special attention to the following specific goals for the next years.

First we need to foster the attendance at our annual conference. In line with that issue, we need to strongly anticipate the organization of the next conferences and reach new countries and continents to enlarge and densify the RMA's network. I am confident in this regard as we have numerous stimulating proposals for the following years. Barcelona 2017 is already progressing well thanks to the main organizer Nuria Prat-Guitart. The central theme of the conference namely "Vulnerability and Resilience of Socio-ecological Systems" as well as the keynote speakers including Linda Nøstbakken (Norway), Mark Finney (US), Marc Castellnou (Spain) and Frank van Langevelde (Netherlands) are all very stimulating and appealing. The awarding of both the Rollie Lamberson Medal and the prize of best student presentation during the conference will also contribute to the attractiveness of the conference and more gener-

ally of the association. Moreover, RMA still needs to reinforce its communication through electronic networking. The use of Twitter, Facebook, Research Gate or LinkedIn networks should be more intensive and systematic. In that respect young scientists engaged on the board should play a major role and, accordingly, will be strongly supported. For the website which has been significantly improved and reinforced these last years by Harry Gorfine, the insertion of more modeling content such as information on software devoted to scientific calculus should be fruitful and helpful for scientists working in our fields. Regarding the NRM journal, we need to more actively encourage researchers in our networks to submit papers and propose special issues as illustrated by the one derived from the 2015 Bordeaux conference. At this stage, let me mention that publishing a paper in NRM constitutes a strong competitive advantage to be nominated for the Lamberson award although other papers from a RMA member are also eligible for this prize.

We also aim at developing new RMA activities in the next years. As regard these new initiatives, I hope that we will soon make progress regarding the organization of a RMA summer school dedicated to "modeling, management and viability of ecosystems" both to attract young researchers, typically doctorate, and to engage senior and prestigious researchers in our field to teach in a friendly way within the framework of RMA.

Bonne fin d'année 2016 et vive RMA.

—Luc Doyen

## Transition of Editors

by Catherine Roberts and Bob Fray

In January 2017, with the first issue of Volume 30 of RMA's journal *Natural Resource Modeling* (NRM), the position of Editor-in-Chief will change. Our long-time editor, Catherine Roberts, will be stepping down and will be replaced by Shandelle Henson, Professor of Mathematics at Andrews University in Michigan, USA.



Catherine Roberts and Shandelle Henson

Catherine has served as Editor-in-Chief of NRM since January 2004, and she has guided the journal to a level of professional excellence with the journal being listed in the ISI Science Citation Index, effective January 2008. Early in her tenure she investigated the possibility of associating NRM with an international publisher. Through her diligence Blackwell Publishing agreed to handle publishing and promotion of the journal and membership of the society. Later John Wiley and Sons bought Blackwell and has been publishing NRM since then. Thanks to Catherine's indefatigable efforts the journal has increased circulation and the number of submitted manuscripts. The stature of the journal has been greatly enhanced while she has been in charge. Since 2003 she has been a member of the Board of Directors of RMA, and she was the organizer of the 2007 World Conference on Natural Modeling which was held on Cape Cod, Massachusetts. Last spring Catherine was chosen to be the Executive Secretary of the American Mathematical Society, a very prestigious appointment. We wish her well in this new and important position. We will sorely miss her enthusiasm and experience in advising the leadership of RMA.

Our new Editor-in-Chief, Shandelle Henson, has served on the editorial board of NRM since 2004. She is Professor of Mathematics at Andrews University in Michigan USA. Her research is in dynamical systems and bifurcation theory as applied to ecology and animal behavior. She also studies the effect of weather, climate, and disturbance on animal behavior and reproduction.

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## ROLLIE LAMBERSON AWARD



The initial Rollie Lamberson Awards were presented at the Resource Modeling Association's conference last June (read about the winners on the next page). This award will be presented annually at the RMA conference to the author(s) of the most outstanding paper in natural resource modeling of the previous two years by an RMA member.

This award was established to recognize the contributions of Professor Roland (Rollie) Lamberson to the growth of the RMA and its journal *Natural Resource Modeling*. Rollie is a founder of the Resource Modeling Association and has served as our founding President and our Executive Secretary, receiving an Award for Distinguished Service from the association in 1991. He has also contributed substantially to the *Natural Resource Modeling* journal, acting as Managing Editor 1985–1991, and editing numerous special issues, and still serves on NRM's Senior Advisory Council.

All papers published in *Natural Resource Modeling* within the past two calendar years, with at least one

current RMA member as an author, will automatically be considered for the award. Papers published in other journals by current RMA members may also be nominated for consideration. This is done by submitting an electronic copy of the paper in English along with a nominating letter detailing why the paper merits the Rollie Lamberson Award. These nominated papers should be sent to [editor@resourcemodeling.org](mailto:editor@resourcemodeling.org).

The award recipients will be decided by an awards committee comprising representatives from the RMA board of directors and the editorial board of *Natural Resource Modeling*. The committee members and the RMA president are ineligible for the award. The award-winning paper will be the one most consistent with the RMA's goals of advancing modeling excellence to transcend divides among natural resources disciplines, and will have broad reach and implications for the natural resource modeling community. Detailed criteria for the award can be found at the RMA website [resourcemodeling.org/awards](http://resourcemodeling.org/awards).

The authors of the winning paper will each receive the Rollie Lamberson Medal. In addition, one author will be invited to deliver the Rollie Lamberson Award address in a plenary session of the RMA conference, including subsidized attendance at the conference.

## Lamberson Award Winners

by Rollie Lamberson and Bob Fray

The first ever winners of the prestigious Lamberson Medal for an exemplary research paper in resource modeling were presented at the conference banquet of the 2016 World Conference on Natural Resource Modeling. The winners are Encarna Esteban and Ariel Dinar for their paper "The Role of Groundwater-Dependent Ecosystems in Groundwater Management," and Nina Sidneva and Eric Zivot for their paper "Evaluating the Impact of Environmental Policy on the Trend Behavior of US Emissions of Nitrogen Oxides and Volatile Organic Compounds."

Encarna and Ariel's paper addresses issues critical to the American West and around the world, over exploitation of groundwater. The authors apply optimal control theory in assessing the joint management of groundwater and groundwater-dependent ecosystems. The results are then applied to an aquifer in Spain and its associated wetland. A shortened version of this paper is published on page 2 of this newsletter.

The Sidneva and Zivot paper uses a proper and sophisticated time series approach to assess policy impacts when there is data uncertainty. They apply their methodology to assess the trends in the air pollutants, nitrogen oxides and volatile organic compounds, through the period of implementation of the Clean Air Act. Their results demonstrate that the Clean Air Act was effective in reducing air polluting emissions.

The *Resource Modeling Association* encourages all members to submit their research papers to the editor of *Natural Resource Modeling* for consideration for the Lamberson Medal as a recognition of the excellence of their research and publication. See the previous page for further details.



Eric Zivot, Nina Sidneva, Rollie Lamberson, and Encarna Esteban

## Student Award-Winning Presentation

by Bob Fray

What is the optimal management of a forest in order to decrease the severity of forest fires and the cost of suppression? This was the question Betsy Heines investigated in her talk "Assessing the Economic Tradeoffs between Prevention and Suppression of Forest Fires." Her presentation was given the award for the best student paper at the recent World Conference of the Resource Modeling Association in Flagstaff.

Betsy grew up in Louisville, Kentucky, received her bachelor's degree in mathematics from Transylvania University, and her masters degree from the University of Tennessee. Currently she is working on her doctorate at Tennessee in the area of mathematical ecology under the supervision of Professor Suzanne Lenhart. More specifically, she is working on optimal control of economic models in solving fire management in forests.

The stimulus for Betsy's research was a seminar by Professor Charles Sims, an economist at the University of Tennessee, on reducing the cost of mitigating amplified natural disturbance events. This led to the study of the work by Professor Bill Reed. She discussed her ideas with Professor Lenhart, and their collaboration ensued. Betsy expects to receive her doctorate in mathematics in August 2017.



Catherine Roberts and Betsy Heines

# Student Research Statements

## Anne-Sophie Lafuite

Centre for Biodiversity Theory  
and Modelling  
Theoretical and Experimental  
Ecology Station  
CNRS & P. Sabatier University  
lafuite.as@gmail.com

I am a final-year PhD student working under Michel Loreau at the Centre for Biodiversity Theory and Modelling. I am broadly interested in understanding and modelling the dynamics of coupled social-ecological systems (SESs) at large temporal and spatial scales. I use dynamical models to explore theoretical questions, such as the long-term consequences of ecological feedbacks on the sustainability of SESs.

Over the last two years, my main focus has been on the ecological feedback of biodiversity-dependent regulating services (e.g. pollination and pest control) on agricultural production. Habitat conversion and fragmentation have long-term effects on the structure and function of natural and semi-natural habitats. Indeed, ecological relaxation times generate a time lag between habitat conversion and biodiversity-dependent ecosystem service loss. I show that such a time lag can lead to environmental crises in the long run, i.e. a food shortage followed by large human population and well-being declines. Moreover, characteristics common to modern SESs (e.g. high technological efficiency and labor intensity) are found to increase the vulnerability to environmental crises. In order to be able to counteract these unsustainable trends, we need to define integrative sustainability objectives. My model provides integrative thresholds for biodiversity loss, land conversion and human population growth—each threshold being related to the others through the parameters of the SES. Such integrative thresholds can thus be used

to assess the effect of socio-economic changes on conservation objectives, and can be applied to a wide range of SESs.

## Jacob L Moore

Department of Evolution and Ecology  
University of California, Davis  
jlmooor@ucdavis.edu



I am a PhD candidate working with Dr. Sebastian Schreiber at the University of California Davis. Broadly, my dissertation research focuses on understanding oyster population dynamics and assessing restoration strategies. To this end, I have developed a size- and age-structured integral projection model (IPM) to describe Pacific oyster dynamics in Oregon. Using this model, I obtained three main results: 1) age- and size-structured models give a better fit to demographic data when compared to models only accounting for size-structure; 2) the long-term population growth rate is least sensitive to changes in the survival of medium-sized oysters; and 3) there are distinct differences in stable size and stable age distributions between declining, recruitment limited populations, and populations increasing in size due to high local retention. These results demonstrate the importance of including both age and size as structuring variables when modeling oyster dynamics. Additionally, the results suggest that implementing a maximum size limit, in addition to the current minimum size limit, could be an effective management strategy. Finally, patterns in stable size- and age-distributions point toward potential patterns in population structure that can be used to determine whether a population is persisting or declining toward extinction, and thus a means of evaluating the success of restoration efforts. Next, I am working to extend

the model to account for positive feedbacks in the system, as well as stochastic recruitment.

## Helen Bothwell

Department of Biological Science,  
Northern Arizona University  
Helen.Bothwell@nau.edu



I recently completed my PhD with Dr. Thomas Whitham, and am currently a post doc working with Dr. Gery Allan and Dr. Samuel Cushman at the

Center for Environmental Genetics & Genomics in Flagstaff, Arizona. Conserving whole communities and ecosystems under a rapidly-changing climate poses a major challenge. Foundation or dominant tree species have a large impact on their surrounding communities due to their role in stabilizing ecosystem processes that dependent species rely on. More closely-related host trees support more similar communities of arthropods, fungi, microbes, etc., and similar to species-area relationships, community biodiversity increases with foundation tree genetic diversity. Therefore, understanding climate change impacts on foundation species genetic diversity and structure aids conservation of not only the focal species, but also the diverse associated communities and ecosystem services they support. We are developing models that relate cottonwood tree gene flow across the landscape to geographic and climatic variables to understand both the factors that support species resiliency in the face of perturbations and restrict its capacity to adapt and migrate under future climate change scenarios. My work seeks to provide efficient and economical solutions to land stewards for conservation genetic management of forest trees and the biodiversity and ecosystem services they support.

## Barcelona Meeting

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Energy and climate economics are also areas of her work. Frank van Langevelde is a terrestrial ecologist and modeler in the Resource Ecology Group of Wageningen University, the Netherlands. The effect of constraints of animal movement and distribution due to fragmentation, food depletion and harsh weather conditions on local populations and communities of animals is the focus of Franks' research. Marc Catelinou is a Senior Fire Analyst in the General Department of Prevention and Extinction of Fires and Rescue Services of the Catalan Government located in Barcelona. He is a coordinator of research projects in the fields of forestry fuel patterns, fire ecology and fire management.

Barcelona is one of the world's most beautiful and exciting cities and the most cosmopolitan city in Spain. Restaurants and bars are always packed, as is the seaside in summer. It regards its past with pride; its city center retains its medieval street plan and contains one of the greatest concentration of Gothic architecture. But there is also stunning modern architecture, the most fascinating is La Sagrada Familia, the church to which the creative genius Antoni Gaudi dedicated the latter part of his life. In addition, there are dozens of museums including one dedicated to Picasso, another to Miro, and yet another to Barça. Spain's most famous boulevard, La Rambla, is always lively, day or night. It is packed with people, restaurants and stores.

On Tuesday, June 6, there will be excursion to Montserrat, a multi-peaked rocky mountain range compound of striking pink conglomerate. Pilgrims have been drawn to this area, Spain's first national park, since sightings of Holy Visions in 800 AD. We will visit some sites of past wildfires and hear about plans to mitigate the risk of wildfires while increasing the agricultural potential of the land.



## Transition of Editors

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Shandelle earned her PhD in mathematics at the University of Tennessee in partial differential equations with Thomas G. Hallam. As a post-doctoral student at the University of Arizona working with Jim Cushing, Shandelle began working in non-linear population dynamics using lab populations of *Tribolium* to test the theories of nonlinear dynamics in ecology. They have documented an impressive range of nonlinear phenomena in population data and have successfully linked observed lab behavior explicitly to mathematical models. As you can imagine, bird and mammal populations in the field instead of the lab introduce more complicated dynamics. Shandelle belongs to an interdisciplinary Seabird Ecology Team that develops mathematical models of complex animal behavior observed in the field. The mathematical predictions of population dynamics are tied to field data and are tested in the field. Shandelle and Jim gave fascinating keynote presentations on their most recent work at the 2016 World Conference on Natural Resource Modeling in Flagstaff, Arizona. Please visit [andrews.edu/~henson/seabird](http://andrews.edu/~henson/seabird) to learn more about this research.

Shandelle has many terrific ideas to continue to elevate the impact and reach of *Natural Resource Modeling*. For example, you will soon see a revised format for manuscripts we publish. This will include a three to five bullet list at the start of each paper describing the implications of the reported results for managers. Times are a-changing in US politics and NRM leadership; we are confident that in the case of NRM, the change will be for the good.

# Editor's Column

by Catherine A. Roberts  
Editor of Natural Resource Modeling



I am delighted to announce Shandelle Henson as the new Editor-in-Chief of our society's journal *Natural Resource Modeling*. She will begin her term in January 2017.

Please keep an eye out for the first issue of Volume 30, a special issue edited by Luc Doyen from papers

given at the World Conference on Natural Resource Modeling in Bordeaux, France in 2015. This special issue is devoted to the theme "Modeling and Sustainability of Biodiversity and Ecosystem Services." The papers of this special issue are complementary and give an interesting overview of modeling challenges underpinning the management and conservation of biodiversity. They cover

a large spectrum in terms of methods and applications. In terms of applications, they range from fisheries to agriculture, forest or groundwater issues. As regards methods, optimal control, game theory, risk management are major tools mobilized. The authors of this special issue are Martin Drechsler, Frank Wätzold, Christopher Costello, Daniel Kaffine, Robert D. Cairns, Daniel Ryan, Carl Toews, Paul R. Armsworth, James N. Sanchirico, Quentin Grafton and Richard Lorne Little.

*Please remember that membership in the Resource Modeling Association includes expedited reviews of manuscripts you submit to our journal. It also includes online access to our journal. If you do not know how to access this, please send an email query to Michael Maroney at [mmaroney@wiley.com](mailto:mmaroney@wiley.com).*



## RMA MEMBERSHIP INCLUDES:

- Subscription to the journal *Natural Resource Modeling* (NRM)
- RMA Newsletter
- Reduced registration fee for the annual conference
- Eligibility for the Rollie Lamberson Award
- A 25% discount on all Wiley and Wiley-Blackwell product lines

*The official newsletter of the  
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Bob Fray, editor  
[bob.fray@furman.edu](mailto:bob.fray@furman.edu)

Mathematics Department  
Furman University  
3300 Poinsett Highway  
Greenville, South Carolina 29613