CEES

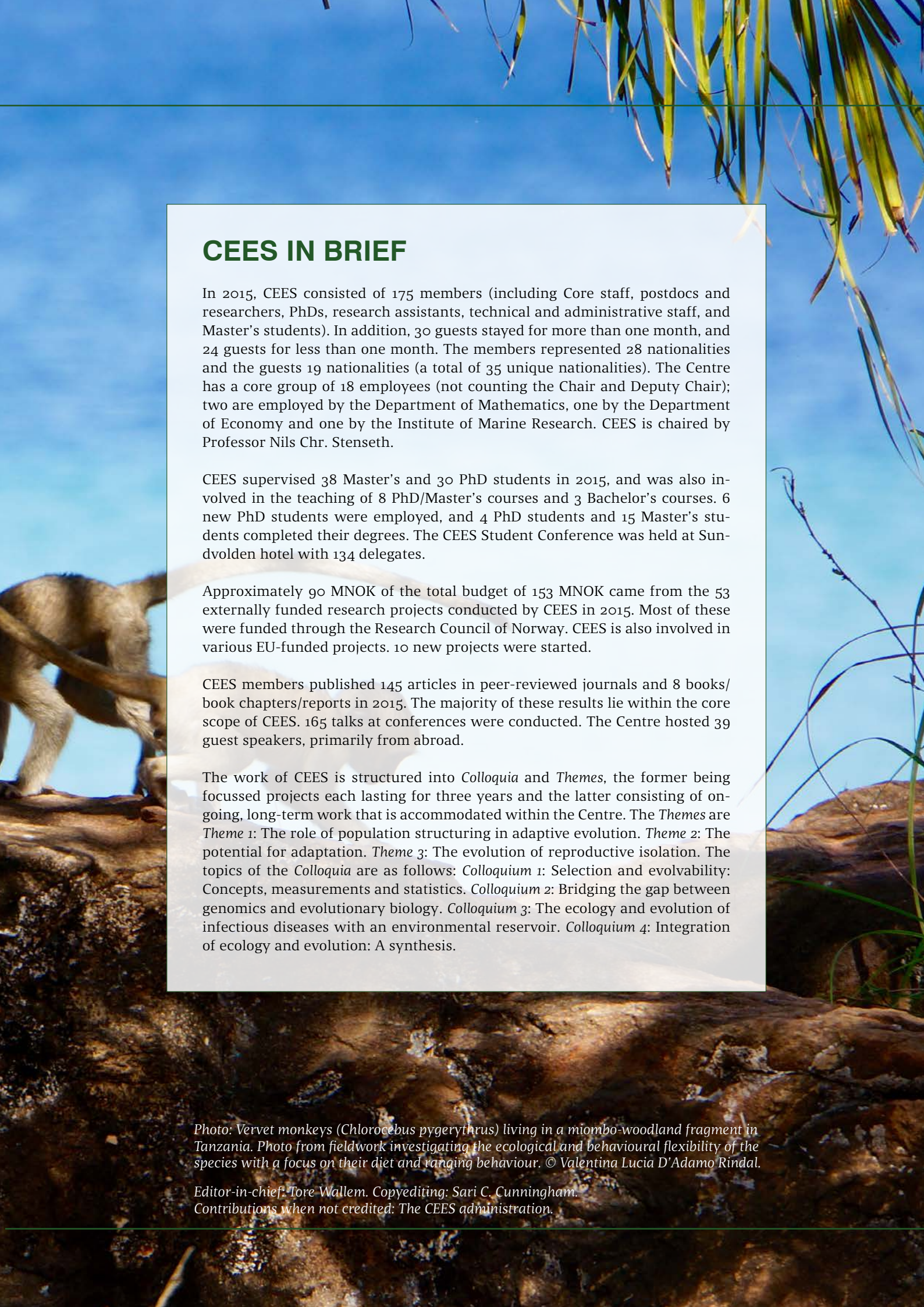
Centre for Ecological and Evolutionary Synthesis

2015 | ANNUAL REPORT

UiO : University of Oslo

The Centre for Ecological and Evolutionary Synthesis (CEES) combines a broad spectrum of disciplines (such as population biology, statistical and mathematical modelling, and genomics) to foster the concept of ecology as a driving force of evolution via selective processes, with a corresponding influence of evolutionary changes on ecology.

Cover photo: Great gerbil (Rhombomys opimus), southern Kazakhstan, Central Asia. Plague is a bacterial disease that predominantly persists in wildlife rodents and their fleas. CEES researchers observed that during the second plague pandemic climate fluctuations in Asia were followed by new waves of plague arriving first in southern Russia, and then into European harbours. Likely, in each of these waves, plague outbreaks in one of Asia's natural rodent reservoirs reached the trade routes, and spilled over into human civilisation. *See page 17.* *© Nurlan Kalchinov / Alamy Stock Photo.*



CEES IN BRIEF

In 2015, CEES consisted of 175 members (including Core staff, postdocs and researchers, PhDs, research assistants, technical and administrative staff, and Master's students). In addition, 30 guests stayed for more than one month, and 24 guests for less than one month. The members represented 28 nationalities and the guests 19 nationalities (a total of 35 unique nationalities). The Centre has a core group of 18 employees (not counting the Chair and Deputy Chair); two are employed by the Department of Mathematics, one by the Department of Economy and one by the Institute of Marine Research. CEES is chaired by Professor Nils Chr. Stenseth.

CEES supervised 38 Master's and 30 PhD students in 2015, and was also involved in the teaching of 8 PhD/Master's courses and 3 Bachelor's courses. 6 new PhD students were employed, and 4 PhD students and 15 Master's students completed their degrees. The CEES Student Conference was held at Sundvolden hotel with 134 delegates.

Approximately 90 MNOK of the total budget of 153 MNOK came from the 53 externally funded research projects conducted by CEES in 2015. Most of these were funded through the Research Council of Norway. CEES is also involved in various EU-funded projects. 10 new projects were started.

CEES members published 145 articles in peer-reviewed journals and 8 books/book chapters/reports in 2015. The majority of these results lie within the core scope of CEES. 165 talks at conferences were conducted. The Centre hosted 39 guest speakers, primarily from abroad.

The work of CEES is structured into *Colloquia* and *Themes*, the former being focussed projects each lasting for three years and the latter consisting of ongoing, long-term work that is accommodated within the Centre. The *Themes* are *Theme 1*: The role of population structuring in adaptive evolution. *Theme 2*: The potential for adaptation. *Theme 3*: The evolution of reproductive isolation. The topics of the *Colloquia* are as follows: *Colloquium 1*: Selection and evolvability: Concepts, measurements and statistics. *Colloquium 2*: Bridging the gap between genomics and evolutionary biology. *Colloquium 3*: The ecology and evolution of infectious diseases with an environmental reservoir. *Colloquium 4*: Integration of ecology and evolution: A synthesis.

Photo: Vervet monkeys (Chlorocebus pygerythrus) living in a miombo-woodland fragment in Tanzania. Photo from fieldwork investigating the ecological and behavioural flexibility of the species with a focus on their diet and ranging behaviour. © Valentina Lucia D'Adamo Rindal.

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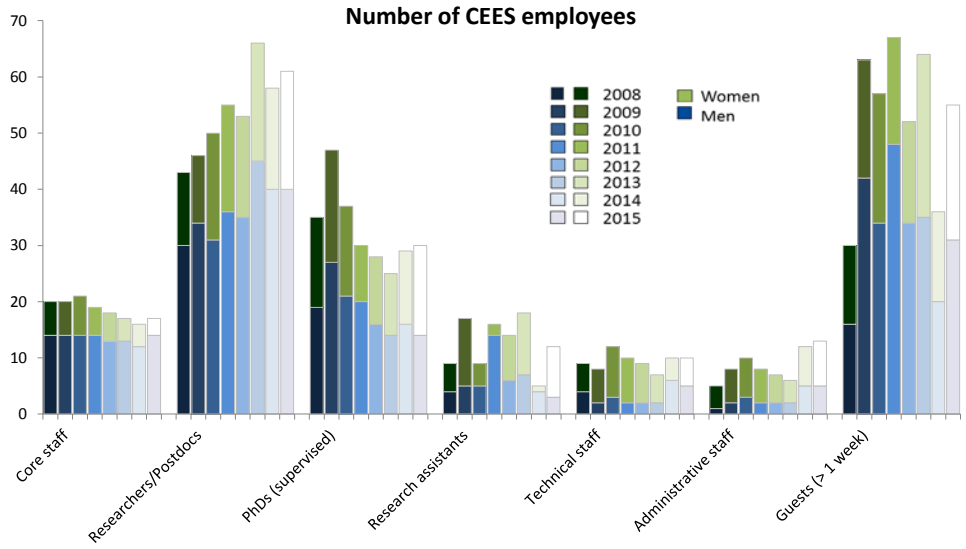

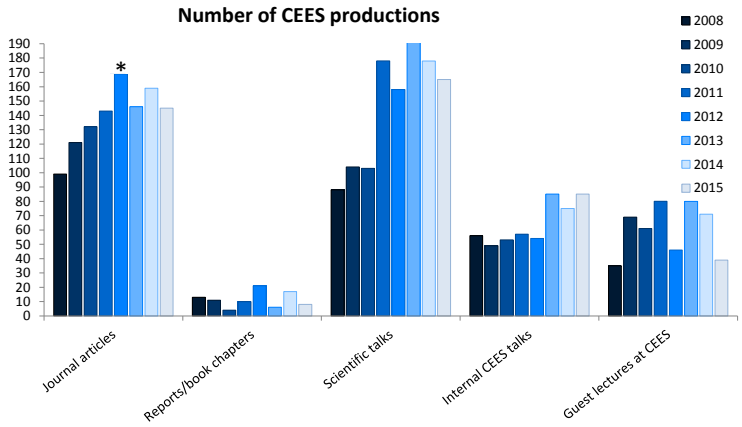

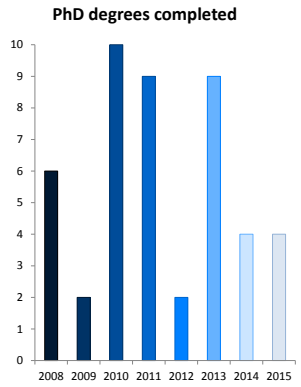

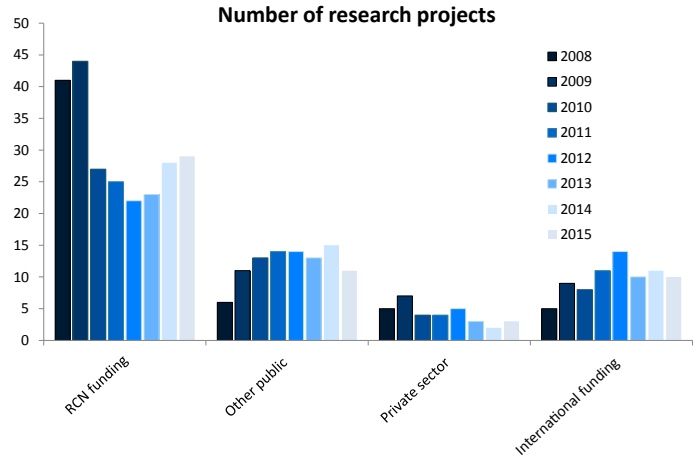

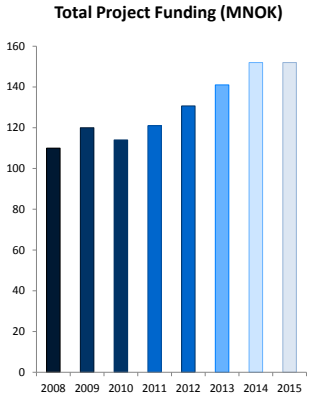

*A change in the national routines for registering publications (inclusion of online first) skews the numbers in favour of 2012.

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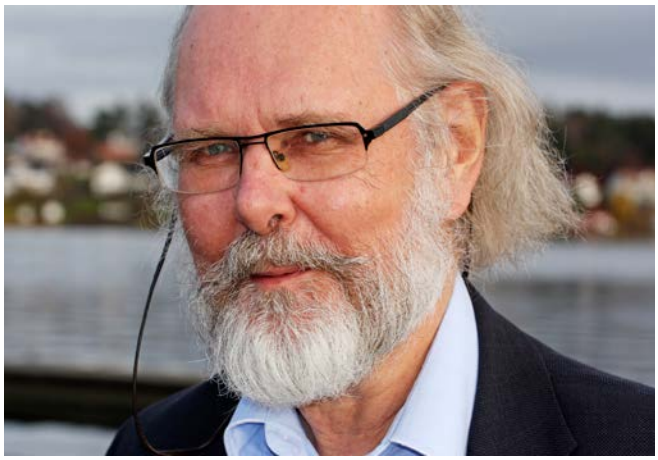
1 THE CHAIR'S COMMENTS



Chair Nils Chr. Stenseth. © Eva C. Simensen.

Having assessed the progress that CEES has made during 2015, I am pleased to see that we have maintained a high level of activity within the Department of Biosciences. We continue to lead with regards to our scientific output, and the non-technical communication of both evolutionary biology and science in general. During 2015, we published 145 peer-reviewed articles in established journals, and kept up our strong public presence both online and through the media. Additionally, we secured a sizable amount of external funding, totalling 153 MNOK (divided over 53 projects). Our community continues to evolve, as by the close of the year the CEES family had 175 members – 18 core members (not counting the Chair and Deputy Chair), 45 postdocs/researchers, 25 PhD students, 23 Master's students, 6 technicians, and 7 administrative staff members. Our family is diverse (when including our guests, we had 35 nationalities represented in 2015), young and dynamic (the median age of our members, not including the Master's students, was 37). We are proud of the young researchers that we have educated – in 2015 15 Master's students and 4 PhD students graduated from CEES.

Given the level of productivity and success that we have achieved, it is difficult to come to terms with the fact that our Centre of Excellence (CoE) is nearing its planned conclusion in the autumn of 2017. It is obvious that we ought to capitalise on our success and continue as a research and training centre, as pointed out by both the Board and the Scientific Advisory Board (SAB) (see page 11). Indeed, our aim is to continue as a centre, maintaining the excellent infrastructure and management that we have in place (an administrative staff that serves our scientists – both students and faculty), and benefitting from the CEES trademark which is recognised both nationally and internationally. I am convinced that both the department as well as the entire university will benefit from this, as was the intention when the Centre of Excellence programme was established in 2003 by the Research Council of Norway and the Norwegian Government.

In 2015 we secured several new prestigious projects, covering a broad range of research interests. What follows is a taste of the exciting research to come:

MARmaED (Marine Management and Ecosystem Dynamics under Climate Change). MARmaED is designed to explore and investigate marine ecosystem change from physical and biological effects to economic management implications, and is unique in the way in which it will integrate effect studies with economic perspectives. The project has a broad range of academic and non-academic partners. A key element is the 15 PhD positions that will be used to create new trans-disciplinary collaborations encouraged by specifically tailored secondments in the non-academic sector. Joël Durant is the coordinator of MARmaED.

SUSTAIN (Sustainable management of renewable resources in a changing environment: an integrated approach across ecosystems). In this project, three research groups within ecology and evolution in Norway will join efforts to study the combined impacts of environmental change and harvesting across marine, freshwater and terrestrial ecosystems. This effort will counteract the currently profound fragmentation within Norwegian environmental science, and establish collaboration net-

works for a new generation of scientists and managers. The two nodes in addition to CEES (where I'm the project leader) are: the Centre for Biodiversity Dynamics (CBD, Norwegian University of Science and Technology, NTNU, where Bernt-Erik Sæther is the project leader) and the Department of Arctic and Marine Biology (University of Tromsø, UiT, where Rolf Anker Ims is the project leader). Two of a total of six Work Package (WP) leaders are from CEES: Joël Durant and Øystein Langangen.

ECOVAR (Managing ecosystems in an increasingly variable world). This project will advance our knowledge of biological responses to climate variability, through a synergistic combination of approaches: theoretical analyses using stochastic population and food-web models, comparative meta-analyses of observational data, and a detailed experimental study. Combined, these approaches will improve our understanding of underlying life history properties, ecosystem responses, and climate variability. The project leader for ECOVAR is Yngvild Vindenes.

On the role of hybridisation in evolution – the case of Eurasian *Passer* sparrows. This project will use *Passer* sparrow species as the model system, and a unique combination of state-of-the-art technology in genomics and morphometrics. It proposes to address three urgent challenges in evolutionary biology: 1) How does hybridisation affect genome evolution? 2) How does reproductive isolation evolve between a homoploid hybrid lineage and the parental populations? 3) What are the consequences of hybridisation for adaptation and diversification? The project will result in a novel understanding of the modularity of the genome, of the processes of adaptation and speciation, and of the role hybridisation plays in speciation. Glenn-Peter Sætre is the project leader for this project.

MarGen. This project is based in the Skagerrak/Kattegat area, and comprises an international consortium of researchers from seven different institutes. Broadly, MarGen will focus on marine and freshwater ecological questions. One of the main goals will be to utilise the newest methodologies within genome analysis, electronic tagging, and data modelling, in order to address how fish are able to adapt and survive under climate change. The results will have implications for sustainable management of fisheries and marine ecosystems. The project leader for MarGen is Halvor Knutsen.

Two colloquia are currently running – *Colloquium 3* (Ecology and evolution of infectious diseases) and *Colloquium 4* (Integration of ecology and evolution). Within the umbrella of *Colloquium 3* we are actively carrying out field-, lab- and theoretical work.

Our work on plague – a key component of *Colloquium 3* – flourishes. 2015 kicked off with a publication in *PNAS* by Schmid *et al.* (see page 17). In this publication we presented statistical evidence that plague was imported to Europe several times during the Medieval period in response to favourable climatic conditions in Central Asia. This publication sparked tremendous international media attention, giving us an opportunity to explain our research to a broad audience. According to Nature Index, this publication received the highest altmetric score (an indicator of the amount of attention) of all publications from the University of Oslo in 2015. Currently we are testing our hypothesis presented in the publication using ancient DNA techniques, as part of the work being funded by the multidisciplinary ERC advanced grant investigating the medieval plague pandemics (MedPlag).

Our collaboration with our Chinese counterparts on plague research continues, involving experimental work both in the field and the laboratory in order to understand both the evolution of virulence as well as the possible evolutionary effects of climate change. A new and exciting development for us is our partnership with Chinese archaeologists working on possible ancient plague

1 THE CHAIR'S COMMENTS

epidemics in China. It is still too early to report any results, but I am convinced that I will be able to do so in future annual reports. One thing, however, is clear: without the very good Chinese collaborative links that we have established, much of our work on plague would have been impossible.

Recent funding through the RCN's INTPART programme for PlagPART – a Norwegian-Russian-Chinese research and training network on the study of plague – will prove very important for the continuation of this work. The main objective of this project is to develop a highly visible international consortium under the leadership of CEES, playing a central role in the training of PhD students in research on the ecology and evolution of infectious diseases with an environmental reservoir, using plague as the focal model and study system. The project received funding for 3 years (2016-2018) with a total budget of 4.5 MNOK. This will enable the project to organise the exchange of PhD students and researchers between Norway and Russia and China, as well as to arrange workshops and guest lectures.

Our name includes the word "synthesis", and the synthesis of ecology and evolution is the main focus of *Colloquium 4*. I was pleased to note that the SAB now feels that our effort towards achieving this synthesis is (finally) coming along. During 2015 we started working on a book on the subject of how to bring together ecological and evolutionary thinking. In this book we will report on the work we have done within CEES towards bridging ecology and evolution, as well as have external colleagues contribute individual chapters. This work will definitely constitute an important part of our work during the remaining years of our CoE period, and will add to our legacy.

Closely linked to our overall work on synthesis, is the work on the Red Queen co-evolutionary theory (see page 24). It has taken a long time for this work to mature – but now it is coming to full flower. We now have a critical number of people working on this hypothesis – both theoretically and experimentally (using bacteria as an experimental system). An important development in our work on the Red Queen hypothesis is our partnership with Professor Jan Nordbotten from the University of Bergen – a mathematician working on differential equations with evolution of the structure of the system (i.e., coupling ecology and evolution). This work has sparked several developments which I will return to in next year's Annual Report.

The CEES ancient DNA (aDNA) laboratory was officially opened on 21 May 2015. Although the opening of this new and modern laboratory was quite a bit delayed, I am pleased to observe that it is now heavily used by several members of CEES as well as external colleagues. The establishment of this lab – indeed one of the best ancient DNA laboratories worldwide – is a collaborative effort involving UiO's Department of Biosciences (IBV), CEES, the Museum of Cultural History (KHM), and the Natural History Museum (NHM). I am sure this collaborative effort will contribute towards making CEES an attractive partner on various future projects, especially as we can build off of our excellent genomics facilities as well as our very broad scientific platform covering both classical ecology and evolution.

Core members. I would like to welcome Joël Durant and Leif Christian Stige as new CEES core members. You have both contributed significantly to the success of CEES, and I look forward to your contributions in the years to come. Camilla L. Nesbø left the core in 2015, for new opportunities in Canada; Camilla, I would like to thank you for all of your contributions to CEES.

Congratulations to our 2015 award recipients. 2015 was once again a year in which several of our members achieved prominent awards, and I would like to take this opportunity to highlight a few of them. **Sissel Jentoft** was appointed Associate Editor for the *Journal of Animal Ecology* in January. **Anders Nielsen** became a member of the Norwegian Scientific Committee for Food Safety's Panel on Alien Organisms and Trade in Endangered Species (CITES). **Asbjørn Vøllestad** was appointed membership in the Academia Europea. **Kjetil Lysne Voje** was awarded a

Young Research Talent grant from the Research Council of Norway to investigate "Dissecting evolutionary rates across time: Bridging micro- and macroevolution". Last, but not least, the research of **Kjetill S. Jakobsen** and his team on the immune system of cod (*Gadus morhua*) has literally rewritten the textbook, as it was highlighted in a chapter in *Biology: The Dynamic Science*. Congratulations to all of you!

Thanks. I would like to thank Sissel Jentoft for her excellent work as Deputy Chair, helping me make CEES an exciting hub for the merger of ecology, classical evolutionary biology, and genomics. I would like to thank Anne K. Brysting for being a valuable link to the department management. I'd like to thank all members of CEES: the scientific staff for doing great science, and the administrative and technical staff for making it possible to do so. As I have said in previous years: Excellence starts with people – without talented people grant money is of little use. At CEES, we have both talented people and excellent funding sources. To all members of CEES – your contributions make our centre such a stimulating place to work at, both intellectually and socially.

Thanks!

Cherie Enawgaw Beyene (1968–2015)

We are deeply sorry to have to report that Cherie Enawgaw Beyene, PhD student at CEES/IBV, died in Addis Abeba, Ethiopia, on 2 July 2015. He died at Addis Cardiac Hospital, after a short time of feeling ill. He had just returned to his homeland of Ethiopia in order to undertake the second field season on the long distance migration of white eared kob in Ethiopia and southern Sudan.

We express our deepest condolences to his family and friends.

2 MANAGEMENT AND ADMINISTRATION

CEES is established as a Centre of Excellence (CoE) by the Research Council of Norway (RCN). It is hosted by the Department of Biosciences (IBV) under the Faculty of Mathematics and Natural Sciences at the University of Oslo (UiO). The research at IBV is divided into five sections, of which CEES is the largest. RCN and UiO are the main financial contributors and constitute the final reporting entities that define the guidelines under which the Centre operates.

Administrative structure

Administrative structure

The Centre is run on a daily basis by the Chair, the Deputy Chair and the CEES administrative team. The Chair and Deputy Chair communicate on a daily basis regarding scientific progress within the Centre. Management and strategic issues are dealt with at weekly meetings. In order to facilitate the running of CEES, and to provide a good cooperative relationship with its host, IBV, weekly meetings are conducted where the Head of Department, the Head of Administration at the Department, representatives from the economy section and HSE, and a representative from the CEES administrative team are all present.

The CEES administrative team is responsible for the daily running of the Centre. This includes managing the budget and accounting, coordinating funding proposals and reporting (RCN, EU and other), employment, and ensuring that guest researchers are well received and enjoy their stay. It also includes implementing arrangements like weekly seminars, conferences, workshops and public lectures, maintenance of the website, and contact with the media. The administrative team also organises and takes minutes at all Core-, Board-, and SAB meetings. Most of the general correspondence with the university, the department, RCN and the media goes through the CEES administration. In addition, the CEES Lab Board is responsible for the running of the laboratories, and arranges a mandatory introduction course for new users.

Chair	Nils Chr. Stenseth, Professor
Deputy Chair	Sissel Jentoft, Researcher and Project Coordinator
Administrative team	Gry Gundersen, Senior Adviser Kari B. Rygg, Senior Adviser Delphine C. Nicolas, Adviser Tore Wallem, Adviser Ane Mari Bjørnæs, Higher Executive Officer (from August 2015) Camilla S. Thomsen, Higher Executive Officer (until August 2015) Alexander E. Egidius, Executive Officer (part time, until August 2015)
Lab Board	Anne K. Brysting, Professor, Leader of the Lab Board Kjetill S. Jakobsen, Professor Cecilie Mathiesen, Head Engineer Nanna W. Steen, Head Engineer Ave Tooming-Klunderud, Senior Engineer
Administrative Leader of Fieldwork Resources	Atle Mysterud, Professor

The Board and the Scientific Advisory Board

The CEES Board is an administrative body that meets approximately twice a year to focus on strategic and control functions as well as approving budgets, accounts and annual reports.

The Board	Home institution
Chair	
Knut Liestøl	Head of the Department for Informatics, University of Oslo, Norway
Members	
Rolf A. Ims	Department of Arctic and Marine Biology, University of Tromsø, Norway
Finn-Eirik Johansen	Chair of the Department of Biosciences, University of Oslo, Norway
Hanne C. Winther-Larsen	School of Pharmacy, and Centre for Integrative Microbial Evolution (CIME), University of Oslo, Norway
Bernt Øksendal	Centre of Mathematics for Applications, Department of Mathematics, University of Oslo, Norway

Comments by the Board Chair: Knut Liestøl

The Board met twice in 2015, on 11 March and on 22 October. The agendas included budgets; reports on economy, applications and funding; and discussions on strategic issues, with emphasis on the continuation of core CEES activities past the end of the Centre of Excellence period in 2017.

The Centre's economy is sound and well-managed, and the long-term budget indicates a satisfactory economy also for the remaining Centre period. Nevertheless, continued work on securing new funding is vital to keep up the high activity level of today. Thus, the Board is pleased by the continued high focus on applications. A total of about 50 applications were sent to the Research Council of Norway (RCN), EU/European Research Council (ERC), and other funding agencies. The Board is pleased to see that several application submissions in 2015 were successful, including a RCN "Toppforsk" grant that was awarded substantial funding, and a Centre of Excellence application that at the time of writing is in the final round of the selection process. Moreover, the Board is impressed with the continual output of high-quality science, which in 2015 included a paper on climate-driven introduction of the Black Death into Europe (Schmid *et al.* 2015 *PNAS*) that became the University of Oslo's most cited paper.

We once again saw high activity with regards to the number of seminars, workshops, conferences, and other scientific meetings held in 2015. An impressive list of foreign guests visited and worked at the Centre. Additionally, events like the Darwin Day and the Kristine Bonnevie Lectures were well organised and well attended.

The Scientific Advisory Board (SAB) states that "CEES is internationally unique in producing high quality research that empirically integrates ecology and evolution", and that the science conducted "is now genuinely world-class". Moreover, the SAB notes the "careful nurturing of excellent young researchers" and "a uniquely vibrant and creative research environment".

Given these statements, the pressing strategic issue is to ensure the continuation of the core CEES activities past 2017. While the research funding system includes several options for funding specific projects, obtaining resources for the continuation and management of a "vibrant and creative research environment" is much more challenging. Accordingly, supporting actions to obtain such funding will be given the highest priority by the Board in the coming period.

The Board wants to congratulate all members of the CEES scientific staff and management team with another very successful year.

Knut Liestøl

2 MANAGEMENT AND ADMINISTRATION

The CEES Scientific Advisory Board (SAB) has been appointed by the CEES Board. The SAB holds an annual meeting, and provides invaluable feedback on the research carried out at CEES. In 2015, the SAB meeting was held at the University of Oslo from 3–4 September.

The Scientific Advisory Board	Specialisation and home institution
Chair	
Rita R. Colwell	Microbiologist, University of Maryland, USA
Members	
Tim Coulson	Population Biologist, Imperial College, London, UK
Edward J. Feil	Microbiologist, University of Bath, UK
Olivier Gimenez	Biostatistician, Center for Functional and Evolutionary Ecology (CEFE), France
Barbara Mable	Evolutionary Biologist, University of Glasgow, UK
Anne Magurran	Behavioural Ecologist, University of St. Andrews, UK
Gordon H. Orians (Corresponding member)	Evolutionary Biologist, University of Washington, Seattle, USA

Comments by the Scientific Advisory Board Chair: Rita R. Colwell

The Scientific Advisory Board (SAB) held its annual meeting at the University of Oslo from 3–4 September, 2015. CEES scientists presented their ongoing work and reported exciting and carefully conducted research. The disease work that was presented was impressive, as were studies of hybridisation in birds and micro- and macroevolution in fish. The results demonstrated that CEES researchers are empirically integrating ecology into genomics and evolutionary research, and vice versa. It is clearly evident that CEES is internationally unique in producing high quality research that empirically integrates ecology and evolution, and is at the forefront when it comes to groundbreaking results. Presentations to the SAB were a mixture of five minute "late breakers" on key scientific questions, followed later in the sessions by more detailed talks which covered the last few years of work. A number of detailed presentations were delivered representing a mixture of proposals and recently funded projects. Based on the impressive research presented, the SAB could clearly conclude that CEES has been a resounding success.

Although CoE funding will continue for two more years, it is obvious that the quality of science generated at CEES is now genuinely world-class. The Centre has played to its strengths extremely well and has considerably developed core research foci (within e.g. infectious disease, aquatic and terrestrial science, speciation, and genomics) to such an extent as to enable outstanding contributions within these fields. Perhaps more importantly, the collaborative networks, methodology and model systems established at CEES should provide a fruitful research base well into the future. This has been achieved through the careful nurturing of excellent young researchers, shrewd investments in technology (such as the Norwegian Sequencing Centre and the ancient DNA laboratory) but also, less tangibly, by actively pursuing

a uniquely vibrant and creative research environment. More specific achievements are also notable – the focus on outreach and the excellent web presence of the Centre, and the mindful and progressive consideration of gender issues and egalitarianism in the workplace.

However, serious challenges do remain and with the impending end of core funding there are inevitably some uncertainties. Although it is very reassuring that there is clearly so much effort currently invested into future funding, it would seem astute to carefully consider strategies for reinforcing bridges locally within the department, and perhaps elsewhere in the university. CEES has much to offer as a model of a successful and ambitious research environment, and there is no reason why the achievements of CEES could and should not ripple outwards. This would also in turn help to ensure the legacy of the CoE through a strengthening of the status, visibility and world standing of the department, the university, and indeed Norwegian science in general. Most importantly, by securing the future of CEES the department would achieve international recognition for scientific excellence and leadership in the synthesis of ecology and evolution.

A more specific legacy pertains to an assessment of the degree to which a successful "synthesis" between ecology and evolution has been achieved, or even whether it is clear that this means the same thing to different research groups. It would indeed be a useful exercise over the coming year for each group to reflect on its own research within the context of the over-arching mission statement of CEES.

The SAB has concluded that it would be helpful for CEES, at this stage of its development, to construct an overarching framework to contextualise its approaches to the synthesis of ecology and evolution that characterises the research being done. There are several potential approaches. The Red Queen theory that Professor Stenseth has pursued and recently made progress on may provide one such model[1,2]. A useful first step could be to identify theoretical work that attempts to link ecology and evolution and use empirical work on each system to challenge predictions. The SAB considers that such an approach could provide the synthesis proposed in *Colloquium 4*.

Clearly as CEES approaches the end of its 10 year funding cycle, there is rightfully a strong focus on its legacy. There is no question that the legacy of CEES will be represented by research outputs and follow-on projects. The science needs to be defined so that the legacy of CEES can be promulgated. In a digital age, publishing a book in print may not be the best method to reach the widest audience. Career advancement is likewise less dependent on traditional venues of publication since some of the metrics now employed for fellowships, academic positions, and promotions exclude books, e.g. emphasis is placed on citation counts and H-indices. The SAB would therefore like to see an initial review article in a journal, for example *Trends in Ecology & Evolution* (*TREE*), employing case studies from CEES to demonstrate the value of integrating ecology and evolution and highlighting the major issues and questions that remain to be answered. Likewise, it would be interesting to see a special issue of a journal focussed exclusively on specific scientific questions pertaining to the legacy of CEES. There are suitable journals for this, including *Ecology & Evolution*; *Evolutionary Ecology*; and *Evolutionary Applications*. A review paper in *TREE* (or perhaps even *Nature* or *Science*) could be influential, and relatively straightforward. One key issue, however, is that a synthesis of ecology and evolution needs to consider the field as a whole, although CEES output will inevitably be an important component, particularly with regards to case studies.

There are many possibilities open to further disseminate the research of CEES: A monograph for a relevant series (e.g. by Princeton or Oxford), whereby one or a few authors would take on the challenge of producing an integrated synthesis. An issue of a relevant journal (ideally open access) with a focus on CEES research is another option, as is an issue (or part thereof) of a relevant journal in which respected researchers from across the field (including but not restricted to those from CEES) provide their ideas on the synthesis between ecology and evolution. Contributions to a blog such as Dynamic Ecology – or perhaps even a new stand-alone CEES one would provide an opportunity to interact with and receive feedback from the wider community. Finally, a bid to run a high-profile conference or symposium, such as a *Royal Society Discussion Meeting* and similar such meetings could include other external expertise as well.

In any case, whether a book and/or edited journal volumes may be appropriate for promulgating the extensive and valuable work of CEES needs to be further discussed. Each publication venue has its risks and

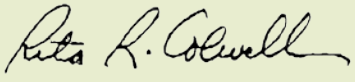
advantages, and requires considerable investments of both time and energy. Therefore, the best strategy for CEES researchers to have their work widely read and cited will require further deliberation.

The SAB also discussed the legacy of CEES with senior administrators at the University of Oslo, who clearly appreciate that CEES has produced internationally acclaimed science. Concerns were raised that this success and momentum would be lost upon completion of the CoE. A failure of the university to invest in CEES in terms of further appointments could turn this view into a self-fulfilling prophecy, as lack of support and investment would almost certainly negatively impact research conducted by CEES, as well as its profile. Conversely, the university's continued support and investment would allow CEES to flourish.

Additional observations by the SAB are that CEES continues to produce cutting-edge research on a wide range of topics, much of it driven by young and dynamic researchers. The morale within the Centre of Excellence has improved substantially over the years and it is now a place with an international reputation for attracting the highest quality of young researchers who are very comfortable with the opportunities and challenges offered at CEES. Reluctance to move on to positions in other institutions is testament to the positive dynamics within CEES. While this is overall highly commendable, there is some concern as to the implications for the careers of individuals at the end of the CEES era. While most of the current funding is obtained outside of the core CEES budget, without the umbrella of the CEES brand there is a need to identify a strategy for long-term career stability for the young researchers who have driven its success. An interesting suggestion was posed that universities in Norway might consider and benefit from developing a more flexible funding model to allow more dynamic hiring processes. Such a model could link the Norwegian Research Council and/or the Norwegian Government to successful Centre of Excellence initiatives, perhaps employing a metric such as success in obtaining external research funding and/or quality/quantity of publications. This additional funding could be earmarked for recruitment and/or retention of high-quality researchers within the areas of expertise associated with specific centres.

In order to start the task of legacy building, each CEES researcher could construct a single sentence summary as to what he/she perceives to be the main achievement(s) of CEES as well as its gaps – namely what questions still linger at the end of 10 years. Researchers could also be asked to prepare statements to showcase their understanding of the synthesis between ecology and evolution and these statements could be presented at a workshop, email, or conference/retreat. Ecologists and evolutionists should assemble and ask, for each level of organisation, what new insights they gained from each other that enriched their understanding of the fields of e.g. behavioural ecology, population ecology (insights into population structure, population interactions), community ecology (much from the excellent work on diseases), ecosystem ecology, and evolution (where the organising framework would probably be timescales).

Synthesis is a core component of the CEES mission. Achieving a synthesis between ecology and evolution will be the signature of CEES. Furthermore, if the department and the university invest in a future for CEES, it is clear that the international recognition already achieved by CEES will be significantly enhanced, to the benefit of not only CEES but the department and the university as well. To this end, maintaining the excellent administrative structure will of course be crucial. Most importantly, the most effective investment that the department and the university could make would be to allocate tenured positions in the field of ecology and evolutionary synthesis linked to genomics and underpinned by molecular biology.



1. **Voje, K. L.**, **Holen, Ø. H.**, **Liow, L. H.**, **Stenseth, N. C.** (2015). The role of biotic forces in driving macroevolution: beyond the Red Queen. *Proceedings of the Royal Society B. Biological Sciences*, 282, 20150186.

2. Nordbotten, J. M., **Stenseth, N. C.** (2016). Asymmetric ecological conditions favor Red-Queen type of continued evolution over stasis. *Proceedings of the National Academy of Sciences of the United States of America*, 113 (7), 1847–1852.

CEES as a contributor of resources at the Department of Biosciences

CEES is approaching the end of its 10-year period as a Centre of Excellence (CoE). During this period, CEES has had well-working financial and administrative agreements with its host department, the Department of Biosciences (IBV). As the CoE period comes to an end, these agreements will naturally be subject to revision in the near future. With this in mind, we think that it is important to highlight that CEES has contributed significantly to IBV with our administrative services.

CEES has, for most of the Centre period, received administrative support from IBV in the form of two full-time administrative positions (currently filled by Gry Gundersen and Kari B. Rygg – see page 10). The CoE funding has additionally (also for most of the Centre period) covered the payment for two full-time administrative positions (currently filled by Tore Wallem and Ane Mari Bjørnæs). At the same time, CEES has taken on the responsibility, which normally rests with the department, to e.g. perform HR-administration, project administration, hourly wage payments, and dealing with invoices and reimbursements.

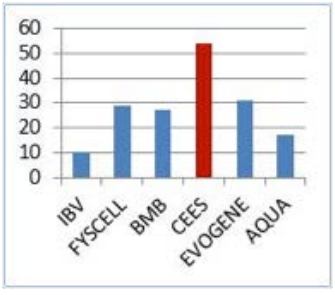
CEES members make up about 1/3 of the people employed at IBV. Therefore, supporting CEES with an administrative position that dedicates itself to HR (one out of a total of three such positions at IBV) should not be seen as pure support to the Centre. Likewise, CEES owns around 1/3 of the projects at IBV. Therefore, supporting CEES with an administrative position dedicated to project administration should not be seen as pure support to the Centre either.

In addition, a full-time economy consultant (Ane Mari Bjørnæs) is paid by CEES. For the period 2014/2015 she (and her predecessor) handled 1/3 of the department's total hourly wage payments and travel- and other reimbursements, as well as ¼ of all invoices. This constitutes pure support from CEES to IBV.

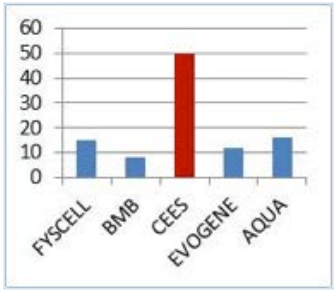
One full-time adviser (Tore Wallem), paid by CEES, supports the department by registering researcher's activities in CRIStin (the Current Research Information System in Norway); the rest of his duties encompass CEES-related work, though the scientific and public seminars he coordinates benefit the whole department.

It is also important to mention that the full salary for the CEES chair (Nils Chr. Stenseth) has been paid by the Centre for the full 10-year CoE period (as required by the Research Council of Norway for all CoEs), instead of by IBV's payroll (freeing up money at IBV that has been used to support other activities at the department).

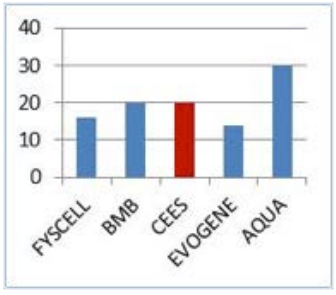
Taking the above facts into consideration, it is obvious that CEES has been a net contributor of resources to the department. Combined with a closer look at the level of CEES production in relation to that of other sections at IBV (figure 1), it is clear that CEES plays a crucial role within the department.



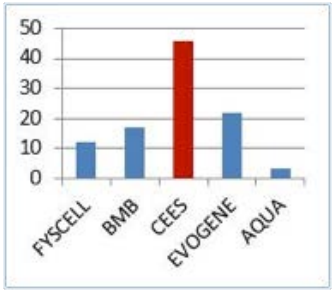
Distribution of IBV projects among sections (counts) for the year 2015.



Publication points (%).*



Distribution of teaching effort (%).*

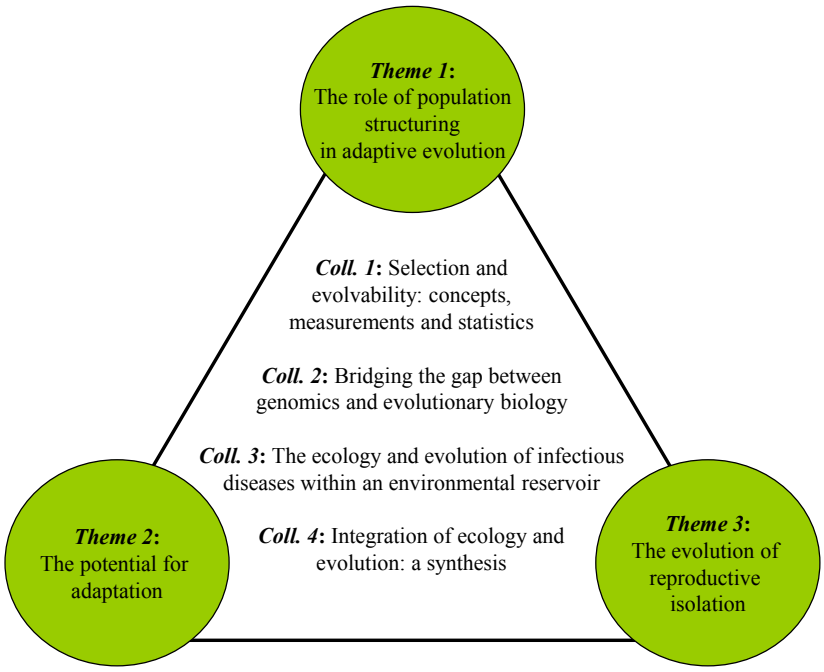


Overhead contributions between sections (%).*

*Figure 1: CEES production compared with the four other sections at IBV (*Numbers are taken from production-based income distributed to the sections in 2015, based on production in 2014).*

3 SCIENTIFIC ACTIVITY

"Bridging the gaps" has become a trademark of CEES – fitting very well with our overall aim of bringing ecological and evolutionary thinking closer together. CEES has been successful in getting classically trained, organismic-oriented scientists (focussing on both ecological and evolutionary processes) to work together with genomics-oriented scientists. That in itself is an achievement we are very proud of, and we consider it a major accomplishment. To a large extent it has been made possible by the work within *Colloquium 2* ("Bridging the gap between genomics and evolutionary biology") and the subsequent work building upon that colloquium. Our work on the ecology and evolution of cod populations and on the hybrid speciation in sparrows – both part of *Colloquium 2* – are prime examples of the integration of ecological and evolutionary thinking. Another such example is the work that we are conducting on plague. This is part of *Colloquium 3* ("The ecology and evolution of infectious diseases within an environmental reservoir"). Much exciting synthesis work is currently taking place in that colloquium. Our new ancient DNA laboratory, officially opened 21 May 2015, will certainly facilitate this work. *Colloquium 4* ("Integration of ecology and evolution") is the final colloquium of CEES, within which the synthesis work is to be concluded. Within this colloquium we are bringing together paleobiological work, experimental microbial work, and theoretical work. The synthesis work within this colloquium has received additional external funding, greatly facilitating it. Few if any other research groups cover such a broad range of competence in the quest to understand how evolutionary and ecological processes are mutually interwoven and lead to macroevolutionary dynamics.



The research at CEES is organised around three intertwined Themes and four multidisciplinary Colloquia. Each Colloquium has a limited number of years for the main activity, and together they span the 10-year CoE period.

Scientific highlights 2007–2015

Our **sequencing of the cod genome** (Star *et al.* 2011 *Nature*) has fundamentally changed our understanding of the evolution of the immune system in vertebrates. The research revealed that Atlantic cod (*G. morhua*) has lost genes that are essential for the functioning of the major histocompatibility complex (MHC) II pathway, thought to be essential for combatting infections, and instead relies on other genes for its immune defense.

Another of our **marine research** highlights is the study to determine whether genetic changes resulting from fishing pressure have significant economic effects (Eikeset *et al.* 2013 *PNAS*). We showed that for Atlantic cod, evolutionary changes allow individual fish to grow faster and mature earlier, which increases stock productivity and revenue for fishermen. However, if harvesting pressure is particularly high, genetic changes have negative consequences and incur economic costs.

Our work on the Italian sparrow demonstrates that one of the world's most common birds is at the centre of an extremely rare event: **hybrid speciation**. We have shown that the ubiquitous house sparrow has interbred with the Spanish sparrow, forming a third distinct species, the Italian sparrow. This provides important insight into how new species arise.

The above-mentioned projects all show that we have been able to integrate genomics and evolutionary thinking (the main focus of *Colloquium 2*).

Our empirical and theoretical biology work explores the evolution, persistence, and distribution of **disease pathogens** (the main focus of *Colloquium 3*). A publication by Schmid *et al.* in *PNAS* (2015) shows a strong association between climate-driven outbreaks of *Yersinia pestis* in Asian rodents and waves of plague in Europe. This suggests that the plague bacterium was continuously reintroduced into Europe during the second pandemic.

Colloquium 4 will represent the culmination of the Centre's research by linking ecological and evolutionary thinking closer together. A good example of the kind of research conducted under the umbrella of *Colloquium 4* is the theoretical work by Voje *et al.* in *Proceedings of the Royal Society B* (2015). Their research fits models describing hypotheses of biotically driven macroevolution (that is, caused by living organisms) to data in order to transcend pattern description and narrow the divide between our current understanding of micro- and macroevolution.

Scientific highlights in 2015

The climatic pulse of Asia: the Black Death and successive plague reintroductions into Europe

Plague is a bacterial disease that predominantly persists in wildlife rodents and their fleas. It regularly flares up and causes local epidemics in rodents and other hosts that get bitten by infected fleas, including humans, but sometimes these local epidemics escalate into large plague pandemics. One of the most well-known of these outbreaks is the Black Death, an epidemic that struck Europe in 1347, and killed somewhere between 30-50% of the population in six violent years.

The Black Death signalled the start of the second plague pandemic in Europe – a period of near continuous plague outbreaks scattered across Europe that lasted until the second half of the 17th century, when the disease gradually disappeared from Europe. For many years it was assumed that during these centuries there must have been animal reservoirs of plague in Europe where the disease could persist in between the times of outbreaks among humans.

Our aim was to find these reservoirs. If European reservoirs of plague indeed existed, we would expect them to be associated with local climate fluctuations, like plague reservoirs in Asia are. Short-term climate fluctuations influence the agricultural yields of farmland and the primary productions of forests, and so affect the population density of urban and wildlife rodents. The rise and fall of these rodent populations would have been important for rodent-driven plague outbreaks in European cities.

We indeed found that Europe's plague outbreaks were associated with climate fluctuations (figure 1), but to our surprise that statistical association was with Central Asian climate records, rather than European ones. In our paper published in *PNAS* (Schmid *et al.* 2015), we showed that plague reintroductions at European harbours were associated with periods of wet conditions, followed by drought, across large parts of Central Asia approximately 15 years earlier.

The strength of the paper lies – as one of the reviewers aptly remarked – not so much in the statistical strength of the analysis, but in that it creates a new way of looking at the Black Death. The paper shifts the perspective from *a single introduction and subsequent persistence of the plague*

in reservoirs in Europe, to that of *numerous reintroductions of the disease that only needed to have transiently persisted in Europe*. Its most important contribution is that it opens up a multitude of new research questions that can eagerly be explored by historians, computational biologists, and molecular biologists. Indeed, since the paper's publication in early 2015, four ancient DNA labs are now exploring whether they can find genetic evidence of multiple reintroductions. Their initial results indicate that late European plague strains are derived from plague strains genetically similar to that of the Black Death. However, the genetic difference between the *medieval* Black Death strains and *current-day* plague strains from reservoirs in northwest China (the region at the centre of our finding of climate-driven plague reintroductions) is very small, making it hard to phylogenetically discern between the two different perspectives described above.

For this paper, we had to combine scientific results from climatology, ecology, history, molecular biology and epidemiology. It made the research work a fascinating and rewarding experience, especially as we now see our results being picked up and taken further by colleagues from other labs and disciplines. We will continue to work on plague, as it is an exceptional resource for scientists who wish to understand the conditions under which an endemic wildlife disease can grow to pandemic proportions.

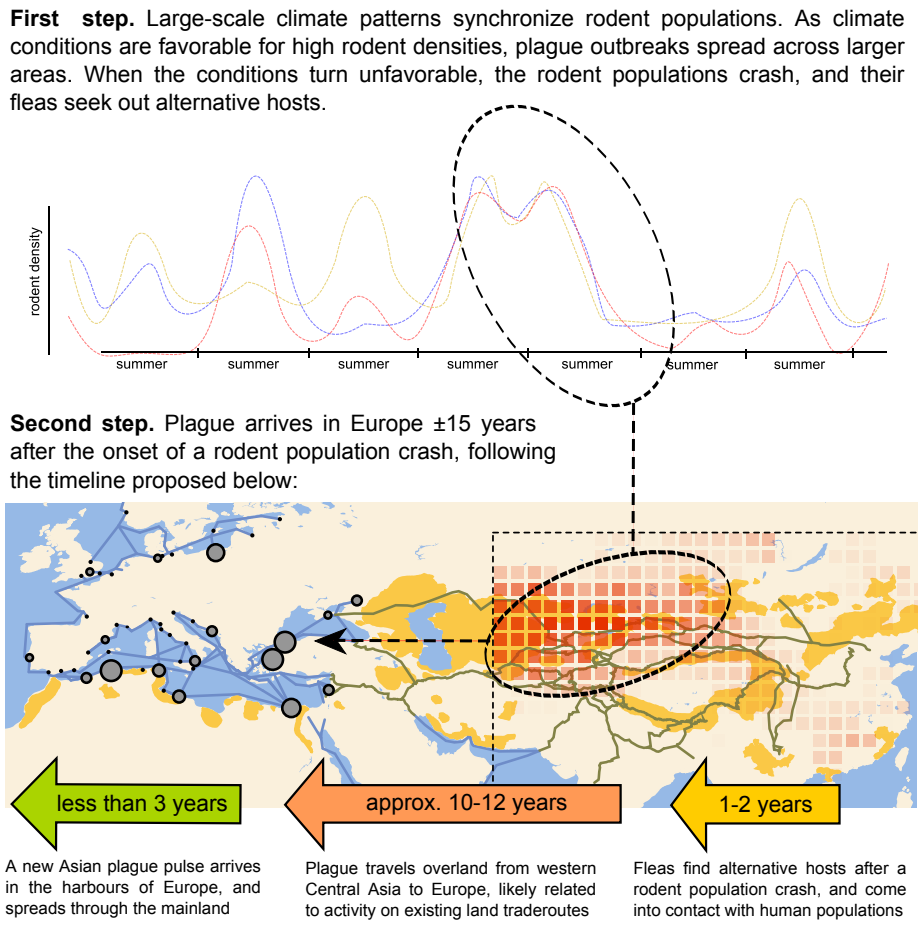


Figure 1: Climate fluctuations, rodent populations, and the spread of plague. (Modified from Schmid et al. 2015 PNAS).

Summarised by Boris Schmid.

Further reading:

Schmid, B. V., Büntgen, U., **Easterday, R.**, Ginzler, C., Walløe, L., **Bramanti, B.**, **Stenseth, N. C.** (2015) Climate-driven introduction of the Black Death and successive plague reintroductions into Europe. *Proceedings of the National Academy of Sciences of the United States of America*, 112 (10), 3020–3025.

Boris Schmid

Oil droplet pollution and marine fish embryo development – a toxic combination

Worldwide energy demands have resulted in increased hydrocarbon extraction activity, yet the toxicity of oil droplets towards marine fish embryos is still being debated. Few studies have addressed whether physical interaction with oil micro-droplets is a relevant exposure pathway for open water marine species, even though exposure to dissolved petroleum compounds alone is sufficient to cause characteristic developmental toxicity. In a recent paper published by *PLoS ONE* (Sørhus *et al.* 2015), pelagic embryos and larvae of a marine teleost, the Atlantic haddock (*Melanogrammus aeglefinus*), were exposed to mechanically dispersed crude oil via controlled delivery.

The Atlantic haddock is a teleost belonging to the Gadidae family, and is a commercially important marine fish distributed on both sides of the North Atlantic. In Norway, its distribution is very similar to the more iconic Atlantic cod, *Gadus morhua*, spanning from the Barents Sea in the North Arctic areas to the continental shelf along the Norwegian coast (figure 1). Atlantic haddock spawning occurs at depths of 30–500 m or more, and the fertilised eggs rise to the surface where they are subject to transport by water currents. The haddock eggs have high buoyancy, thus the majority of eggs are found in the upper 20 m of the water column.

The major undertaking of Sørhus' study was to obtain more realistic toxicity data on early life stages of Atlantic haddock exposed to oil dispersion containing a combination of 1) water-dissolved components of crude oil in water accommodated fractions (WAFs), and 2) oil micro-droplets. Sørhus' study was original as it merged results obtained from both a histological and phenotypic component, along with gene expression. Haddock embryos were exposed either continuously or in pulses to two different concentrations of dispersed crude oil (high and low). By 24 hours of exposure, micro-droplets of oil were observed adhering and accumulating on the chorion, accompanied by highly elevated levels of *cyp1a*, a well established biomarker for exposure to aryl hydrocarbon receptor (AhR) agonists, such as polyaromatic hydrocarbons (PAHs) and other xenobiotics. Embryos from all treatment groups showed abnormalities representative of crude oil cardiotoxicity at hatch (5 days of exposure), such as pericardial and yolk sac oedema (figure 2). Assessment parameters were accomplished by fitness measurements (survival and growth), recording phenotypic and histological abnormalities, and examining the expression of genes (especially *cyp1a*) involved in the detoxification pathway.

A high toxicity for Atlantic haddock embryos

The major finding from this study was an amplified embryo-toxicity observed in Atlantic haddock compared to similar species (e.g., Atlantic cod) when exposed to dispersed crude oil during early developmental stages. Compared to other species, the frequency and severity of toxic effects was higher than expected for the waterborne PAH concentrations (e.g., 100% of larvae had oedema at the low treatment). These findings suggest an enhanced tissue uptake of PAHs and/or other petroleum compounds from attached oil droplets. Sørhus' study therefore highlights a novel property of haddock embryos leading to a greater than expected impact from dispersed crude oil.

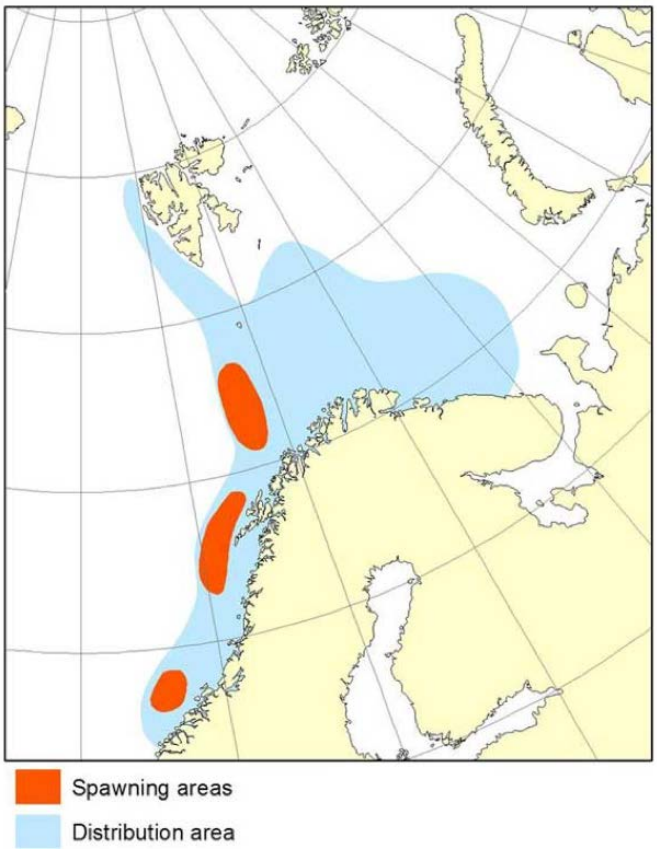


Figure 1: Spawning grounds overlapping the major oil fields in Norway, and distribution areas of the Atlantic haddock. © BarentsPortal.

Figure 2: Abnormalities resulting from embryonic oil exposure (Sørhus et al. 2015). One day post hatch, 7 days of exposure. (A) Control. (B) Low dose group. Abnormalities are indicated: Pericardial oedema (P), yolk sac oedema (Y), spinal curvature (S), craniofacial deformities (CD), and jaw deformities (JD).

This study indicates that haddock embryos are highly impacted by oil exposure when using a realistic oil exposure system that includes dispersed oil droplets in addition to the water accommodated fraction. The haddock embryo is known to have an adherent chorion, which seems to attract micro-droplets of oil, creating a direct connection between the toxic components of the dispersed crude oil and the embryo, and thereby enhancing the exposure. Given the very limited number of marine species tested in similar exposures, the likelihood of other species with similar properties could be high. Observations and data obtained in this study therefore emphasise the overall importance of also taking into account toxicity of oil droplets in risk assessments.

Summarised by Elin Sørhus, Sissel Jentoft and Joël Durant.

Further reading:

Sørhus, E., Edvardsen, R., Karlsen, Ø., Nordtug, T., van der Meeren, T., Thorsen, A., Harman, C., **Jentoft, S.**, Meier, S. (2015) Unexpected interaction with dispersed crude oil droplets drives severe toxicity in Atlantic haddock embryos. *PLoS ONE*, 10 (4), doi: 10.1371/journal.pone.0124376.

Elin Sørhus

Sissel Jentoft

Joël Durant

Adaptation to low salinity promotes genomic divergence in Atlantic cod (*Gadus morhua L.*)

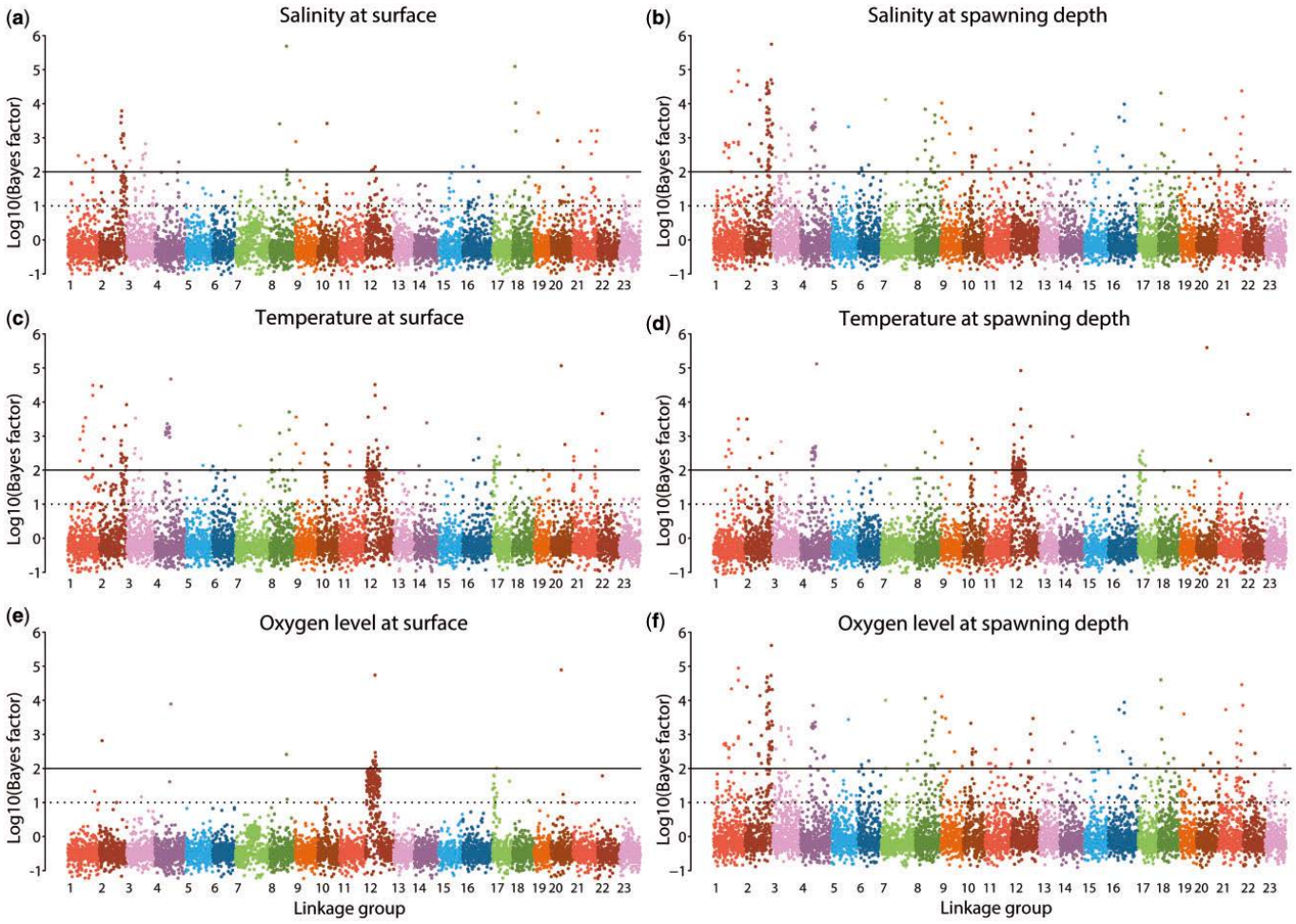
How genomic selection enables species to adapt to divergent environments is a fundamental question in ecology and evolution. In a recent paper in *Genome Biology and Evolution* (Berg *et al.* 2015), we investigated the genomic signatures of local adaptation in Atlantic cod (*Gadus morhua* L.) along a natural salinity gradient (figure 1), ranging from 35‰ in the North Sea to 7‰ within the Baltic Sea. We provide the first individually genotyped whole genome-wide approach to date on this species. By utilising a 12K SNPchip, we simultaneously assessed neutral and adaptive genetic divergence across the Atlantic cod genome.

Teleost fish occupy a range of aquatic habitats, from freshwater environments to extreme marine environments. In order to spawn in marine habitats, teleost fish are adapted to a hyper-osmotic environment by producing e.g. highly hydrated eggs. The adaptation of neutral egg buoyancy towards those salinity levels found in the marine environment could arguably impede the successful colonisation of less saline environments. In less saline environments, hyper-osmotic eggs would sink to the bottom, requiring an even higher degree of egg hydration (as is the case for Atlantic cod adapted to the Baltic Sea environment). Hence, the selection pressure to adapt to low saline waters is a major force influencing the spawning success of cod in the Baltic Sea. As such, adaptation to specific osmotic conditions requires a wide range of molecular and physiological modifications, but the genetic basis of broad salinity tolerance has so far remained unclear.

As the Baltic Sea originated approximately 8000 years ago, the adaptation of Atlantic cod to low saline conditions is likely to be of relatively recent evolutionary origin, hence providing an excellent opportunity to study the genomic architecture behind salinity adaptation in a natural environment. The ecological adaptation of Atlantic cod to a low-saline environment may contribute to reduced gene flow, and thereby promote population divergence. Therefore, the investigation of the genomic architecture of Baltic cod may give insights into ecological speciation in nature, and especially to the genetic link between adaptation and reproductive isolation.

By combining outlier analyses with a landscape genomic approach, we identified a set of directionally selected loci that were strongly correlated with habitat differences in salinity, oxygen, and temperature in the Baltic Sea (figure 2). Our results show that discrete regions within the Atlantic cod genome are subject to directional selection and associated with adaptation to the local environmental conditions in both the Baltic and the North Sea, indicating divergence hitchhiking and the presence of genomic islands of divergence. Candidate SNPs for selection were detected in all LGs, but LG2 clearly stood

Figure 1: Sampling locations of Atlantic cod specimens. Samples were obtained between 2002 and 2008 using trawling/ line fishing. Only mature specimens were selected for genetic analysis. Average surface salinity is denoted in ‰. (Berg et al. 2015).



out with the highest number of outliers with respect to the Baltic Sea and salinity and oxygen association (figure 2). A large portion of the outlier SNPs detected reside within ecologically important genes affecting egg buoyancy and general osmoregulation, and are thus likely to constitute an evolutionary response to the ecological conditions in the Baltic Sea. Such an adaptive response may contribute to a strong and effective reproductive barrier, leading to ecological speciation in the Baltic cod.

Figure 2: SNPs associated with environmental variables in Atlantic cod. Manhattan plots of SNP association with salinity, temperature and oxygen level (all at surface and at spawning depth) based on median log10 Bayes factor from 32 independent runs of BAYENV. The SNPs are plotted according to linkage group and their respective position within the linkage groups along the X-axis. (Berg et al. 2015).

Summarised by Paul R. Berg.

Further reading:

Berg, P. R., **Jentoft, S.**, **Star, B.**, Ring, K. H., **Knutsen, H.**, Lien, S., **Jakobsen, K. S.**, André, C. (2015) Adaptation to low salinity promotes genomic divergence in Atlantic cod (*Gadus morhua* L.). *Genome Biology and Evolution*, 7, 1644–1663.

Paul R. Berg

Individual heterogeneity in life history and eco-evolutionary dynamics

Variation among individuals has always been an integral part of evolutionary theory, as evolution can only occur if there is genetic variation in traits under selection. In contrast, classical population models in ecology usually ignore individual variation, since they focus mainly on population level processes. Even age structured models typically assume that all individuals have the same life history, so that at a given age all individuals have the same vital rates governing survival and reproduction. Recently, however, the importance of individual heterogeneity has also been increasingly recognised in ecological theory. Individual heterogeneity is especially relevant to our understanding of eco-evolutionary dynamics on a contemporary time scale.

In our study in *Ecology Letters* (Vindenes & Langangen 2015), we present a conceptual demographic model framework that incorporates individual heterogeneity in life histories in a flexible way, by separating static and dynamic traits. Static traits are traits that remain constant over the lifetime of an individual, such as sex, size as offspring, or spatial location in the case of sessile organisms. Dynamic traits, such as age and body size, vary over the lifetime of individuals. Both traits may interact with each other as well as with environmental variables to shape the individual trajectories of survival, fecundity, and changes in the dynamic trait through life. The static trait can also represent a quantitative genetic trait, that is to say a trait having a genetic component. As a result, this framework can include many kinds of individual heterogeneity (including genetic variation), as well as different mechanisms of inheritance. Compared to other demographic frameworks used to study eco-evolutionary dynamics, in particular age-stage structured models, this framework provides a more explicit link to underlying individual traits, and only one heritability measure is needed for each static trait, rather than one measure per age.

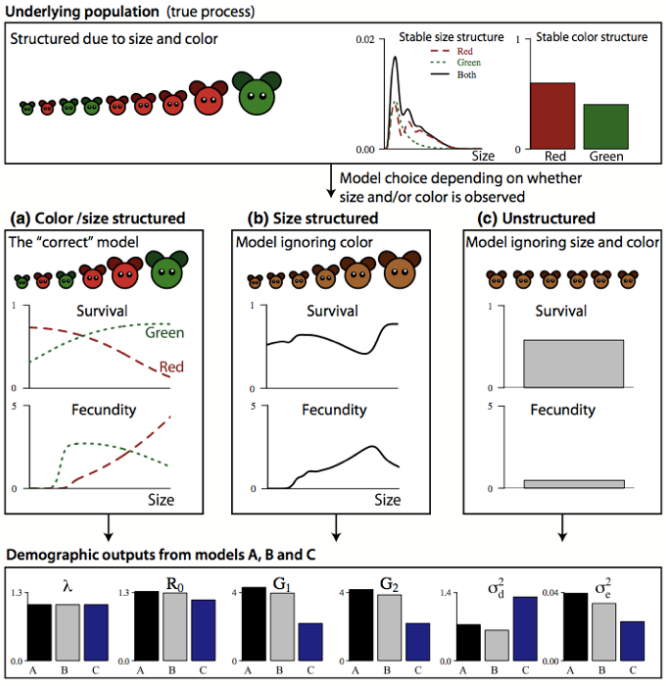


Figure 1: Results for a hypothetical size-structured population of red and green individuals. We investigated the consequences of ignoring either only colour (b), or both size and colour (c) for a range of demographic model outputs (bottom panel, from left: the mean population growth rate, net reproductive rate, two generation time measures, the demographic variance, and the environmental variance). (Vindenes & Langangen 2015).

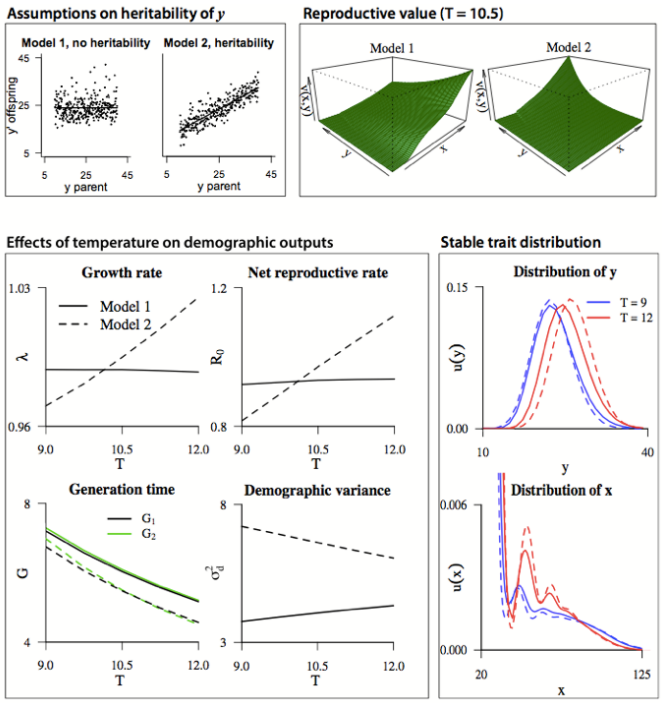


Figure 2: Results for a model parameterised for pike (Esox lucius) from Windermere, U.K., where individual heterogeneity in length at age 1 affects growth and survival through life. Two models were compared, where model 1 assumes no heritability in length at age 1, while model 2 assumes a heritability of 0.6. We investigated effects of changing temperature in the two cases, and some demographic outputs were very sensitive to heritability. (Vindenes & Langangen 2015).

We present two main applications of the model. First, we provide for the first time a comprehensive overview of the consequences of ignoring heterogeneity for a range of demographic parameters describing population dynamical and life history properties (average population growth rate, net reproductive rate, two generation time measures, and stochastic properties including extinction risk). An example is shown in figure 1, for a hypothetical population structured according to size (dynamic trait) and colour (static trait). A general conclusion is that besides the average long-term growth rate, all parameters can be affected by hidden heterogeneity. We also discuss some differences in study questions in the literature (effects of changing heterogeneity vs. effects of ignoring underlying heterogeneity), which have not always been recognised and could complicate comparison between studies.

The second application of the framework is to model eco-evolutionary dynamics of structured populations, and we present a theoretical example with Mendelian inheritance of a discrete trait, as well as an empirical example for pike (*Esox lucius*). In the pike example, the dynamic trait is length and the static trait is length at age 1, and we explore potential consequences of changing the heritability of length at age 1 for various population responses to warming (figure 2). We also discuss some differences in the literature in definitions of eco-evolutionary dynamics, and highlight the differences between studies that focus on parameters that are *important* to evolution (such as selection differentials), and studies that actually consider the process of evolution (which requires an understanding of the underlying genetic composition of the population, as well as the mechanisms giving rise to selection pressures).

The demographic framework introduced in this study provides a useful addition to demographic models for eco-evolutionary dynamics, and future applications of this model can answer some of the many interesting questions that require a detailed knowledge of the underlying mechanisms of eco-evolutionary processes.

Summarised by Yngvild Vindenes and Øystein Langangen.

Further reading:

Vindenes, Y., Langangen, Ø. (2015) Individual heterogeneity in life histories and eco-evolutionary dynamics. *Ecology Letters*, 18, 417–432.

Yngvild Vindenes

Øystein Langangen

The role of biotic forces in driving macroevolution

Evolution via natural selection happens when populations adapt to changes in the abiotic or biotic parts of their environment. Abiotic factors constitute the non-living part of the environment of a population (such as temperature and precipitation), while the biotic part of the environment consists of e.g. predator-prey interactions, competition for limited resources and other interactions between organisms. Both biotic and abiotic factors are considered to be important driving forces of evolutionary change on short (microevolutionary) timescales, while changes only in the abiotic part of the environment are generally considered more important for driving macroevolutionary change. However, subscribing to the view that different parts of the environment are responsible for driving evolution on different timescales limits our possibility to understand long-term evolutionary change based on the evolutionary processes we observe on short timescales.

While a large list of hypotheses exists for how changes in the abiotic environment cause macroevolutionary change, the idea that biotic factors can drive long-term evolution is usually referred to as a single hypothesis, namely the Van Valen's (1973) Red Queen hypothesis. In essence, Van Valen proposed that biotic interactions suffice to drive species to evolve indefinitely, as evolutionary advantages gained by one species cause evolutionary disadvantages to other species in the community, independent of changes in the abiotic environment. Thus, the Red Queen hypothesis invokes a microevolutionary process of biotic interactions (ecology) to explain macroevolutionary patterns.

The Red Queen hypothesis has received extensive criticism from both neontologists and palaeobiologists ever since it was proposed, with the consequence that many disregard biotic forces as important drivers of macroevo-

Illustration: Tenniel, John (1871), The Red Queen lecturing Alice, From Through the Looking Glass, by Lewis Carroll.

lution. In a perspective/review article (Voje *et al.* 2015), we argue that even though the Red Queen hypothesis is built on some falsified assumptions, an increasing body of both theoretical and empirical work demonstrates the plausibility of biotically driven long-term evolution. There are many ways in which biotic interactions can affect macroevolution. Therefore, research on the relative importance of biotic factors in evolution should move beyond simply supporting or falsifying Van Valen's original formulation of the Red Queen hypothesis.

We highlight parts of the literature within ecology and evolutionary biology that are poorly known across these fields, but which nonetheless are relevant for theories and hypotheses in both. For example, a number of recent theoretical models have investigated evolutionary dynamics of food webs and have shown that biotic interactions have the potential to drive long-term evolution. However, few of these theoretical developments are discussed in the palaeobiological literature. We also argue that it is important to contrast predictions from relevant theories within ecology and macroevolution, and that relevant processes should not be conveniently dismissed as operating on different timescales if the goal is a synthesis of ideas from palaeobiology, ecology and evolution.

We also argue that another likely reason as to why biotic factors often are neglected as important drivers of long-term evolutionary change is because they are notoriously difficult to study in deep time. However, if we want to disentangle the effects of biotic and abiotic drivers of macroevolutionary change, it is impossible to avoid this challenge. A more mechanistic understanding of macroevolutionary change may help us to reduce the micro- and macroevolutionary divide. To promote discussion, we therefore have developed a list of hypotheses that assert a clear role for biotic forces in shaping macroevolution that are independent of the original Red Queen hypothesis. We also point to empirical studies within palaeobiology that have tested the effects of both biotic and abiotic factors and found that both play important roles in shaping macroevolution.

Summarised by Kjetil L. Voje.

Further reading:

Van Valen, L. (1973) A new evolutionary law. *Evolutionary Theory*, 1, 1–30.

Voje, K. L., **Holen, Ø. H.**, **Liow, L. H.**, **Stenseth, N. C.** (2015) The role of biotic forces in driving macroevolution: beyond the Red Queen. *Proceedings of the Royal Society of London. Series B. Biological Sciences*, 282 (1808), 20150186–20150186.

Kjetil L. Voje

Competition matters: evolutionary consequences of brachiopod and bivalve ecological interactions

Interspecific competition involves the competition between different species for common resources, such as food or territory. The increasing population size of a successful competitor can negatively impact the population sizes of less successful competitors, hence changing the dynamics of a community. Yet it is difficult to infer the evolutionary consequences of competition played out over long timescales, timescales that span well beyond the historical records. In a recent paper in *Ecology Letters* (Liow *et al.* 2015), we provide evidence to support the long-held belief that the present-day dominance of clams in our oceans is because they managed to outcompete the brachiopods, an ecologically similar group of organisms.

Brachiopods once dominated the Paleozoic oceans, but they are relatively rare today. However, clams (a very diverse group of bivalve molluscs) are not only prevalent in the marine environment, but are also found in the freshwater one as well. In order to empirically test the claim that clams displaced brachiopods evolutionarily, Gould and Calloway (1980) assembled data on known fossils of brachiopod and bivalve species from the beginning of the macroscopic fossil record (the Cambrian Period, c. 541-484 million years ago), and statistically tested the

Fossils of brachiopods (Paraspirifer bownockeri) at the Houston Museum of Natural Science. Source: Wikimedia Commons.

temporal association between brachiopod diversity and bivalve diversity. They found no association between brachiopod and bivalve diversity, and hence concluded that clams did not outcompete brachiopods but that the two were "ships that passed in the night".

As new data and new tools have emerged since the 1980s, we decided to re-examine the question of long-term competition between brachiopods and bivalves. We used the largest global compilation of fossil observations of clams and brachiopods, spanning 500 million years of their evolutionary history, and inferred their rates of speciation and extinction. These inferred rates were first teased apart from sampling biases via capture-re-capture modelling, a technique usually only applied to living organisms. Then, using a sophisticated time series analyses toolbox called linear Stochastic Differential Equations (SDEs), we tested for causal versus correlative relationships between brachiopod and bivalve diversification, sampling time series, and published records of time series reflecting environmental changes through 500 million years of earth history.

Our results showed that factors such as temperature, sea-level and tectonics did not explain the patterns of diversification found in bivalves and brachiopods. However, we found strong support for the hypothesis that high extinction rates in bivalves led to high speciation rates in brachiopods. In other words, bivalves as a group, though evolutionarily distantly related to brachiopods, have nonetheless acted as suppressors of brachiopod evolution.

In his well-known book *On the Origin of Species* (1859), Darwin wrote: "As the individuals of the same species come in all respects into the closest competition with each other, the struggle will generally be most severe between them; it will be almost equally severe between the varieties of the same species, and next in severity between the species of the same genus." Focus is often placed on this statement about intraspecific competition, yet Darwin was equally engaged with thoughts on interspecific competition, as evidenced by the following line: "On the other hand the struggle will often be severe between beings remote in the scale of nature." (Darwin 1859). Our research lends support to Darwin's theory that competition acts as a driving force in evolutionary dynamics, both in the short and long term.

Summarised by Lee Hsiang Low.

Further reading:

Liow, L. H., **Reitan, T.**, Harnik, P. G. (2015) Ecological interactions on macroevolutionary time scales: clams and brachiopods are more than ships that pass in the night. *Ecology Letters*, 18, 1030–1039.

Gould, S. J., Calloway, C. B. (1980) Clams and brachiopods – ships that pass in the night. *Paleobiology*, 6 (4), 383–396.

Darwin, C. (1859) *On the Origin of Species*, London: John Murray.

Lee Hsiang Low

NorMER

Nordic Centre for Research on Marine Ecosystems and Resources under Climate Change

Manmade environmental issues – including the impact of unsustainable fishing practices and numerous climate change drivers – are at the top of the agenda for marine research and management in the Nordic region. Such challenges, by their very nature, must be dealt with collectively, but whilst a great deal of research activities already focus on these topics, they are yet to be optimally coordinated as a whole.

The Nordic Centre of Excellence (NCoE) NorMER was established as a pan-Nordic centre, and is funded by Nordforsk, the Norwegian Top-level Research Initiative (TRI), and 10 collaborating Nordic research institutions. NorMER fosters collaboration in the area of marine research between all Nordic research groups and several US institutions, with the aim to achieve a multidisciplinary strategy for research on the biological, ecological and management consequences of global climate change in marine ecosystems with a focus on the Nordic region.

NorMER stimulates collaboration across scientific and geographical borders by using Atlantic cod (*Gadus morhua*) as a model species. We believe that by using a common model species we are able to provide a platform that facilitates interaction among our PhD students and postdocs. This is important because all members of NorMER come from diverse scientific backgrounds and, with no single common physical location, our researchers are dispersed over many interacting geographical nodes. The young researcher projects within NorMER are organised into a scientific framework of functional groups. These groups are designed to address different levels of the biological and socio-economic system with the aim to create knowledge that facilitates holistic ecosystem-based management. The individual goals of this framework are to assess the effects of climate change on (see figure 1): a) ecosystem properties of Nordic marine systems, b) lower trophic levels and cod-prey interactions, c) cod population dynamics, and d) harvesting, socio-economic consequences, and optimal management of cod populations. NorMER has been successful in this approach, as showcased by a total of 140+ NorMER-related peer-reviewed publications, an increasing proportion of which are Nordic, involving collaborations between research teams from two or more Nordic countries.

NorMER is designed so that each of the PhD and postdoc projects has a strong 'curiosity-driven' scientific element: our primary ambition has been to provide solid and high-quality science. In addition, through the combined results of the work of the PhDs and the postdocs, we aim to provide a framework of professional and societal connections so that results can also be applied. Indeed, communicating our perspectives and results to a broad spectrum of people, not the least with politicians, has been an important part of NorMER. In order to facilitate dialogue with politicians and industry managers about the science we are doing within NorMER, we have emphasised opportunities for our leadership, and more importantly our young researchers, to engage with these sectors.

Together, our PhD students and postdocs are the most valuable members of NorMER. They bring an indispensable energy and future potential that could not be achieved by senior researchers alone, and are of utmost importance to the long-term success of NorMER.

NorMER has been an effective Nordic window to Europe, and indeed the rest of the world. It has made our marine research more visible and attractive internationally. It has strengthened cohesion among Nordic scientists. And, it has positioned us to better address global-sized challenges. Most importantly, all of this was achieved while training a large cohort of PhD students who believe this is how science is done, with the skills and backgrounds to carry this approach into the rest of their careers.

Evidence of the overall success of NorMER can be seen in the comments from Simon Levin, the Chair of the external Centre Advisory Panel (CAP), in his summarising statement during the last meeting: "The CAP continues to be impressed with the remarkable achievements of NorMER, especially with regard to the training of the next generation of Nordic marine environmental scientists … We know of no program of comparable scope,

certainly not in the Nordic countries, and we urge that efforts be made to continue the training dimension through subsequent programs building on complementary environmental themes. NorMER has created an outstanding core of young scientists, who will place Nordic environmental science in a leadership role for decades to come … This has created a network across the Nordic countries, and indeed beyond, that will catalyze interdisciplinary science for years to come. This should not be allowed to wither, and we urge the identification of new funding to expand and solidify the network, including the availability of such funds for the senior investigators.

As we face greater and greater cross-boundary environmental problems in the decades to come, scientific cooperation across disciplines and across national boundaries will become more and more essential. NorMER is a model for how to achieve that."

Summarised by Jason Whittington.
NorMER is administered by CEES.
Website: normer.org

A full report of NorMER's activities throughout its total 5-year period is available on its website.

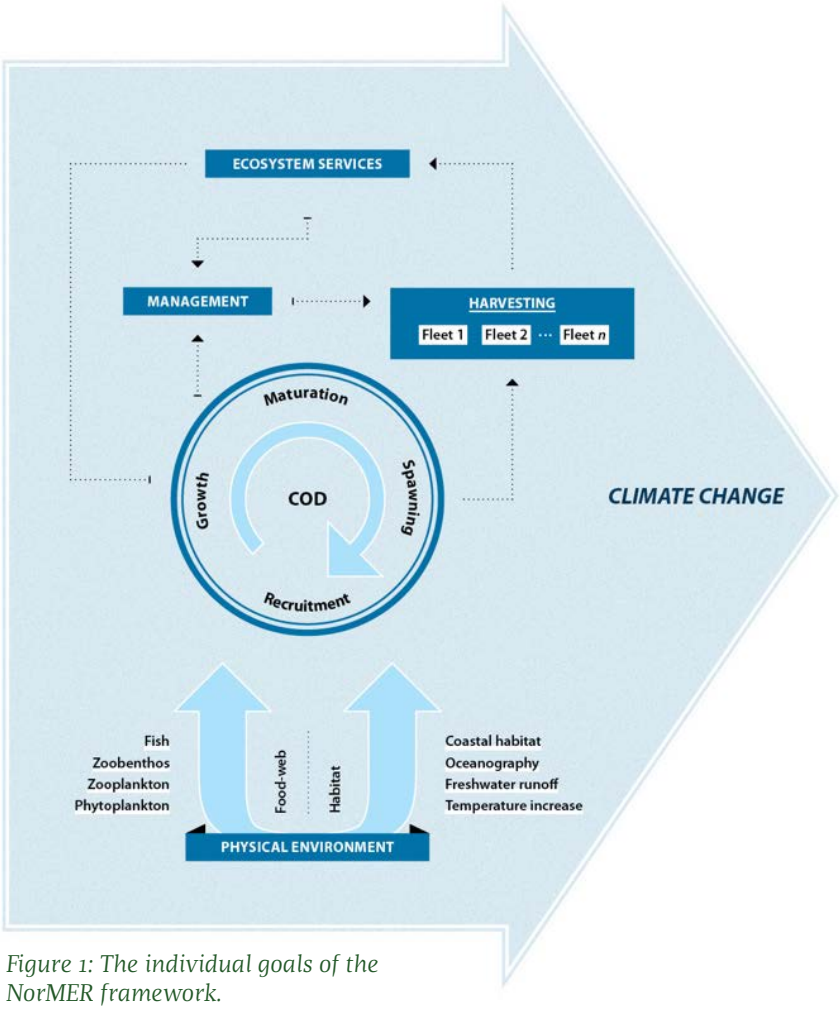


Figure 1: The individual goals of the NorMER framework.

GreenMAR

Green Growth Based on Marine Resources: Ecological and Socio-Economic Constraints

GreenMAR is a project funded by Nordforsk that studies the complexities of marine systems in the Nordic regions, and how these systems adapt to increasing stress factors. Marine ecosystems provide unique opportunities to meet a growing global demand for healthy and nutritious food, if harvested more efficiently and sustainably. Yet, overexploitation, climate change and other anthropogenic stressors challenge such a development. The fundamental challenge of green growth is to use our renewable natural resources more efficiently, while ensuring that ecosystems retain their functionality. By investigating how the ecological and social components of complex marine systems can adapt to growing stress factors, we can provide management recommendations for improved harvesting strategies.

GreenMAR consists of an interdisciplinary Nordic research team, linked to researchers in the USA, Russia, and the Netherlands. We bring together some of the best scientists in the fields of climatology, ecology, sociology, and economy. All of our partners have considerable experience within the broad theme of sustainability, but typically focus on different sub-topics or have different and complementary approaches. Their disciplines need to be integrated to produce the knowledge necessary to achieve green growth. To achieve such integration, GreenMAR brings together research groups which in the past have only collaborated loosely or not at all.

Our climatologists and oceanographers provide state-of-the-art model results on how climate affects sea surface temperature, ocean circulation, and freshwater run-off. Modelled and observed environmental data are combined with biological time-series to unravel effects on fish populations, with particular focus on possible critical thresholds in the effects of climate and fishing. Our sociologists perform in-depth studies on how fishermen adapt to changes in their environment. These insights will be integrated in social-ecological models to quantify how systemic properties, such as resilience, sustainability, and viability, will be affected by climate change. In parallel, bio-economic models will be developed to predict the economic effects of climate change and to investigate how industry and regulation can adapt in a cost effective way. Together, such a multidisciplinary approach provides knowledge to ensure the sustainable management of our oceans, as a necessity and a catalyst for green growth. In addition, by including a leading Nordic fishing company, the relevance and utility of the research is enhanced. Moreover, through a strong focus on training and communication (by organising a series of policy forums, outreach events, workshops and courses), we aim to contribute to the formation of a new generation of multi-disciplinarily skilled scientists, administrators and industrialists. Our consortium will contribute profoundly to the competitiveness of the Nordic region, both scientifically and in the sustainable management of common resources.

The dedication of the partner institutions to this collaboration is signified by their high own contributions (>50% of total budget), including funding dedicated to developing new collaborative projects using GreenMAR as a stepping-stone. A significant side benefit is the establishment of interactions between members of three Norwegian Centres of Excellence (NorMER, Nord-Star, and SVALI), centres which otherwise would not have a reason to collaborate. GreenMAR further strengthens the links between academia, industry and other stakeholders within the topic of green growth, through the involvement of Aker Seafoods and the environmental NGO, WWF Norway. Finally, GreenMAR is strongly devoted to hands-on training of young researchers: they will receive a wide range of workshops and courses in education, innovation and communication, with emphasis on outreach. All seminars are open for other scientists to attend/apply, and are also open to the public where feasible. GreenMAR will thus contribute to educate, facilitate and encourage a new generation of scientists in an era with demand for green growth.

Summarised by Anna V. B. Mazzarella.
GreenMAR is administered by CEES.
Website: greenmar.uio.no

MARmaED

MARine MAnagement and Ecosystem Dynamics under climate change

A fundamental **challenge for European marine science** is to deliver scientific impact, global leadership and sustainable blue growth for Europe in times of overexploitation, climate change, and other anthropogenic stressors. At CEES, a Marie Skłodowska-Curie Innovative Training Network named **MARmaED**, coordinated by Joël Durant, kicked off on 1 October 2015. This project will take important steps towards answering the challenge faced by the European marine science sector by connecting science, policy and people, thus transcending national borders, disciplinary barriers and sectorial divides. One of its chief aims is to train tomorrow's researchers by educating 15 PhD students within 8 partner institutions.

Understanding the complex dynamics of seas and oceans under rapid environmental change with a particular focus on the resulting socio-economic consequences is of key importance. To answer this challenge, the European marine science community must reinforce its position as a global leader by building a greater knowledge base, breaking down traditional barriers between scientific disciplines, and by communicating wider awareness of the seas and oceans to the general public. Therefore, there is a need for an ecosystem-based management of natural resources, and an urgent requirement to increase and modernise the fundamental knowledge on how marine ecosystems are functioning and to propagate this knowledge to society.

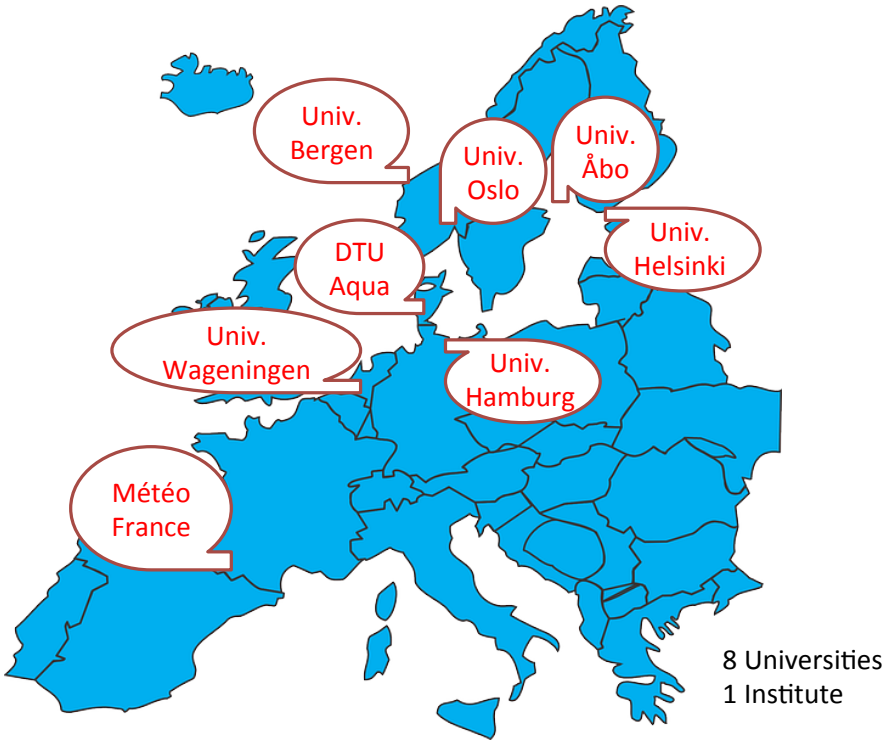


Figure 1: The academic partners involved in training the MARmaED PhD students.

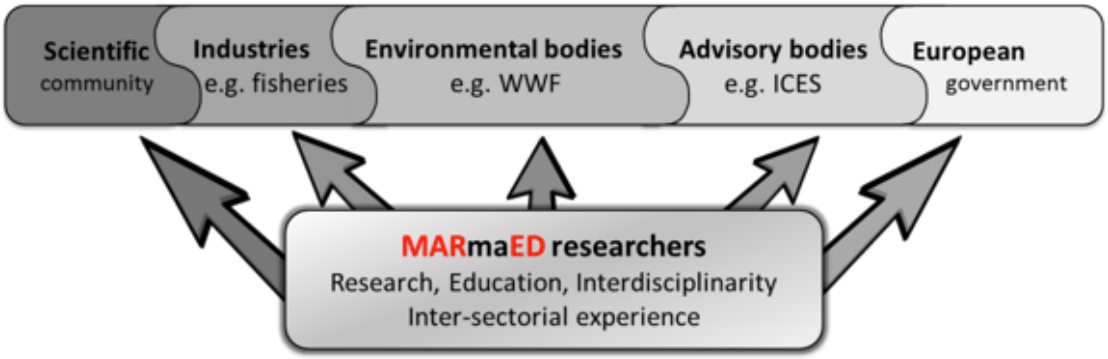


Figure 2: The newly trained MARmaED PhD students will be an asset in the above sectors.

In May 2015, we were granted an Innovative Training Network named MARmaED by the European Commission. MARmaED is an **international** and **interdisciplinary** network (figure 1) that unifies specific and complementary competences in marine sciences from Norway (University of Oslo – CEES, University of Bergen), Finland (University of Helsinki, Åbo Akademi University), Denmark (Technical University of Denmark), the Netherlands (Wageningen University), Germany (University of Hamburg) and France (Météo France) to investigate how the cumulative stress from **biodiversity loss**, **climate change** and **harvesting** will affect Europe's **complex marine systems** and the consequences this will have for optimal **resource management**. Our network **integrates** European **education** and **research** in **essential disciplines**, specifically genetics, ecophysiology, ecology, climatology, physical oceanography, statistics and economics, to achieve new knowledge and improved management of the marine systems in question. Through targeted secondments in the non-academic sector, MARmaED will also constitute an **intersectorial** project that provides the network's students with broad training and strong favourable employment opportunities within industry and other non-academic sectors.

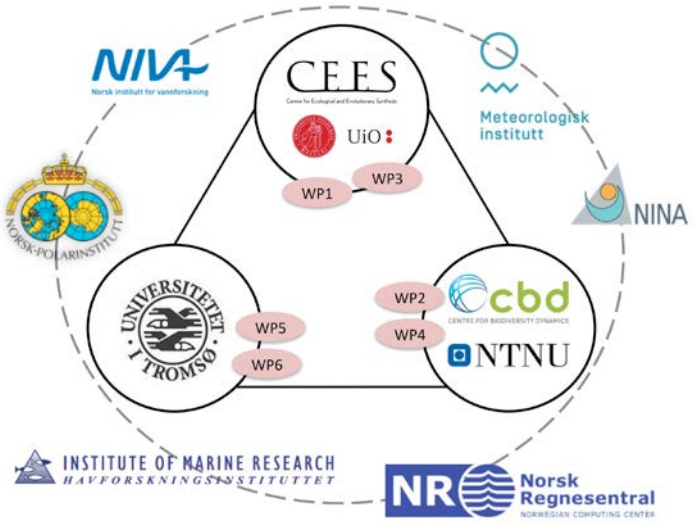
More than ever a strong involvement of the non-academic sector.

MARmaED is designed to explore and investigate marine ecosystem change in careful detail, from physical and biological effects to economic management implications, and is unique in the way it will integrate effect studies with economic perspectives. However, integrating scientific reasoning into policy implementation poses a great challenge. MARmaED will use PhD students as links between disciplines and countries in order to create new trans-disciplinary collaborations, encouraged by specifically tailored secondments in the non-academic sector. Within MARmaED, the 15 PhD students will be dispatched between the 8 partner institutions. The PhD projects are interwoven and will be internationally co-supervised between participating groups. The main objectives and benefits will be for students to learn how the secondment partners operate (Danish Pelagic Producers' Organisation, Pelagic Freezer Trawler Association, Institute of Marine Research, International Council for the Exploration of the Sea, World Wide Fund for Nature, Marine Stewardship Council, and Ministry of Trade, Industry and Fisheries Norway) (figure 2). The MARmaED students will thus acquire experience in combining physical, biological, and economic aspects of ecosystem-based management while achieving a better understanding of biological and societal impacts of climate change in European marine ecosystems. This will be achieved through a collaborative and cross-disciplinary approach on a scale rarely seen in these fields. Thus, the new generation of researchers emerging from the network will continue the school inherited from NorMER that is expected to have a long-lasting impact on the European and international scientific community as these researchers move through their respective careers.

Summarised by Joël Durant.
MARmaED is administered by CEES.
Website: www.marmaed.eu

SUSTAIN

SUSTAIN



SUSTAIN is a project funded by the Norwegian Research Council that studies the combined impacts of environmental change and harvesting across natural ecosystems. Terrestrial, freshwater, and marine ecosystems are currently all affected by major anthropogenic stressors, like climate change and harvesting. Yet, the interactive effects of these stressors remain poorly understood, and they are generally studied separately within each system. Such interactions may alter ecosystem functions and processes in previously unexpected ways, also impacting the ability to provide ecosystem services. SUSTAIN addresses the general question of how combined anthropogenic and climatic changes affect different harvested ecosystems, and how management strategies can be improved to ensure sustainable exploitation and resilience in those ecosystems.

SUSTAIN brings together three of the strongest scientific groups within ecology and evolution in Norway, from the universities of Oslo, Trondheim and Tromsø. This effort counteracts the profound fragmentation within Norwegian environmental science and establishes collaboration networks for a new generation of scientists and managers. The SUSTAIN network also consists of six other research centres from Norway (NINA, NIVA, Norsk Polarinstitutt, Norsk Regnesentral, Havforskningsinstitutt, Meteorologisk Institutt) with expertise ranging from statistics and ecology to meteorology and marine science. In addition, SUSTAIN collaborates closely with a panel of end-users. These are representatives from NGOs, stakeholders, monitoring programmes and management bodies for the ecosystems and renewable resources concerned.

The work in SUSTAIN is organised around a "strategic foresight protocol", a framework that provides a structured process whereby rigorous science scopes the options for an uncertain future. In collaboration with the panel of end-users, SUSTAIN uses both theoretical development and empirical analyses of high quality data to develop an ensemble of ecological models and explore impacts of environmental change and management interventions across environments, spatiotemporal scales, and from single populations to entire food webs. The results of these scientific analyses are intended to provide an integrated assessment of the studied ecosystems and evaluate their management strategies. This information can then be used to adjust management interventions as well as monitoring programmes. The continuous interaction with the panel of end-users should facilitate this latter part of the project. With this aim, meetings with the end-users are scheduled throughout the project. This is done to firstly identify their needs for knowledge and link them to our scientific objectives, and secondly to interpret our results and contribute to the decision-making process.

A crucial part of SUSTAIN is the training of young researchers. New PhD students and postdoc researchers make up the workforce of the project, including a number of them financed directly by the three main partner institutions. Related to the training is the mentoring of the younger, more junior scientists by the more senior members of the team, including the PI and co-PIs, so as to help them become project and science leaders. This will help develop their careers so as to be more competitive with regards to European funding. Another key aspect of the training is mobility. The PhD students appointed to the project are required to spend at least four months both at another national node, as well as at a collaborating institution outside the country, and the postdocs are encouraged to do the same.

All in all, SUSTAIN will not only contribute to the formation of a new generation of skilled scientists in the field of sustainability, but it will also provide sound scientific knowledge to assist decision makers in improving both the management and the monitoring of important harvested ecosystems. This will greatly contribute to the sustainability of those ecosystems.

Summarised by Luis Cadahia.
SUSTAIN is administered by CEES.
Website: sustain.uio.no

PlagPART

An international research and training network on the study of plague

PlagPART is a Norwegian-Russian-Chinese research and training network on the study of plague, funded by the Research Council of Norway. In the current geopolitical, demographic and economical situation, developing ties between European, Russian and Chinese institutions is of great importance for meeting security challenges on several levels. On a scientific level, rapid population growth both globally and in Asia, climate change, and economic instability, all mean that it is of paramount importance to understand zoonotic diseases (which make up the great bulk of emerging and re-emerging infectious diseases).

Against this backdrop, PlagPART is developing a highly visible international consortium (figure 1). This consortium will play a central role in the training of disease researchers on all levels in the study of the ecology and evolution of infectious diseases with an environmental reservoir, using plague as the focal model and study system. Through student and researcher mobility and workshops, PlagPART will organise joint courses and develop a common platform for research and training. The main aim of PlagPART is to extend the collaboration among disease researchers and scholars, mutually connected by their research on plague, training a new generation of interdisciplinary students within an international setting.

The PlagPART consortium consists of CEES (Principal Collaborating Institution) and leading research and education institutions in China and Russia. The main Chinese partners are Beijing Normal University, Tsinghua University and Zhejiang University, and the main Russian partner is Lomonosov Moscow State University. In addition, Chinese associated institutions include the Chinese Academy of Sciences, the Beijing Institute of Microbiology and Epidemiology, the Academy of Military Medical Science, and the Chinese Center for Disease Control and Prevention. Russian associated institutions include the Russian Academy of Sciences and the State Research Center for Applied Microbiology and Biotechnology. Third party institutions linked to the consortium include the National Center for Disease Control and Public Health of Georgia, the National University of Mongolia, and the Republican Anti-Plague Station of Azerbaijan.

The main outcomes of PlagPART will be 1) students trained in an interdisciplinary, international, world-leading environment and 2) the informal development of networks and skills through lectures, courses and supervision, by researchers at all involved institutions. Another key outcome will be the formalisation and expansion of course and curriculum development, to target and improve the subjects that benefit most from joint training. In addition, PlagPART will facilitate the continuation of research and education collaboration into the future, with the development of agreements on various joint activities regarding teaching, the training of research students, and research collaboration. Added value will result from new knowledge emerging from the comparative work within the PlagPART network, as well as from training candidates for employment at research institutions and in the public sector (such as public health institutions within the countries involved).

In addition to current research, both China and Russia draw on centuries of data from plague research and surveillance – data largely unparallelled by any other ecological system. Collaborating with these institutions places CEES and the University of Oslo at the centre of zoonotic disease research, and in the global forefront of plague research.

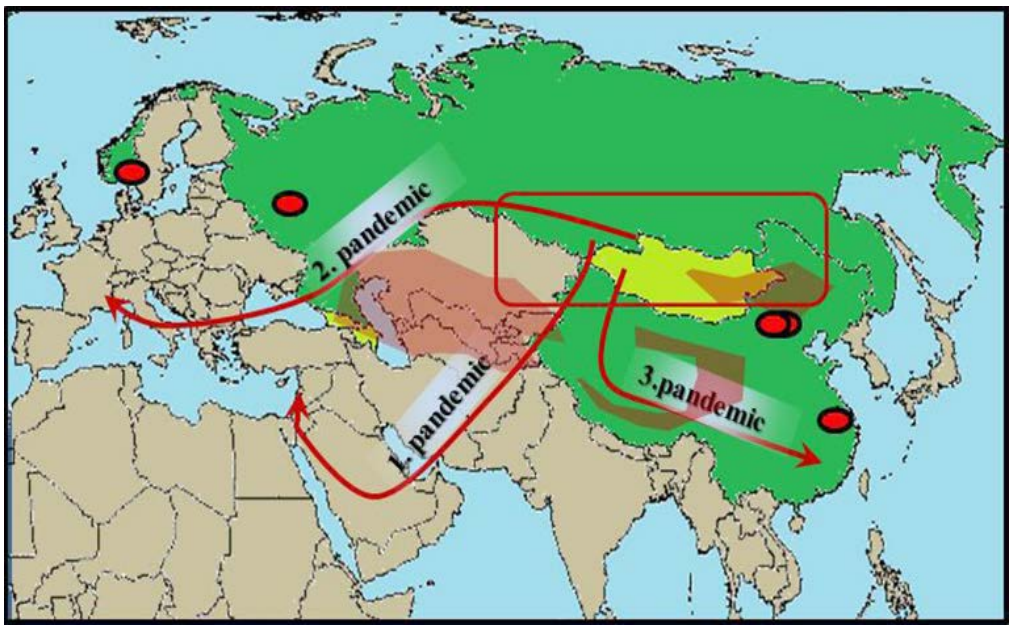
Summarised by Jo Skeie Hermansen.
PlagPART is administered by CEES.

CEES
Centre for Ecological and Evolutionary Synthesis

UiO : University of Oslo

ZHEJIANG UNIVERSITY 1897

LOMONOSOV MOSCOW STATE UNIVERSITY 1755



TSINGHUA UNIVERSITY 1911

BEIJING NORMAL UNIVERSITY 1902

北京師範大學
BEIJING NORMAL UNIVERSITY

Figure 1: The Norwegian-Russian-Chinese PlagPART consortium, in relation to the spread of plague during the three great pandemics. The red dots on the map shows the location of the main partners.

4 EDUCATION AND RESEARCH TRAINING

CEES aspires to provide excellent education and training facilities for our students, to supply outstanding candidates for future positions. Our host department, as well as other units of the university, delivers the basic education to our Bachelor's and Master's/PhD programmes. In 2015, CEES permanent scientific staff contributed to the teaching of 3 Bachelor's courses and 8 Master's/ PhD courses. 34 Master's students were supervised by CEES members, and 15 completed their degrees in 2015. We provide a stimulating research environment for our students by organising workshops, regular seminars and journal clubs, and by frequently inviting prominent scientists as speakers.

The Annual Student Conference

The CEES Annual Student Conference is a compulsory event that provides a good forum for students to hone their communication and presentation skills in a professional setting. This year the conference was held 14-15 October at Sundvolden Hotel with 134 delegates. Including a few talks by senior scientists, a total of 67 talks were given.

Journal clubs and discussion groups

CEES arranges several different journal clubs, e.g. the Colloquium Four Reading Group (27 sessions in 2015), the Speciation Journal Club (20 sessions), the Microbiome Journal Club (4 sessions) and the Genomic Analyses Club (4 sessions).

Participating students select relevant papers that focus on scientific challenges within the field of ecology and evolution. The journal clubs encourage critical reading of scientific papers and provide an opportunity for students to keep updated in their field of study, as well as in related scientific fields, thereby also promoting synthesis within the Centre.

Late Lunch Talks (LLT)

The Late Lunch Talk seminar series is a forum where employees, visiting scientists, and students at CEES present and discuss their work and ideas. The format is informal, with the objective being the facilitation of stimulating, topical discussions. A total of 18 sessions were held in 2015.

Delegates at the Annual CEES Student Conference, Sundvolden Hotel. © CEES.

5 GENDER EQUALISING STRATEGY

Gender balance in high-rank academic positions is a priority for both the Research Council of Norway (RCN) and the University of Oslo. CEES has implemented several guidelines to counter the attrition of women at all levels, from Master's students to tenured scientific staff, and all stages in between. Our strategy to attract and keep women scientists is based on optimising the conditions for our women students, and emphasising women role models. We acknowledge that in order to develop good scientific leaders for the future, one must give the young talented women (and men) an opportunity to develop and get the necessary training under the right conditions.

During the nine years that CEES has been running, we have had 141 researchers/postdocs as members of the Centre, and 40% of these have been women. Of 78 PhD positions, 47% have been held by women. In addition, the Scientific Advisory Board is chaired by a woman, the Deputy Chair is a woman, and two of the three *Themes* are co-chaired by women scientists.

In collaboration with CEES, the Department of Biosciences submitted a proposal to the UiO gender balance funds ("UiO sentrale likestillingsmidler") in 2014. The proposal was granted close to half a million NOK, and was matched by the same amount from IBV, to perform several measures that were initiated in 2015. All women at the Department of Biosciences holding a PhD degree, but without a permanent position (this constitutes approx. 40 persons), were offered 2 hours of career prospects guidance with a hired professional consultant from *Yellow Research* in collaboration with different resource persons from the department. Each woman had her CV reviewed, and each received specific guidance and a tailored plan of action as to how to improve her competitiveness and chances of pursuing a further career within academia.

Seven women (including Sanne Boessenkool, Anne Maria Eikeset, and Melissah Rowe from CEES) with exceptionally good prospects were thereafter prioritised for further measures. Some were granted a research stay abroad, others received some months of research assistance for labwork and similar, and one received funding to arrange a workshop to improve her international scientific network. All of them were offered help and funding in order to establish a mentoring agreement, and received funds for travel and accommodation in order to interact with their mentors. All women were offered guidance via a research leader course, and also offered skilled help to build their own professional-looking personal webpages. There were also several smaller facilitations, for instance helping them to increase their teaching and supervising experience. Several expensive publications were also funded. As mentioned above, each woman received a tailored plan of action, well suited to her specific needs. We believe that this is the reason for the success that we have so far observed from this project. The project is ongoing, and will be evaluated next year.

6 SCIENTIFIC OUTREACH

An important goal of CEES is to communicate its research and findings, as well as to increase the appreciation and understanding of science. Our aim is to reach both Norwegian and international audiences.

Public events

A central part of our scientific outreach is the open seminars featuring high-profile researchers and communicators of science, held both on the university's campus and at public venues such as Oslo's House of Literature (Litteraturhuset). For the tenth year in a row, the annual events of Darwin Day and the Kristine Bonnevie Lectures on Evolutionary Biology were held, the latter constituting a regular part of the university's annual anniversary day. In 2015, the topic for **Darwin Day** (12 February) was *Mendel, Darwin and the changing views on genetics*, and featured lectures by Michaela Jarkovská (the Mendel Museum in Brno, the Czech Republic), Staffan Müller-Wille (University of Exeter, UK) Stig Omholt (Norwegian University of Science and Technology – NTNU) and Aoife McLysaght (University of Dublin, Ireland). **The Kristine Bonnevie Lectures on Evolutionary Biology** (2 September) consisted of talks by Georgina Mace (University College London, UK) on *How should we value nature in a human-dominated world?* and James Wilsdon (University of Sussex, UK) on *The science and art of scientific advice.*

Open scientific events

Our Friday seminars and Extra seminars are also open to the public, although they are more technical and aimed at researchers and students. In 2015, 25 such seminars were held.

Media

The members of CEES are accessible to the media, and are encouraged to contribute their comments on issues of public concern when their expertise is applicable. The press coverage of research conducted at CEES is conveyed through a broad array of both national and international media, including newspapers, magazines, radio, television, and web-based information channels. Several CEES members, though not mentioned here by name, contributed extensively towards communicating their research in 2015.

Social media

Scientists, academic organisations and research groups use social media to broadcast their work, and CEES is no exception. CEES has several active bloggers (www.mn.uio.no/cees/english/outreach/), and is active on Facebook (www.facebook.com/pages/CEES-Centre-for-Ecological-and-EvolutionarySynthesis/295891987141021) and Twitter (@CEESUiO).

Speakers at Darwin Day 2015 (left to right): Aoife McLysaght, Michaela Jarkovská, Nils Chr. Stenseth, Staffan Müller-Wille and Stig Omholt. © CEES.

7 EXPERIMENTAL FACILITIES

CEES manages dedicated labs for DNA/RNA isolation, separate PCR facilities, post PCR, sequencing services and ancient DNA.

The CEES DNA lab is a molecular research core facility and is fully equipped for DNA and RNA extraction from various types of bacteria, protists, algae, fungi, and animal and plant tissues (including blood, faeces, and ancient DNA). It contains all the basic instrumentation of a modern molecular biology laboratory, including equipment for gene cloning, genomic libraries, real-time PCR, DNA/RNA quantification, and chip-based analysis of DNA, RNA, and protein. The annual turnover of the CEES DNA lab was approximately 300 000 NOK in 2015, and 50 researchers used the lab. The CEES DNA lab is open to users from the Department of Biosciences, and is at present actively used by CEES and the Microbial Evolution Research Group (MERG).

The ancient DNA (aDNA) lab

We finally have a state-of-the-art ancient DNA (aDNA) lab at UiO, capable of handling both human and non-human aDNA. The lab, which officially opened on 21 May 2015, was made possible following an initiative by CEES, and through a tight and successful collaboration with IBV, the Museum of Cultural History (KHM), and the Natural History Museum (NHM). In addition, there was strong support from the Faculty of Mathematics and Natural Sciences, the Medical Faculty and the Estate Department.

Fast development within high-throughput sequencing has revolutionised our ability to analyse historic and ancient DNA. Such approaches are increasingly being used in the various fields of biology (including evolutionary biology), biomedicine and forensic sciences, historical and archaeological research, and physical anthropology. Old DNA is typically damaged and broken down into short fragments and is often present in minute amounts. The degraded nature and minute quantities of aDNA require that experiments involving such DNA need to be carried out in a dedicated and specially designed laboratory.

The aDNA lab is run by CEES, in collaboration with our partners from NHM and KHM; the project is a prime example of interdisciplinary collaboration across faculties at UiO. A lab board headed by Sanne Boessenkool and including members of both the Natural History Museum and the Museum of Cultural History has recently been put into place, and a steering committee will be established in 2016. The tight coupling to the competence and services of the Norwegian Sequencing Centre (NSC) at CEES is an ideal situation for the aDNA lab activities, and will add international competitiveness to this interdisciplinary core facility. The demand for the aDNA lab is driven by ongoing and newly funded projects at CEES. Most importantly, an ERC funded project on medieval *Yersinia pestis* outbreaks (the MedPlag project chaired by Barbara Bramanti) was a driving force for establishing the aDNA lab. In addition, there are several projects at CEES that will strongly benefit from access to the new aDNA lab. Examples include a RCN funded project investigating evolutionary effects of fishery pressure on Atlantic cod using historic samples (led by Bastiaan Star and Sissel Jentoft), and the recently funded "Young Research Talent" project of Sanne Boessenkool involving collaborations between CEES, NHM and KHM. With this lab, UiO has gained infrastructure supporting aDNA research at the international forefront.

Summarised by Kjetill S. Jakobsen and Sanne Boessenkool.

Lisbeth Thorbek working in the new aDNA lab.
© Sanne Boessenkool.

7 EXPERIMENTAL FACILITIES

NORWEGIAN SEQUENCING CENTRE

The Norwegian Sequencing Centre (NSC) has two equal nodes hosted by the Centre for Ecological and Evolutionary Synthesis (CEES) at the Department of Biosciences at the University of Oslo, and the Department of Medical Genetics (DMG) at Oslo University Hospital and the University of Oslo. NSC has been placed on the National Roadmap for research infrastructures and large national projects since 2014, due to large funding from the Research Council of Norway's National Financing Initiative for Research Infrastructure (INFRASTRUKTUR).

Offered sequencing applications: NSC offers the Norwegian research community access to a broad range of high-throughput sequencing technologies (HTS) and applications. We possess state-of-the-art facilities and provide services covering most applications within the deep sequencing field, e.g. *de novo* sequencing, exome sequencing, sequencing of ancient DNA and other degraded DNA samples, as well as transcriptome-, miRNA-, amplicon-, bisulphite- and chromatin immunoprecipitation (ChIP)-sequencing, and base modification detection for smaller genomes.

Platform updates: In 2015, a large increase in national sequencing capacity was made possible by funding from INFRASTRUKTUR as NSC entered into partnership with HTS facilities at Radium Hospitalet (Oslo), Haukeland Universitetssjukehus (Bergen), and the Norwegian University of Science and Technology (Trondheim). NSC is the major partner (hub) in this collaboration, named the National Consortium for Sequencing and Personalised Medicine (NCS-PM). As part of this agreement, several additional sequencing instruments have been delivered and will be installed at the CEES node in early 2016. Taking these into account, NSC now has the following instruments available: 4 x HiSeq X, 2 x HiSeq 3000/4000, 3 x Illumina HiSeq 2500, 1 x Illumina HiSeq2000, 2 x Illumina NextSeq500, 3 x Illumina MiSeq, and 1 x Pacific Biosciences RSII. Finally, an order was placed for the newest Pacific Biosciences instrument, the Sequel, scheduled for delivery in 2016. The PacBio Sequel offers seven times the output per run, relative to the RSII for the same types of reads. This is by far the largest instrument park for HTS in Norway. In addition, NSC has a considerable infrastructure of supporting hardware to increase throughput and automation (Hamilton robot, Beckmann Biomek FX robot, two Pippin Prep instruments, Covaris DNA sonicators, etc.).

2015 saw the implementation of the Genologics Clarity Laboratory Information Management System (LIMS) at both the OUS and UiO nodes of NSC. Integration of sequencing procedures and machines with the LIMS system is still ongoing. Currently, the following are completely integrated with the LIMS system: sample submission, HiSeq sequencing, primary data analysis, and sample archiving. For 2016, we plan to complete integration of sample library preparation procedures, and NextSeq and MiSeq sequencing runs.

Instrument upgrades: HTS technology is developing quickly, and NSC has implemented important upgrades on our current instruments in order to continuously provide state-of-the art service. The Illumina HiSeq instruments have been upgraded to version 4 chemistry, increasing throughput (delivering up to 1 Tbase of data in a single run), while reducing run time. In addition, new chemistry for the Pacific Biosciences RS II has enabled another significant increase in read length and hence throughput.

Offered services: Services include project consultation, sample preparation, and running the sequencing reactions on the DNA sequencers, together with quality assessment of the data. For projects sequenced on Illumina instruments, mapping of the data to a reference is performed. For bacterial PacBio projects, we continue to deliver fully assembled genomes to our users. In addition to *de novo* genomes, base modification analyses can be provided for bacterial and fungal genomes sequenced on PacBio RS II. NSC may also offer advice on analysis software tools. For more advanced projects, users are referred to bioinformatics services/help desks (such as ELIXIR), or to research collaborations when appropriate. The submission of projects is handled through our website (www.sequencing.uio.no) where there is a single

contact point for both nodes (CEES and DMG), to help ensure that the optimal technology is applied for each project.

Sequencing activity: In 2015, approximately 7500 different samples in total were sequenced at NSC – a 15% increase relative to 2014. These samples represent 340 projects from 166 research groups – mostly from Norway, but also from several other European countries. The largest fraction of the samples was run on the Illumina platform (HiSeq/MiSeq). However, the number of samples sequenced on PacBio is still steadily growing.

Large projects: Currently, the largest project that NSC is performing sequencing for is the Aqua Genome (AG) project – led by CEES. In the AG project, 1000 individuals of Atlantic cod (*Gadus morhua*) will be sequenced with Illumina technology. The AG project started in 2014 and we will finish the sequencing in early 2016. We anticipate that large projects will be increasingly important for NSC in the future, and there are several such projects in the pipeline – both within biomedical and biological research.

Outreach: We have been involved in organising a three-week, hands-on course on "High Throughput Sequencing technologies and Bioinformatics Analysis", held at UiO in collaboration with the Computational Life Science initiative (CLSi) and the FUGE/ELIXIR Bioinformatics platform.

Summarised by Lex Nederbragt and Ave Tooming-Klunderud with help from the NSC team at CEES.

Sanne Boessenkool (left) and Heidi Maria Nistelberger sampling horse bones at the Natural History Museum in Bergen. © Brad Durrant.

8 COMPUTATIONAL AND BIOINFORMATIC RESOURCES

Computational and bioinformatic resources

In 2015 we saw a continued increase in the bioinformatics activities at CEES. This was mainly driven by an increase in the number of CEES researchers who applied for access to the computational resources that CEES offers.

Infrastructure

At CEES, we use a combination of self-owned servers, and CPU hours we have applied for on the UiO supercomputer 'Abel'. This maximises flexibility for CEES researchers in choosing the right resource for their project. Memory-intensive applications can be run on our own servers, while CPU-intensive applications can be submitted to Abel and therefore do not take up valuable time on the servers. The servers CEES owns (see below) are attached to the Abel system. This means users can seamlessly access the same programmes and disks through the self-owned servers, as well as through Abel. For storage ('project disk space') beyond what is available on our own servers, we rent space from the University Center for Information Technology (USIT) (attached to Abel) at UiO, rather than buy and administer our own.

Hardware

Starting with the project to sequence and assemble the genome of Atlantic cod in 2009, CEES has invested in its own hardware for computation. These servers are hosted and maintained by the High Performance Computing (HPC) group of USIT. In collaboration with the Norwegian Sequencing Centre and the Aqua Genome project, and with support from the faculty of Mathematics and Natural Sciences, we were able in 2015 to order hardware to completely renew, as well as extend, the computer resources of CEES. The following computational infrastructure is now available to CEES: (i) three high-memory servers with 32 CPUs and 1.5 Terabyte of RAM, and 64 TB local disk space each; (ii) a more modest server to be developed into a genome browser (see below); and (iii) 256 regular CPUs, providing us with the equivalent of 2.2 million CPU hours per year. On the university computer cluster Abel, we have allocations on the national HPC infrastructure through Notur (notur.no), for CPU-intensive computations. We estimate that we used roughly 6.7 million CPU hours in 2015. CEES bioinformaticians use 165 TB of common, shared, disk space with another 60 TB disk space for long-term archival of data at Norstore (norstore.no), the national Norwegian infrastructure for the archiving of digital scientific data.

Organisation

The bioinformaticians are organised through a mailing list and occasionally meet to discuss common interests or papers. Two journal clubs, the Genome Analysis Club (TGAC) and the Microbiome Group, discuss papers and programmes focussing on analytical methods for genomic data. There is a wiki containing a growing number of articles dealing with the practicalities of using the resources at CEES, tips and tricks, etc. (https://wiki.uio.no/mn/bio/cees-bioinf/). Although the day-to-day administration of the servers and disk space is the responsibility of USIT, there is still a considerable amount of overhead for CEES staff. Aspects of this include applying for, and reporting on, the use of CPU hours on Abel; correspondence with USIT on required software and interruptions of the servers; feedback to CEES users; administration of the user base, mailing lists, and wiki; and instructing new users.

Projects

Examples of projects requiring large computational resources and large amounts of disk space are: (i) projects to generate *de novo* genome assemblies of both small (bacterial) and large (eukaryote) genomes; (ii) re-sequencing projects (SNP finding and genotyping) that require many CPU hours for mapping sequencing data to a reference; (iii) metagenomics and environmental sequencing projects; (iii) genome annotation pipelines; (iv) sequencing of mitochondrial genomes; and (v) ecological modelling.

Genome browser

In collaboration with the Norwegian ELIXIR environment at the Norwegian University of Life Sciences (NMBU), CEES is in the process of establishing a Genome Browser for each genome resulting from research performed at CEES. A genome browser is a graphical interface for viewing and accessing genomic data for a species. Once ready, links to these genome browsers will be added to http://www.mn.uio.no/cees/english/genome-browser/.

Outlook

In 2016, we will improve the abovementioned wiki and move it over to a new website, develop lesson material and hold the first teaching sessions for new users of the infrastructure. We will also release the first genome(s) through the Genome Browser, starting with the new version of the Atlantic cod genome.

Summarised by Lex Nederbragt.

Ancient bones from Atlantic cod are used for reconstruction of whole genome sequence data from prehistoric populations, and for comparison with their contemporary counterparts. © Agata Teresa Gondek.

9 FINANCES

Accounting principles

CEES funding is derived primarily from RCN sources (approximately 10 MNOK in core funding per year), supplemented by funds from UiO (2 MNOK per year plus funding for several positions), and other sources defined as own funding. Our own funding can be divided into the sub-categories: funding from RCN projects; funding from other public sector based projects; funding from private sector based projects; and funding from international projects.

Expenditures are sub-categorised into salary expenses, indirect costs, R&D services, equipment, running costs (composed mainly of operational expenses for laboratory and fieldwork) and travel and representation. In addition to revenues and expenditures that are accounted for, we also have those that are not accounted for. These are mainly defined as the expenditures of those personnel that work within CEES, but receive their salaries from other parties. The value of these services is calculated using official UiO budgeting procedures. In this report we present the accounting figures for 2015, and the budget for 2016.

Inger Maren Rivrud at a bear's den. © Atle Mysterud.

Revenues and expenditures 2015/Budgeted revenues and expenditures 2016

Total funding			Accounted revenues		Revenues not in account
	2015	Budget 2016	Figures 2015	Budgeted figures 2016	Revenues not in account 2015[1]
RCN-CoE	9 405	9 200	9 405	9 200	
UiO	30 425	7 678	9 368	7 678	21 057
RCN – CEES related projects	51 179	63 464	51 179	63 464	
Other public sector based projects	3 856	2 245	3 856	2 245	
International funding	35 094	13 071	22 870	13 071	12 224
Private sector based projects	77	223	77	223	
Transferred revenues	22 909	31 589	22 909	31 589	
Total funding	***152 945***	***127 470***	***119 664***	***127 470***	***33 281***

Accounted expenses 2015 (Acc 15)/Budgeted expenses 2016 (Bud 16)

	Total		RCN-CoE		UiO		RCN projects		Other public sector based pro.		International funding		Private sector based projects	
	Acc 15	Bud 16	Acc 15	Bud 16	Acc 15	Bud 16	Acc 15	Bud 16	Acc 15	Bud 16	Acc 15	Bud 16	Acc 15	Bud 16
Salary expenses	37 574	48 376	6 705	8 802	3 884	3 956	17 175	24 665	2 733	1 421	7 053	9 532	24	
Indirect costs	11 462	14 876	927	1 232	1 065	1 137	6 648	9 765	1 300	519	1 522	2 223		
R&D services	21 481	23 948					10 354	18 448			11 127	5 500		
Equipment	13 328	8 351					1 204	8 275	25		99	76		
Running costs	15 139	19 995	325	1 200	2 011	2 800	9 430	8 689	750	1 542	2 537	5 541	86	223
Travel and representation[2]	1 090		175		915									
Total	***88 074***	***115 546***	***8 132***	***11 234***	***7 875***	***7 893***	***44 811***	***69 842***	***4 808***	***3 482***	***22 338***	***22 872***	***110***	***223***

Expenses not in account 2015 (Nacc 15)

	Nacc 15	Bud 16	Nacc 15	Bud 16	Nacc 15	Bud 16	Nacc 15	Bud 16	Nacc 15	Bud 16	Nacc 15	Bud 16	Nacc 15	Bud 16
Salary expenses	24 175				15 210						8 965			
Indirect costs	9 107				5 847						3 260			
Total[3]	***33 282***				***21 057***						***12 225***			

Balance 2015/Budgeted balance 2016

	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Revenues	130 036	95 881	9 405	9 200	30 425	7 678	51 179	63 464	3 856	2 245	35 097	13 071	77	223
Transf. revenues	22 909	33 774	450	1 723	285	1 778	2 136	8 504	1 058	106	21 132	21 63	33	0
Total expenses	121 356	115 546	8 132	11 234	28 932	7 893	44 811	69 842	4 808	3 482	34 563	22 872	110	223
Balance	***31 589***	***14 109***	***1 723***	***-311***	***1 778***	***1 563***	***8 504***	***2 126***	***106***	***-1 131***	***21 663***	***11 862***	***0***	***0***

All figures are given in 1000 NOK.
1) Not posted revenues for 2015. These are mainly defined as the efforts of those personnel that work within CEES, but receive their salaries from other parties.
2) Travel and representation is included in running costs for all funding sources except RCN-CoE and UiO.
3) Not posted expenditures for 2015.

Etosha National Park, Namibia. Etosha National Park has been visited frequently by CEES researchers conducting fieldwork. © Delphine C. Nicolas.

10 APPENDICES

CEES-members

Core scientific staff

Name	Nationality	Position	Period	Funding 2015	CEES share (%)
Brysting, Anne K.	Denmark	Professor	Oct. 2007–	UiO-IBV	75
Durant, Joël	France	Researcher	Oct. 2007–	RCN/NORDFORSK	100
Ergon, Torbjørn	Norway	Assoc. Professor	Jan. 2013–	UiO-IBV	50
Hansen, Thomas F.	Norway	Professor	Oct. 2007–	UiO-IBV	75
Hessen, Dag O.	Norway	Professor	Oct. 2007–	UiO-IBV	20
Hestmark, Geir	Norway	Professor	Jan. 2014–	UiO-IBV	75
Hjort, Nils L.	Norway	Professor	Oct. 2007–	UiO-Math	25
Jakobsen, Kjetill S.	Norway	Professor	Oct. 2007–	UiO-IBV	75
Lampe, Helene M.	Norway	Professor	Oct. 2007–	UiO-IBV	75
Mysterud, Atle	Norway	Professor	Oct. 2007–	UiO-IBV	75
Ottersen, Geir	Norway	Senior Scientist	Oct. 2007–	IMR/RCN-CoE	25
Slagsvold, Tore	Norway	Professor	Oct. 2007–	UiO-IBV	75
Stenseth, Nils Chr.	Norway	Professor & CEES Chair	Oct. 2007–	RCN-CoE	100
Stige, Leif Christian	Norway	Researcher	Oct. 2007–	RCN	100
Storvik, Geir	Norway	Professor	Oct. 2007–	UiO-Math	20
Sætre, Glenn-Peter	Norway	Professor	Oct. 2007–	UiO-IBV	75
Viljugrein, Hildegunn	Norway	Assoc. Professor	Oct. 2007	UiO-IBV	20
Vøllestad, Leif Asbjørn	Norway	Professor	Oct. 2007–	UiO-IBV	75

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Postdocs and Researchers

Name	Nationality	Position	Period	Funding 2015	CEES share (%)
Atickem, Anagaw M.	Ethiopia	Researcher	Apr. 2013–May 2016	RCN-CoE	20
Barth, Julia M. I.	Germany	Postdoc res. fellow	Jan. 2014–Jan. 2017	UiO-IBV	100
Bianucci, Raffaella	Italy	Researcher	Jul. 2013–Jun. 2015	ERC	38
Boessenkool, Sanne	The Netherlands	Researcher	Dec. 2012–Feb. 2018	RCN	82
Bramanti, Barbara	Italy	Researcher	Jun. 2013–Oct. 2015	ERC	75
Cadahia, Luis	Spain	Researcher	Sep. 2014–Dec. 2018	RCN	50
de Muinck, Eric	USA	Postdoc res. fellow	Jun. 2014–May 2017	UiO-IBV	100
Di Martino, Emanuela	Italy	Researcher	Jan. 2015-Nov. 2016	RCN	92
Diekert, Florian	Germany	Postdoc res. fellow	Oct. 2011–Oct. 2015	NORDFORSK	100
Easterday, William R.	USA	Postdoc res. fellow	Jan. 2012–May 2016	UiO-IBV	83
Eikeset, Anne Maria	Norway	Researcher	Oct. 2007–Mar. 2017	NORDFORSK/ RCN	100
Eroukhmanoff, Fabrice	France	Postdoc res. fellow	Jan. 2013–Dec. 2017	UiO-IBV	100
Fischer, Barbara	Austria	Postdoc res. fellow	Oct. 2010–Mar. 2015	UiO-IBV	25
Haverkamp, Thomas H. A.	The Netherlands	Postdoc res. fellow	Jun. 2012–Mar. 2016	RCN	100
Hermansen, Jo S.	Norway	Researcher	Sep. 2009–Jun. 2016	NORDFORSK	67
Hernandez-Aguilar, Adriana R.	Mexico	Researcher	Jun. 2015–May 2016	RCN-CoE	6
Hjermann, Dag Ø.	Norway	Researcher	Oct. 2007–Dec. 2015	RCN-CoE/IMR	20
Holen, Øistein H.	Norway	Researcher	Oct. 2007–Dec. 2016	RCN-CoE	100
Hutchings, Jeffrey	Canada	Researcher	Sep. 2010–Sep. 2017	RCN-CoE	20
Hänsch, Stephanie	Germany	Postdoc res. fellow	Jun. 2013–May 2016	ERC	100
Jin, Xingkun	China	Postdoc res. fellow	Jan. 2015–Jan. 2017	RCN	100
Jorde, Per Erik	Norway	Researcher	Oct. 2007–Dec. 2016	RCN/INTERREG	100
Kausrud, Kyrre	Norway	Postdoc res. fellow	Jul. 2010–Nov. 2016	RCN	50
Kjesbu, Olav S.	Norway	Professor	Sep. 2012–Jul. 2016	NORDFORSK	20
Knutsen, Halvor	Norway	Researcher	Oct. 2007–Jun. 2018	RCN/INTERREG	10
Kvile, Kristina	Norway	Researcher	Dec. 2015–Dec. 2016	RCN	4
Langangen, Øystein	Norway	Researcher	Sep. 2010–Mar. 2015	RCN, IMR	25
Larsen, Søren	Denmark	Postdoc res. fellow	Jan. 2011–Apr. 2015	NORDFORSK	33
Liow, Lee Hsiang	Singapore	Researcher	Oct. 2007–Jul. 2018	RCN	100
Llope, Marcos	Spain	Researcher	Jan. 2015–May 2015	NORDFORSK	42

Malmstrøm, Martin	Norway	Postdoc res. fellow	Sep. 2014–Feb. 2017	RCN	100
Martin, Jodie	France	Senior Lecturer	Sep. 2015–Jan. 2016	CAS	15
Martinsen, Lene	Norway	Researcher	Nov. 2015–Dec. 2015	RCN-CoE	4
Matschiner, Michael	Germany	Postdoc res. fellow	Sep. 2013–Sep. 2016	RCN	100
Nielsen, Anders	Norway	Researcher	Oct. 2013–Mar. 2017	RCN-CoE/RCN	100
Nilsson, Anna	Sweden	Researcher	Sep. 2013–Dec. 2017	RCN	100
Nistelberger, Heidi Maria	Austria	Postdoc res. fellow	Mar. 2015–Feb. 2017	RCN	83
Ohlberger, Jan P.	Germany	Researcher	Jul. 2015–Dec. 2016	RCN	15
Olsen, Esben Moland	Norway	Researcher	Oct. 2007–Dec. 2015	RCN	10
Peters, Wibke	Germany	Postdoc res. fellow	Oct. 2015–Sep. 2018	CAS	25
Ravinet, Mark Simon Paul	UK	Researcher	Nov. 2015–Nov. 2018	UiO-IBV	13
Reitan, Trond	Norway	Researcher	Oct. 2013–Aug. 2018	RCN	40
Richter, Andries P.	Germany	Postdoc res. fellow	Mar. 2010–Jun. 2016	RCN	20
Rivrud, Inger Maren	Norway	Researcher/Postdoc res. fellow	Sep. 2008–Apr. 2018	RCN-CoE/RCN	100
Rogers, Lauren	USA	Postdoc res. fellow	Aug. 2011–Nov. 2015	NORDFORSK	9
Rueness, Eli K.	Norway	Researcher	Oct. 2007–Sep. 2017	RCN-CoE	80
Salzburger, Walter	Austria	Researcher	Sep. 2012–Aug. 2015	RCN-CoE	13
Schmid, Boris	The Netherlands	Researcher/Postdoc res. fellow	Apr. 2012–Oct. 2016	RCN-CoE	100
Seierstad, Kristian S.	Norway	Researcher	Sep. 2015–Sep. 2016	RCN	29
Star, Bastiaan	The Netherlands	Researcher	Sep. 2008–Aug. 2017	RCN	100
Starrfelt, Jostein	Norway	Postdoc res. fellow	Oct. 2014–Sep. 2017	RCN	100
Svennungsen, Thomas	Norway	Postdoc res. fellow	Aug. 2011–Oct. 2015	RCN-CoE	83
Tominaga, Koji	Japan	Researcher	Oct. 2013–Dec. 2017	RCN	75
Trosvik, Pål	Norway	Researcher	Apr. 2012–May 2017	RCN	100
van Leeuwen, Casper	The Netherlands	Postdoc res. fellow	Sep. 2013–Sep. 2015	RCN-NINA	75
Vik, Unni	Norway	Researcher	May 2010–Mar. 2016	RCN	50
Vindenes, Yngvild	Norway	Researcher	Apr. 2011–Dec. 2018	RCN	100
Voje, Kjetil L.	Norway	Postdoc res. fellow	Aug. 2007–Jan. 2017	RCN	100
Whittington, Jason	USA	Postdoc res. fellow	Sep. 2013–Jun. 2016	NORDFORSK	33
Yang, Hong	China	Postdoc res. fellow	Nov. 2013–Oct. 2015	RCN	83
Østbye, Kjartan	Norway	Researcher	Oct. 2007–Feb. 2015	RCN	0.5

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PhD students

Name	Nationality	Position	Period	Funding 2015	CEES share (%)
Athumani Ndmuligo, Sood	Tanzania	Research fellow	Aug. 2012–Jul. 2015	Quota Scheme	58
Baalsrud, Helle T.	Norway	Research fellow	Sep. 2012–Jun. 2017	UiO-IBV	42
Berg, Paul R.	Norway	Research fellow	Oct. 2010–Jun. 2015	UiO-IBV	54
Berihun, Mewicha	Ethiopia	Research fellow	Jan. 2009–Dec. 2015	Quota scheme	100
Beyene, Cherie E.	Ethiopia	Research fellow	Aug. 2012–Jul. 2016	Quota scheme	50
Cloete, Claudine C.	Namibia	Research fellow	Sep. 2013–Aug. 2016	RCN	13
Cuevas, Angelica Maria Pulido	Columbia	Research fellow	Feb. 2015–Feb. 2019	UiO-IBV	88
Delkaso, Dereje Tesfaye	Ethiopia	Research fellow	Aug. 2014–Jul. 2017	Quota scheme	100
Deris, Leana	Croatia	Research fellow	Sep. 2015–Sep. 2018	RCN	33
Elgvin, Tore O.	Norway	Research fellow	Jul. 2011–Mar. 2016	RCN	83
Graffi, Giulia	Italy	Research fellow	Sep. 2015–Feb. 2016	ERC	25
Guellil, Meriam	UK	Research fellow	May 2015–Apr. 2018	ERC	58
Guldvog, Caroline Øien	Norway	Research fellow	Aug. 2015–Aug. 2018	RCN	42
Gutema, Tariku Mekonnen	Ethiopia	Research fellow	Jan. 2014–Dec. 2016	Quota scheme	100
Isaksen, Elisabeth T.	Norway	Research fellow	May 2013–Apr. 2016	RCN	100
Kassie, Addisu Mekonnen	Ethiopia	Research fellow	Aug. 2011–Dec. 2015	Quota Scheme	100
Kibaja, Mohamed Julius	Tanzania	Research fellow	Aug. 2014–Jul. 2017	Quota Scheme	100
Kvile, Kristina Ø.	Norway	Research fellow	Aug. 2012–Oct. 2015	NORDFORSK	83
Liljegren, Mikkel	Norway	Research fellow	Oct. 2012–Sep. 2016	UiO-IBV	100
Nater, Chloé Rebecca	Switzerland	Research fellow	Sep. 2015–Feb. 2019	RCN	25
Nilsson, Pernille	Norway	Research fellow	Aug. 2013–Jun. 2018	UiO-IBV	33
Riiser, Even Sannes	Norway	Research fellow	Oct. 2014–Sep. 2017	UiO-IBV	100
Romagnoni, Giovanni	Italy	Research fellow	Sep. 2011–Sep. 2016	UiO-IBV	17
Solbakken, Monica H.	Norway	Research fellow	Jun. 2010–Jun. 2016	RCN	67
Toljagic, Olja	Serbia	Research fellow	Sep. 2013–Aug. 2017	UiO-IBV	100
Trier, Cassandra N.	USA	Research fellow	Sep. 2012–Jun. 2017	UiO-IBV	33
Tørresen, Ole Kristian	Norway	Research fellow	Sep. 2011–Jul. 2016	UiO-IBV	75
Varadharajan, Srinidhi	India	Research fellow	Sep. 2014–Sep. 2018	UiO-IBV	100
Winter, Anna-Marie	Germany	Research fellow	Sep. 2014–Sep. 2017	NORDFORSK	100
Worku, Ejigu Alemayehu	Ethiopia	Research fellow	Aug. 2014–Jul. 2017	Quota scheme	100

Research Assistants

Name	Nationality	Position	Period	Funding 2015	CEES share (%)
Asmervik, Ingvild Fonn	Norway	Research Assistant	Jun.–Aug. 2015	CEES/RCN	13
Byrkjeland, Ragna	Norway	Research Assistant	Jun.–Sep. 2015	CEES/RCN	4
Evankow, Ann	USA	Research Assistant	Sep.–Dec. 2015	CEES	2
Franeck, Franziska	Germany	Research Assistant	Aug.–Nov. 2015	CEES/RCN	25
Hylland, Vetle	Norway	Research Assistant	May–Jul. 2015	CEES/RCN	6
Johansen, Zanna Regina Blom	Norway	Research Assistant	May–Jun. 2015	CEES	3
Kallioniemi, Eveliina Päivikki	Finland	Research Assistant	Jun. 2015	CEES/RCN	13
Skau, Lars Fredrik	Norway	Research Assistant	Jun.–Dec. 2015	CEES/RCN-IMR	20
Stigum, Vetle Malmer	Norway	Research Assistant	Feb.–Jun. 2015	CEES/RCN	13
Stræte, Tine Øiseth	Norway	Research Assistant	May–Jun. 2015	CEES	1
Sætre, Camilla Lo Cascio	Norway	Research Assistant	Jan.–Nov. 2015	CEES/RCN	23
Thorsteinsen, Camilla	Norway	Research Assistant	Jun. 2015	CEES	0.5

Administrative and technical support staff

Name	Nationality	Position	Period	Funding 2015	CEES share (%)
Bjørnæs, Ane Mari	Norway	Senior Executive Officer	Aug. 2015–Aug. 2016	RCN-CoE	42
Cadahia, Luis L.	Spain	Researcher/Adviser	Jan. 2014–Jun. 2015	RCN-CoE	42
Cunningham, Sari C.	USA/Belgium	Senior Executive Officer	Mar. 2014–Nov. 2015	RCN-CoE	21
Egidius, Alexander E.	Norway	Executive Officer	Aug. 2014–Aug. 2015	NORDFORSK	12
Elgvin, Tore Oldeide	Norway	Adviser	May 2015–Jul. 2015	RCN-CoE	17
Gundersen, Gry	Norway	Senior Adviser	Oct. 2007–	UiO-IBV	100
Hansen, Marianne H. S.	Norway	Senior Engineer	Jan. 2012–Dec. 2015	UiO-IBV	100
Herland, Anders	Norway	Staff Engineer	Jan. 2008–	UiO-IBV	100
Jentoft, Sissel	Norway	Senior Adviser & Deputy Chair	Jun. 2009–Sep. 2017	RCN-CoE	100
Jogi, Suresh K.	Ireland	Senior Executive Officer	Jun. 2013–Feb. 2015	RCN-CoE	3
Kollias, Spyridon	Greece	Head Engineer	Dec. 2014–Dec. 2017	RCN	79
Mazzarella, Anna V. B.	USA	Higher Executive Officer	Oct. 2014–Jun. 2016	RCN/NORDFORSK	100
Nederbragt, Alexander	The Netherlands	Senior Engineer	Oct. 2007–	UiO-IBV	100
Nerli, Emelita R.	Norway	Senior Engineer	Oct. 2007–	UiO-IBV	50
Nicolas, Delphine C.	France	Adviser	Mar. 2014–Mar. 2017	RCN-CoE/UiO-IBV	100
Rydbeck, Kjell Halfdan	Sweden	Senior Engineer	Apr. 2008–Nov. 2017	RCN	75
Rygg, Kari B.	Norway	Senior Adviser	May 2008–	UiO-IBV	100
Skage, Morten	Norway	Senior Engineer	May 2008–	UiO-IBV	100
Steen, Nanna W.	Norway	Staff Engineer	Oct. 2007–	UiO-IBV	100
Thomsen, Camilla S.	Denmark	Senior Executive Officer	Nov. 2012–Aug. 2015	RCN-CoE	58
Thorbek, Lisbeth	Norway	Head Engineer	Apr.–Oct. 2015	RCN	100
Tooming-Klunderud, Ave	Norway	Senior Engineer	Feb. 2011–Dec. 2015	UiO-IBV	100
Wallem, Tore	Norway	Adviser	Dec. 2007–	RCN-CoE	100

Guests of CEES in 2015

Long term research visits (more than one month)

Name	Nationality	Home institution	Period
Anastasiadou, Chryssa	Greece	University of Ioannina, Greece/University of Oslo, Norway	Sep.–Oct. 2015
Areskoug, Veronica	Sweden	University of Oslo, Norway	Jan.–Jun. 2015
Athumani, Sood	Tanzania	University of Oslo, Norway	Aug.–Dec. 2015
Bailey, Richard	UK	University of Oslo, Norway	Jan.–Dec. 2015
Bjørge, Arne Jostein	Norway	Institute of Marine Research, Norway	Jan.–Dec. 2015
Bramanti, Barbara	Italy	University of Ferrara, Italy	Oct.–Dec. 2015
Carneiro, Diana	Portugal	Natural History Museum, University of Oslo, Norway	Jan. 2015–Jan. 2019
Cristofari, Robin	France	University of Strasbourg	Jan.–Sep. 2015
Daskalaki, Eva	Greece	Museum of Cultural History, University of Oslo, Norway	Jun.–Aug. 2015
Dupont, Nicolas	France	Institute of Marine Research, Norway	Jan.–Dec. 2015
Fashing, Peter	USA	California State University Fullerto, USA	Aug. 2015–Aug. 2016
Gautestad, Arild Olsen	Norway	University of Oslo, Norway	Jan.–Dec. 2015
Grabowski, Mark	USA	Fullbright Scholar	Dec. 2014–Dec. 2015
Gusarova, Galina	Norway	Natural History Museum, University of Oslo, Norway	Jun.–Dec. 2015
Helberg, Morten	Norway	University of Oslo, Norway	Jan.–Dec. 2015
Huserbråten, Mats	Norway	Agder University, Norway	Jan.–Dec. 2015
Labra, Antonieta	Chile	Universidad de Chile, Chile	Jan.–Dec. 2015
Langangen, Øystein	Norway	VISTA project	Jan.–Dec. 2015
Martinsen, Lene	Norway	University of Oslo, Norway	Apr.–Dec. 2015
Nguyen, Nga	USA	California State University Fullerton, USA	Aug. 2015–Aug. 2016
Ottesen, Vibeke	Norway		Jan.–Dec. 2015
Rey, Francisco	Chile/Norway	Institute of Marine Research, Norway	Jan.–Dec. 2015
Rinaldo, Natascia	Italy	University of Ferrara, Italy	Sep.–Nov. 2015
Rowe, Melissah	Australia	Natural History Museum, University of Oslo, Norway	Jan.–Dec. 2015
Runemark, Anna	Sweden	University of Lund, Sweden	Jan.–Dec. 2015
Salenius, Fredrik	Iceland	University of Iceland, Iceland	Aug.–Dec. 2015
Skjæraasen, Jan Egil	Norway	Institute of Marine Research, Norway	Jan.–Dec. 2015
Torgersen, Thomas	Norway	Institute of Marine Research, Norway	Jan.–Dec. 2015
Wiebe, Karen L.	Canada	University of Saskatchewan, Canada	Mar.–Apr. 2015
Åberg, Per	Sweden	Gothenborg University, Sweden	Jan.–Feb. 2015

Short term guests (more than one week, less than one month)

Name	Nationality	Home institution	Period
Artemyeva, Liudmila	Russia	Moscow State University, Russia	Feb. 2015
Bartoszek, Krzyszto	Sweden	Uppsala University, Sweden	Oct. 2015
Björkvik, Emma	Sweden	Stockholm Resilience Centre, Sweden	Feb. 2015
Burgess, Matthew	USA	Bren School of Environmental Science and Management, USA	Jun. 2015
Colwell, Jack	USA		Aug.–Sep. 2015
Colwell, Rita	USA	University of Maryland, USA	Aug.–Sep. 2015
Crusoe, Michael R.	USA	Michigan State University, USA	Apr. 2015
Fedorov, Vadim	USA	University of Alaska, USA	Apr. 2015
Finnegan, Seth	USA	University of California, Berkeley, USA	Sep.–Oct. 2015
Garratt, Michael	UK	University of Reading, UK	Jun. 2015
Hannisdal, Bjarte	Norway	University of Bergen, Norway	Sep.–Oct. 2015
Hopkins, Melanie	USA	American Museum of Natural History, USA	Sep.–Oct. 2015
Hunsicker, Mary	USA	NOAA Fisheries, USA	Sep. 2015
Jarkovská, Michaela	Czech Republic	Mendel Museum, Masaryk University, Czech Republic	Feb. 2015
Klein, Emil	USA	Princeton University, USA	Oct. 2015
Klinger, Dane	USA	Princeton University, USA	Feb. 2015
Kröger, Björn	Finland	University Museum Helsinki, Finland	Sep.–Oct. 2015
Mackenzie, Simon	UK	University of Stirling, UK	Jun.–Jul. 2015
Muschick, Moritz	Germany	University of Sheffield, UK	Jul.–Aug. 2015
Oomen, Rebekah	Canada	Dalhousie University, Halifax, Canada and Institute of Marine Research, Flødevigen, Norway	Oct. 2015
Orians, Gordon	USA	University of Washington, USA	Aug.–Sep. 2015
Rünneburger, Estelle	France	Evolution Genomes Comportement Ecologie, National Center for Scientific Research, France	Nov. 2015
Spijkers, Jessica	Belgium	Stockholm Resilience Centre, Sweden	Feb. 2015
Tsuboi, Masahito	Japan	Uppsala University, Sweden	Apr. 2015
Valman, Matilda	Sweden	Stockholm Resilience Centre, Sweden	Feb. 2015

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Research projects

RCN projects				
Name	**Project leader**	**Funding**	**Start**	**End**
Tracking Viking-assisted dispersal of biodiversity using ancient DNA	Boessenkool, Sanne	RCN	2014	2018
Behavioral responses to risk and uncertainty among Norwegian fishers (BiodivERsA)	Hessen, Dag O.	RCN	2013	2015
Effects of climate change on boreal lake ecosystems: productivity and community responses (ECCO)	Hessen, Dag O.	RCN	2013	2016
Genetic variability in population responses of Atlantic cod to environmental change	Hutchings, Jeffrey	RCN	2014	2015
Translating the cod genome for aquaculture	Jakobsen, Kjetill S.	RCN	2010	2015
Functional and comparative immunology of a teleosts world without MHC II	Jakobsen, Kjetill S.	RCN	2013	2017
The Aqua Genome project	Jakobsen, Kjetill S.	RCN	2013	2017
Novel techniques for seabed monitoring of CO_2 leakage and monitoring campaigns based on reservoir, cap rock and overburden migration models	Jakobsen, Kjetill S.	RCN	2014	2016
The Norwegian Sequencing Centre – Phase II	Jakobsen, Kjetill S.	RCN	2014	2017
Phanerozoic diversification: linking observation and process	Liow, Lee Hsiang	RCN	2014	2018
Genetic architecture in Drosophila – The role of the Y chromosome in gene expression across the genome	Martinsen, Lene	RCN	2011	2015
LAND: Partial migration of red deer and tick distribution at the altitudinal colonization border (TickDeer)	Mysterud, Atle	RCN	2011	2015
LAND: Delimiting functional management units for partially migratory deer populations (DeerUnit)	Mysterud, Atle	RCN	2014	2017
Biogeographic and population analyses of *Thermotogales* bacteria from hydrocarbon-rich environments	Nesbø, Camilla	RCN	2008	2015
Pollination; an ecosystem service affected by climate change (LAND)	Nielsen, Anders	RCN	2014	2017
Evolutionary ecology and hydrology – the effects of stream flow dynamics on the white-throated dipper	Nilsson, Anna	RCN	2013	2016
On the evolutionary genomics and behavioural ecology of homoploid hybrid speciation in Passer sparrows	Sætre, Glenn-Peter	RCN	2011	2015
On the role of hybridisation in evolution – the case of Eurasian *Passer* sparrows	Sætre, Glenn-Peter	RCN	2015	2018
Flexibility and constraints in animal movement pattern: ecology, evolution and annual cycles	Stenseth, Nils Chr.	RCN	2010	2015
Fisheries induced evolution in Atlantic cod investigated by ancient and historic samples	Stenseth, Nils Chr.	RCN	2011	2015
Bringing together evolution and ecology – Bringing together evolution and ecology through the Red Queen Perspective	Stenseth, Nils Chr.	RCN	2012	2016
Strengthening the adaptive capacity of institutions in fisheries (ADCAP)	Stenseth, Nils Chr.	RCN	2012	2015
Climate Changes and Zoonotic Epidemiology in Wildlife Systems (ZEWS)	Stenseth, Nils Chr.	RCN	2013	2016
Red Queen coevolution in multispecies communities: long-term evolutionary consequences of biotic and abiotic interactions (ERC-Stenseth)	Stenseth, Nils Chr.	RCN	2013	2017
Sustainable management of renewable resources in a changing environment: an integrated approach across ecosystems	Stenseth, Nils Chr.	RCN	2015	2018
Modeling microbial dynamics of the human infant gut	Trosvik, Pål	RCN	2014	2017
Applying a new demographic framework to understand and project consequences of climate change in size- and age-structured populations	Vindenes, Yngvild	RCN	2013	2016
Managing ecosystems in an increasingly variable world (ECOVAR)	Vindenes, Yngvild	RCN	2015	2018
Tracking signatures of adaptive diversification during postglacial colonization: the build-up of genomic isolation in three spine stickleback	Vøllestad, L. Asbjørn	RCN	2010	2015

Other public sector based projects				
Name	**Project leader**	**Funding**	**Start**	**End**
Seasonal to decadal Changes Affecting Marine Productivity: an Interdisciplinary investigation (SCAMPI)	Durant, Joël	RCN/NERSC	2014	2017
Miljødirektoratet: Miljøgifter i en urban fjord	Helberg, Morten	NIVA	2015	2015
Urbane populasjoner	Helberg, Morten	Fylkesmannen	2015	2015
Biodiversity management and the Water Framework Directive under climate change (BiWA)	Hessen, Dag O.	RCN/NINA	2013	2016
Adaptation or plasticity as response to large scale translocations and harvesting over a climatic gradient in the marine ecosystem?	Jentoft, Sissel	RCN/UiA	2014	2017
Assessment of long-term effects of oil exposure on early life stages of Atlantic haddock using state-of-the art genomics tools in combination with fitness observations	Jentoft, Sissel	RCN/IMR	2014	2016
Spisskompetanse inom marin och akvatisk ekologi och genomforskning for uthållig förvaltning av fisk och skaldjur i Skagerrak – Kattegat – Øresund (MarGen)	Knutsen, Halvor	INTERREG/IMR	2015	2018
Adaptive management of living marine resources by integrating different data sources and key ecological processes (ADMAR)	Stenseth, Nils Chr.	RCN/IMR	2010	2015
Norwegian Marine Data Centre (NMDC)	Stenseth, Nils Chr.	RCN/IMR	2012	2022
Behavioral responses to risk and uncertainty among Norwegian fishers	Stenseth, Nils Chr.	RCN/SNF	2013	2015
Hydropower and connectivity in inland rivers	Vøllestad, L. Asbjørn	RCN/NINA	2013	2015

Private sector based projects				
Name	**Project leader**	**Funding**	**Start**	**End**
Climate effects on harvested large mammal populations	Mysterud, Atle	CAS/DNVA	2015	2016
Quantifying natural variability in spawning and survival of Northeast Arctic haddock (VISTA)	Ottesen, Geir	DNVA	2015	2018
Multi-species dynamics above and beneath the sea-surface (SeaSurf)	Stenseth, Nils Chr.	SNF	2015	2018

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International projects				
Name	**Project leader**	**Funding**	**Start**	**End**
The medieval plagues: ecology, transmission modalities and routes of the infections (MedPlag)	Bramanti, Barbara	ERC EU	2013	2018
MARine Management and Ecosystem Dynamics under climate change (H2020-MSCA-ITN 675997 MARmaED)	Durant, Joël	EU	2015	2019
NCoE Planning grant – Meeting Challenges of a Changing Arctic: biology, economy, society and policy	Eikeset, Anne Maria	Nordforsk	2014	2015
International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT)	Ergon, Torbjørn Håkon	EU/Kungliga Vetenskapsakademien	2011	2015
An integrative approach towards the understanding of an adaptive radiation of East African cichlid fishes (CICHLIDX)	Salzburger, Walter	ERC EU	2014	2019
Climate Change Effects on Marine Ecosystems and Resources Economics – TFI NCoE Programme	Stenseth, Nils Chr.	Nordforsk	2011	2016
Reconstructing the imprint of ecology on the genetic phylogeography of the Plague in Central Asia and China (PlagueEco2Geno)	Stenseth, Nils Chr.	EU	2012	2015
The genetic architecture of secondary sexual traits during hybrid speciation (ARCHIGENE)	Stenseth, Nils Chr.	EU	2012	2015
Green Growth based on Marine Resources: Ecological and Socio-Economic Constraints (GreenMar)	Stenseth, Nils Chr.	Nordforsk	2014	2017
Nordic-Russian Co-operation Programme in Higher Education and Research	Stenseth, Nils Chr.	Nordforsk	2014	2017

Seminars with invited speakers

Friday seminars and Extra seminars			
Name	**Home institution**	**Title**	**Date (Venue: CEES)**
Terrence W. Deacon	University of California, Berkeley, USA	Evo-devo meets devo-devo: the evolution of complex synergies	9 January
Rolf A. Ims	UiT The Arctic University of Norway, Norway	How to monitor terrestrial Arctic ecosystems in the age of climate change: a plan for Climate-ecological Observatory for Arctic Tundra (COAT)	23 January
Andreas Hejnol	Sars International Centre for Marine Molecular Biology, Norway	Protostomy? Deuterostomy? Does it really matter? – about a major split in the Animal Tree of Life	6 February
David Righton & Julian Metcalfe	Cefas, UK	Cod we have known: an individual-based perspective on Atlantic cod in the North Sea	16 February
Darren E. Irwin	Beaty Biodiversity Museum & University of British Columbia, Canada	Ghosts of glaciations past: contact zones as laboratories for the study of bird speciation	19 February
Philipp Mitteröcker	Universität Wien, Austria	Lost in high dimensions: how to measure phenotypic variation in evolution and development?	27 February
Miriam Maas	The National Institute for Public Health and the Environment, The Netherlands	Bovine tuberculosis in African lions – diagnostic assay development and co-infection with FIV	13 March
Frietson Galis	Naturalis Biodiversity Center, The Netherlands	Constraints on the evolvability of the vertebral column in mammals	20 March
Vadim B. Fedorov	University of Alaska Fairbanks, USA	Impact of past climatic changes on genetic diversity in Arctic and boreal species	10 April
Masahito Tsuboi	Uppsala University, Sweden	Functional coupling constraints morphological diversification in Lake Tanganyika cichlids	15 April
Patrick Kestemont	University of Namur, Belgium	Search for biomarkers used in toxicology and immunology combining *in vitro* and *in vivo* approaches-application to the Asian catfish aquaculture (*Pangasianodon hypophthalmus*)	17 April
Michael Crusoe	Michigan State University, USA	The open science workstyle: enriching for serendipity	24 April
Bernard Wood	George Washington University, USA	Reconstructing human evolutionary history: progress and challenges	30 April
Juan Bonachela	University of Strathclyde, Scotland	Friends or foes: using physics to unravel the role of social insects in semi-arid ecosystems	8 May
Matthieu Barbier	Princeton University, USA	Social-ecological complexity in common pool resource use: social foraging and management action in fisheries	26 May
Volkhard Kempf	University Hospital Frankfurt, Germany	Bartonella: "sticky lollipops" & angiogenesis	29 May
Matthew Burgess	University of California, Santa Barbara, USA	Balanced harvesting: is it a good idea?	5 June
Anna B. Neuheimer	Department of Oceanography, University of Hawai'i at Mānoa, USA	How big and how many: Developing physiologically relevant modeling tools to explain fish size and abundance in a changing climate	18 September
Chris Thomas	Department of Biology, University of York, UK	Climate change, species distributions, and conservation	2 October

Matthew A. Wund	The College of New Jersey, USA	Assessing the role of phenotypic plasticity in the adaptive radiation of threespine stickleback fish	22 October
Claudia V. López-Alfaro		Ecological simulations and ecological complexity studies Application: understanding the nutritional mechanisms controlling brown bear populations	30 October
Marius Roesti	University of Basel, Switzerland, and University of British Columbia, Canada	The genomics of ecological vicariance in threespine stickleback fish	13 November
Laura Nuño de la Rosa	University of the Basque Country, Spain	Dispositional concepts in evolutionary biology: the case of evolvability	17 November
Sigrun Jonasdottir	DTU AQUA, Denmark	Fatty acids in the marine environment, from photosynthesis to copepod lipids and sequestration	10 December
Indrė Žliobaitė	University of Helsinki, and Helsinki Institute for Information Technology (HIIT), Finland	Adaptive learning from evolving data	18 December

Darwin Day 2015: Mendel, Darwin and the changing views on genetics

Name	Home institution	Title	Date and venue
Nils Chr. Stenseth	CEES, IBV, University of Oslo, Norway	Introduction	12 February 2015 Vilhelm Bjerknes hus, Aud. 5, Blindern, Oslo
Michaela Jarkovská	Mendel Museum, Masaryk University, Brno, Czech Republic	Gregor Mendel: Man, abbot and scientist	
Staffan Müller-Wille	University of Exeter, UK	Darwin and Mendel on heredity	
Stig Omholt	Norwegian University of Science and Technology (NTNU), Norway	Mendelian genetics in the light of genomics and systems biology	
Aoife McLysaght	University of Dublin, Ireland	Gene duplication and the secret of life	

The Kristine Bonnevie lectures 2015: How should we value nature in a human-dominated world?

Name	Home institution	Title	Date and venue
Ole Petter Ottersen	University of Oslo, Norway	Introduction	2 September 2015 Georg Sverdrups hus, Blindern, Oslo
Georgina Mace	University College London (UCL), UK	How should we value nature in a human-dominated world?	
James Wilsdon	University of Sussex, UK	The science and art of scientific advice	

PhD thesis defences

Jo Skeie Hermansen. 20 February. *A fruitful affair: speciation by hybridization in Passer sparrows.* Supervisor: Glenn-Peter Sætre.

Erling L. Meisingset. 25 August. *Space use of red deer and its implications for management.* Supervisors: Atle Mysterud and Leif Egil Loe.

Anna Virginia Black Mazzarella. 23 October. *Adaptation to freshwater in the threespine stickleback: New perspectives on old questions.* Supervisors: L. Asbjørn Vøllestad, Sanne Boessenkool, Kjartan Østbye and Kjetill S. Jakobsen.

Kristina Øie Kvile. 11 December. *Under the surface: Disentangling climate effects on Calanus finmarchicus dynamics in a high latitude system.* Supervisors: Leif Christian Stige, Padmini Dalpadado, Nils Chr. Stenseth and Øystein Langangen.

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Black backed jackal (upper photo) from the Afar regions of Ethiopia, and African wolf (lower photo) from the Bale mountains, Ethiopia. © Håkan Pohlstrand.

Production

Contributors affiliated with CEES in bold.

Articles in peer-reviewed journals

Aalvik, I. M., Moland, E., **Olsen, E. M.**, **Stenseth, N. C.** (2015) Spatial ecology of coastal Atlantic cod *Gadus morhua* associated with parasite load. *Journal of Fish Biology*, 87 (2), 449–464.

Alsos, I. G., Ehrich, D., Eidesen, P. B., Solstad, H. M., Westergaard, K. B., Schonswetter, P., Tribsch, A., **Birkeland, S.**, Elven, R., Brochmann, C. (2015) Long-distance plant dispersal to North Atlantic islands: colonization routes and founder effect. *AoB Plants*, 7 (1), 1–19.

Andersen, Ø., Johnsen, H., De Rosa, M. C., Præbel, K., Stjelja, S., Kirubakaran, T. G., Pirolli, D., **Jentoft, S.**, Fevolden, S.-E. (2015) Evolutionary history and adaptive significance of the polymorphic Pan I in migratory and stationary populations of Atlantic cod (*Gadus morhua*). *Marine Genomics*, 22, 45–54.

Bailey, R. I., **Tesaker, M. R.**, **Trier, C. N.**, **Sætre, G.-P.** (2015) Strong selection on male plumage in a hybrid zone between a hybrid bird species and one of its parents. *Journal of Evolutionary Biology*, 28 (6), 1257–1269.

Baldo, L., Riera, J. L., **Tooming-Klunderud, A.**, Alba, M. M., Salzburger, W. (2015) Gut microbiota dynamics during dietary shift in eastern African cichlid fishes. *PLoS ONE*, 10 (5), doi: 10.1371/journal.pone.0127462.

Barceló, C., Ciannelli, L., **Olsen, E. M.**, Johannessen, T., **Knutsen, H.** (2015) Eight decades of sampling reveal a contemporary novel fish assemblage in coastal nursery habitats. *Global Change Biology*, doi: 10.1111/gcb.13047.

Bartholomew, J. C., Pearson, A. D., **Stenseth, N. C.**, LeDuc, J. W., Hirschberg, D. L., Colwell, R. (2015) Building infectious disease research programs to promote security and enhance collaborations with countries of the former Soviet Union. *Frontiers in Public Health*, 3, 1–14.

Berg, P. R., **Jentoft, S.**, **Star, B.**, Ring, K. H., **Knutsen, H.**, Lien, S., **Jakobsen, K. S.**, André, C. (2015) Adaptation to low salinity promotes genomic divergence in Atlantic cod (*Gadus morhua* L.). *Genome Biology and Evolution*, 7 (6), 1644–1663.

Bianucci, R. (2015) *Trichuris trichiura* in a post-colonial Brazilian mummy. *Memórias do Instituto Oswaldo Cruz*, 110 (1), 145–147.

Bianucci, R., Araújo, A., Pusch, C., Nerlich, A. G. (2015) The identification of malaria in paleopathology – an in-depth assessment of the strategies to detect malaria in ancient remains. *Acta Tropica*, 152, 176–180.

Bianucci, R., Habicht, M. E., Buckley, S., Fletcher, J., Seiler, R., Öhrström, L. M., Vassilika, E., Böni, T., Rühli, F. J. (2015) Shedding new light on the 18th dynasty mummies of the royal architect Kha and his spouse merit. *PLoS ONE*, 10 (7), 1–21.

Blanco Gonzalez, E., Aritaki, M., **Knutsen, H.**, Taniguchi, N. (2015) Effects of large-scale releases on the genetic structure of red sea bream (*Pagrus major*, Temminck et Schlegel) populations in Japan. *PLoS ONE*, 10 (5), 1–20.

Blenckner, T., **Llope, M.**, Möllmann, C., Voss, R., Quaas, M., Casini, M., Lindegren, M., Folke, C., **Stenseth, N. C.** (2015) Climate and fishing steer ecosystem regeneration to uncertain economic futures. *Proceedings of the Royal Society of London. Biological Sciences*, 282 (1803), 1–9.

Bolstad, G. H., Cassara, J. A., Marquez, E., **Hansen, T. F.**, van der Linde, K., Houle, D., Pelabon, C. (2015) Complex constraints on allometry revealed by artificial selection on the wing of *Drosophila melanogaster*. *Proceedings of the National Academy of Sciences of the United States of America*, 112 (43), 13284–13289.

Boonstra, W., Ottosen, K. M., Ferreira, A. S. d. A., **Richter, A. P.**, **Rogers, L.**, Pedersen, M. W., Kokkalis, A., Bárðarson, H., Bonanomi, S., Butler, W., **Diekert, F. K.**, Fouzai, N., Holma, M. K., Holt, R., **Kvile, K. Ø.**, Malanski, E., Macdonald, J. I., Nieminen, E. E., **Romagnoni, G.**, Snickars, M., Weigel, B., Woods, P. J., Yletyinen, J. K., **Whittington, J.** (2015) What are the major global threats and impacts in marine environments? Investigating the contours of a shared perception among marine scientists from the bottom-up. *Marine Policy*, 60, 197–201.

Buechley, E. R., Sekercioglu, C. H., **Atickem, A. M.**, Gebremichael, G., Ndungu, J. K., Mahamued, B. A., Beyene, T., **Gutema, T. M.**, Lens, L. (2015) Importance of Ethiopian shade coffee farms for forest bird conservation. *Biological Conservation*, 188, 50–60.

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Burgess, M. G., **Diekert, F. K.**, Jacobsen, N. S., Andersen, K. H., Gaines, S. D. (2015) Remaining questions in the case for balanced harvesting. *Fish and Fisheries*, doi: 10.1111/faf.12123.

Burri, R., Nater, A., Kawakami, T., Mugal, C. F., Olason, P. I., Smeds, L., Suh, A., Dutoit, L., Bureš, S., Garamszegi, L. Z., Hogner, S., Moreno, J., Qvarnström, A., Ružić, M., **Sæther, S. A.**, **Sætre, G.-P.**, Török, J., Ellegren, H. (2015) Linked selection and recombination rate variation drive the evolution of the genomic landscape of differentiation across the speciation continuum of *Ficedula* flycatchers. *Genome Research*, 25 (11), 1656–1665.

Cagnacci, F., Focardi, S., Ghisla, A., Van Moorter, B., Merril, E. H., Gurarie, E., Heurich, M., **Mysterud, A.**, Linnell, J. D., Panzacchi, M., May, R. F., Nygård, T., Rolandsen, C. M., Hebblewhite, M. (2015) How many routes lead to migration? Comparison of methods to assess and characterise migratory movements. *Journal of Animal Ecology*, 85, 54–68.

Catarino, D., **Knutsen, H.**, Verissimo, A., **Olsen, E. M.**, **Jorde, P. E.**, Menezes, G., Sannæs, H., Stanković, D., Company, J. B., Neat, F., Danovaro, R., Dell'Anno, A., Rochowski, B., Stefanni, S. (2015) The Pillars of Hercules as a bathymetric barrier to gene flow promoting isolation in a global deep-sea shark (*Centroscymnus coelolepis*). *Molecular Ecology*, 24 (24), 6061–6079.

Chacon, A. F., Moland, E., Espeland, S. H., **Olsen, E. M.** (2015) Demographic effects of full vs. partial protection from harvesting: inference from an empirical before-after control-impact study on Atlantic cod. *Journal of Applied Ecology*, 52 (5), 1206–1215.

Cizauskas, C. A., **Turner, W. C.**, Pitts, N., Getz, W. M. (2015) Seasonal patterns of hormones, macroparasites, and microparasites in wild African ungulates: the interplay among stress, reproduction, and disease. *PLoS ONE*, 10 (4), 1–29.

Colman, J. E., Alemu, D. T., Flydal, K., **Rivrud, I. M.**, Reimers, E., Eftestøl, S. (2015) High-voltage power lines near wild reindeer calving areas. *European Journal of Wildlife Research*, 61 (6), 881–893.

Colombo, M., Damerau, M., Hanel, R., **Salzburger, W.**, **Matschiner, M.** (2015) Diversity and disparity through time in the adaptive radiation of Antarctic notothenioid fishes. *Evolutionary Biology*, 28, 376–394.

Cramer, E. R. A., Laskemoen, T., Stensrud, E., Rowe, M., Haas, F., Lifjeld, J. T., **Sætre, G.-P.**, Johnsen, A. (2015) Morphology-function relationships and repeatability in the sperm of *Passer* sparrows. *Journal of Morphology*, 276 (4), 370–377.

Cristofari, R., **Trucchi, E.**, **Whittington, J.**, Vigetta, S., Gachot-Neveu, H., **Stenseth, N. C.**, Le Maho, Y., **Le Bohec, C.** (2015) Spatial heterogeneity as a genetic mixing mechanism in highly philopatric colonial seabirds. *PLoS ONE*, 10 (2), 1–21.

Crusoe, M. R., Alameldin, H. F., Awad, S., Boucher, E., Caldwell, A., Cartwright, R., Amanda, C., Constantinides, B., Edvenson, G., Fay, S., Fenton, J., Fenzl, T., Fish, J., Garcia-Gutierrez, L., Garland, P., Gluck, J., González, I., Guermond, S., Guo, J., Gupta, A., Herr, J. R., Howe, A., Hyer, A., Härpfer, A., Irber, L., Kidd, R., Lin, D., Lippi, J., Mansour, T., McA'Nulty, P., McDonald, E., Mizzi, J., Murray, K. D., Nahum, J. R., Nanlohy, K., **Nederbragt, A. J.**, Ortiz-Zuazaga, H., Ory, J., Pell, J., Pepe-Ranney, C., Russ, Z. N., Schwarz, E., Scott, C., Seaman, J., Sievert, S., Simpson, J., Skennerton, C. T., Spencer, J., Srinivasan, R., Standage, D., Stapleton, J. A., Steinman, S. R., Stein, J., Taylor, B., Trimble, W., Wiencko, H. L., Wright, M., Wyss, B., Zhang, Q., zyme, e., Brown, C. T. (2015) The khmer software package: enabling efficient nucleotide sequence analysis. *F1000 Research*, doi: 10.12688/f1000research.6924.1.

De Wit, G. A., Over, E. A. B., **Schmid, B. V.**, Van Bergen, J. E. A. M., Van Den Broek, I. V. F., Van Der Sande, M. A. B., Welte, R., Op De Coul, E. L. M., Kretzschmar, M. E. (2015) Chlamydia screening is not cost-effective at low participation rates: evidence from a repeated register-based implementation study in the Netherlands. *Sexually Transmitted Infections*, 91 (6), 423–429.

Dunlop, E., **Eikeset, A. M.**, **Stenseth, N. C.** (2015) From genes to populations: how fisheries-induced evolution alters stock productivity. *Ecological Applications*, 25 (7), 1860–1868.

Eggers, F., **Olsen, E. M.**, Moland, E., Slotte, A. (2015) Individual habitat transitions of Atlantic herring *Clupea harengus* in a human-modified coastal system. *Marine Ecology Progress Series*, 520, 245–256.

Ellis, C., Hodgson, D. J., André, C., Sørdalen, T. K., **Knutsen, H.**, Griffiths, A. (2015) Genotype reconstruction of paternity in European lobsters (*Homarus gammarus*). *PLoS ONE*, 10 (11), 1–14.

Espeland, S. H., Albretsen, J., **Olsen, E. M.**, Bodvin, T. (2015) Modelling drift of pelagic offspring: the importance of egg surveys in providing a realistic model initialization. *ICES Journal of Marine Science*, doi: 10.1093/icesjms/fsv134.

Feng, J., **Durant, J. M.**, **Stige, L. C.**, **Hessen, D. O.**, **Hjermann, D. Ø.**, Zhu, L., Llope, M., **Stenseth, N. C.** (2015) Contrasting correlation patterns between environmental factors and chlorophyll levels in the global ocean. *Global Biogeochemical Cycles*, 29 (12), 2095–2107.

Ferter, K., Hartmann, K., Kleiven, A. R., Moland, E., **Olsen, E. M.** (2015) Catch-and-release of Atlantic cod (*Gadus morhua*): post-release behaviour of acoustically pretagged fish in a natural marine environment. *Canadian Journal of Fisheries and Aquatic Sciences*, 72, 252–261.

Finnegan, S., Anderson, S. C., Harnik, P. G., Simpson, C., Tittensor, D. P., Byrnes, J. E., Finkel, Z. V., Lindberg, D. R., **Liow, L. H.**, Lockwood, R., Lotze, H. K., McClain, C. R., McGuire, J. L., O'Dea, A., Pandolfi, J. M. (2015) Paleontological baselines for evaluating extinction risk in the modern oceans. *Science*, 348 (6234), 567–570.

Fischer, B., Mitteroecker, P. (2015) Covariation between human pelvis shape, stature, and head size alleviates the obstetric dilemma. *Proceedings of the National Academy of Sciences of the United States of America*, 112 (18), 5655–5660.

Fraser, T., Hansen, T. J., **Fleming, M.**, Fjelldal, P. G. (2015) The prevalence of vertebral deformities is increased with higher egg incubation temperatures and triploidy in Atlantic salmon *Salmo salar* L. *Journal of Fish Diseases*, 38 (1), 75–89.

Freitas, C., **Olsen, E. M.**, **Knutsen, H.**, Albretsen, J., Moland, E. (2015) Temperature-associated habitat selection in a cold-water marine fish. *Journal of Animal Ecology*, doi: 10.1111/1365-2656.12458.

Freitas, C., **Olsen, E. M.**, Moland, E., Ciannelli, L., **Knutsen, H.** (2015) Behavioral responses of Atlantic cod to sea temperature changes. *Ecology and Evolution*, 5 (10), 2070–2083.

Garcia-Alvarez, A., **van Leeuwen, C.**, Luque, C. J., Hussner, A., Velez-Martin, A., Perez-Vazquez, A., Green, A. J., Castellanos, E. M. (2015) Internal transport of alien and native plants by geese and ducks: an experimental study. *Freshwater Biology*, 60 (7), 1316–1329.

Gouveia, A., Bejček, V., Flousek, J., Sedláček, F., Šťastný, K., Zima, J., Yoccoz, N. G., **Stenseth, N. C.**, Tkadlec, E. (2015) Long-term pattern of population dynamics in the field vole from central Europe: cyclic pattern with amplitude dampening. *Population Ecology*, 57 (4), 581–589.

Grabowski, M. W., Hatala, K. G., Jungers, W. L., Richmond, B. G. (2015) Body mass estimates of hominin fossils and the evolution of human body size. *Journal of Human Evolution*, 85, 75–93.

Grabowski, M. W., Roseman, C. C. (2015) Complex and changing patterns of natural selection explain the evolution of the human hip. *Journal of Human Evolution*, 85, 94–110.

Haddeland, P. J. T., **Junge, C.**, Serbezov, D., **Vøllestad, L. A.** (2015) Genetic parentage analysis confirms a polygynandrous breeding system in the European grayling (*Thymallus thymallus*). *PLoS ONE*, 10 (3), doi: 10.1371/journal.pone.0122032.

Hagenlund, M., **Østbye, K.**, Langdal, K., Hassve, M. H., **Pettersen, R. A.**, Anderson, E., Gregersen, F., Præbel, K. (2015) Fauna crime: elucidating the potential source and introduction history of European smelt (*Osmerus eperlanus* L.) into Lake Storsjøen, Norway. *Conservation Genetics*, 16 (5), 1085–1098.

Hansch, S., Cilli, E., Catalano, G., Gruppiono, G., **Bianucci, R.**, **Stenseth, N. C.**, **Bramanti, B.**, Pallen, M. J. (2015) The pla gene, encoding plasminogen activator, is not specific to *Yersinia pestis*. *BMC Research Notes*, 8 (1), doi: 10.1186/s13104-015-1525-x.

Hansen, T. F. (2015) Measuring gene interactions. *Methods in Molecular Biology*, 1253, 115–143.

Hardie, D. C., **Hutchings, J.**, (2015) Cannibalistic growth polyphenism in Atlantic cod. *Evolutionary Ecology Research*, 16, 569–580.

Heier, L., **Viljugrein, H.**, Storvik, G. O. (2015) Persistence of plague outbreaks among great gerbils in Kazakhstan: effects of host population dynamics. *Population Ecology*, 57 (3), 473–484.

Hermansen, G. H., Hjort, N. L., **Kjesbu, O. S.** (2015) Recent advances in statistical methodology applied to the Hjort liver index time series (1859–2012) and associated influential factors. *Canadian Journal of Fisheries and Aquatic Sciences*, 73 (2), 279–295.

10 APPENDICES

Hestmark, G. (2015) Lectotypification of *Umbilicaria virginis* (*Umbilicariaceae*). *The Lichenologist*, 47 (1), 77–81.

Hestmark, G. (2015) *Umbilicaria aprina* new to the Pyrenees. *Graphis Scripta*, 27 (1-2), 42–45.

Hothorn, T., Müller, J., Held, L., Möst, L., **Mysterud, A.** (2015) Temporal patterns of deer-vehicle collisions consistent with deer activity pattern and density increase but not general accident risk. *Accident Analysis and Prevention*, 81, 143–152.

Hutchings, J. (2015) Thresholds for impaired species recovery. *Proceedings of the Royal Society of London. Biological Sciences*, 282 (1809), 1–11.

Jackson-Blake, L. A., **Starrfelt, J.** (2015) Do higher data frequency and Bayesian auto-calibration lead to better model calibration? Insights from an application of INCA-P, a process-based river phosphorus model. *Journal of Hydrology*, 527, 641–655.

Jalal, M., Andersen, T., **Hessen, D. O.** (2015) Temperature and developmental responses of body and cell size in *Drosophila*; effects of polyploidy and genome configuration. *Journal of Thermal Biology*, 51, 1–14.

Jeyansingh, P., Chowdhury, P., **Wojewodzic, M.**, Frisch, D., **Hessen, D. O.**, Weider, L. J. (2015) Phosphorus use and excretion varies with ploidy level in *Daphnia*. *Journal of Plankton Research*, 37, 1210–1217.

Jorde, P. E., Søvik, G., Westgaard, J.-I., Albretsen, J., André, C., Hvingel, C., Johansen, T., Sandvik, A. D., Kingsley, M. C., Jørstad, K. E. (2015) Genetically distinct populations of northern shrimp, *Pandalus borealis*, in the North Atlantic: adaptation to different temperatures as an isolation factor. *Molecular Ecology*, 24 (8), 1742–1757.

Keith, D., Akcakaya, H. R., Butchart, S. H. M., Collen, B., Dulvy, N. K., Holmes, E. E., **Hutchings, J.**, Keinath, D., Schwartz, M. K., Shelton, A. O., Waples, R. S. (2015) Temporal correlations in population trends: conservation implications from time-series analysis of diverse animal taxa. *Biological Conservation*, 192, 247–257.

Kubisch, A., **Winter, A.-M.**, Fronhofer, E. A. (2015) The downward spiral: eco-evolutionary feedback loops lead to the emergence of 'elastic' ranges. *Ecography*, 38, 1–9.

Kuparinen, A., Roney, N. E., **Oomen, R. A.**, **Hutchings, J.**, **Olsen, E. M.** (2015) Small-scale life history variability suggests potential for spatial mismatches in Atlantic cod management units. *ICES Journal of Marine Science*, 73 (2), 286–292.

Kvernhaugen Norum, J., Lone, K., Linnell, J. D., Odden, J., Loe, L. E., **Mysterud, A.** (2015) Landscape of risk to roe deer imposed by lynx and different human hunting tactics. *European Journal of Wildlife Research*, 61 (6), 831–840.

Laaksonen, T., Sirkiä, P., Calhim, S., Brommer, J., Leskinen, P., Primmer, C., Adamik, P., Artemyev, A., Belskii, E., Both, C., Bures, S., Burgess, M., Doligez, B., Forsman, J., Grinkov, V., Hoffmann, U., Ivankina, E., Kral, M., Krams, I., **Lampe, H. M.**, Moreno, J., Mägi, M., Nord, A., Potti, J., Ravussin, P., Sokolov, L. (2015) Sympatric divergence and clinal variation in multiple coloration traits of *Ficedula* flycatchers. *Journal of Evolutionary Biology*, 28 (4), 779–790.

Labra Lillo, A., Hoare, M. (2015) Chemical recognition in a snake-lizard predator-prey system. *Acta Ethologica*, 18 (2), 173–179.

Lawson, C., **Vindenes, Y.**, Bailey, L., Van de Pol, M. (2015) Environmental variation and population responses to global change. *Ecology Letters*, 18 (7), 724–736.

Le Rouzic, A., **Hansen, T. F.**, Gosden, T. P., Svensson, E. I. (2015) Evolutionary time-series analysis reveals the signature of frequency-dependent selection on a female mating polymorphism. *American Naturalist*, 185 (6), E182–E196.

Le Vaillant, M., Viblanc, V. A., Saraux, C., **Le Bohec, C.**, Le Maho, Y., Kato, A., Criscuolo, F., Ropert-Coudert, Y. (2015) Telomere length reflects individual quality in free-living adult king penguins. *Polar Biology*, 38 (12), 2059–2067.

Liow, L. H., **Reitan, T.**, Harnik, P. G. (2015) Ecological interactions on macroevolutionary time scales: clams and brachiopods are more than ships that pass in the night. *Ecology Letters*, 18 (10), 1030–1039.

Lone, K., Loe, L. E., **Meisingset, E. L.**, Stamnes, I., **Mysterud, A.** (2015) An adaptive behavioural response to hunting: surviving male red deer shift habitat at the onset of the hunting season. *Animal Behaviour*, 102, 127–138.

Lossouarn, J., **Nesbø, C. L.**, Mercier, C., Zhaxybayeva, O., Johnson, M. S., Charchuck, R., Farasin, J., Bienvenu, N., Baudoux, A.-C., Michoud, G., Jebbar, M., Geslin, C. (2015) 'Ménage à trois': A selfish genetic element uses a virus to propagate within *Thermotogales*. *Environmental Microbiology*, 17 (9), 3278–3288.

Lu, Q., **Yang, H.**, Huang, X., Chuai, X., Wu, C. (2015) Multi-sectoral decomposition in decoupling industrial growth from carbon emissions in the developed Jiangsu Province, China. *Energy*, 82, 414–425.

Mabille, G., Stien, A., Tveraa, T., **Mysterud, A.**, Brøseth, H., Linnell, J. D. (2015) Mortality and lamb body mass growth in free-ranging domestic sheep – environmental impacts including lethal and non-lethal impacts of predators. *Ecography*, 38, 1–11.

Mabille, G., Stien, A., Tveraa, T., **Mysterud, A.**, Brøseth, H., Linnell, J. D. (2015) Sheep farming and large carnivores: what are the factors influencing claimed losses? *Ecosphere*, 6 (5), 1–17.

Mancinelli, S., **Peters, W. E. B.**, Boitani, L., Hebblewhite, M., Cagnacci, F. (2015) Roe deer summer habitat selection at multiple spatio-temporal scales in an Alpine environment. *Hystrix: The Italian Journal of Mammalogy*, 26 (2), 1–9.

Marcussen, T., **Heier, L.**, **Brysting, A. K.**, Oxelman, B., **Jakobsen, K. S.** (2015) From gene trees to a dated allopolyploid network: insights from the angiosperm genus *Viola* (Violaceae). *Systematic Biology*, 64 (1), 84–101.

Matschiner, M. (2015) Fitchi: haplotype genealogy graphs based on the Fitch algorithm. *Bioinformatics*, doi: 10.1093/bioinformatics/btv717.

Mazzarella, A. V. B., **Voje, K. L.**, **Hansson, T. H.**, **Taugbøl, A.**, **Fischer, B.** (2015) Strong and parallel salinity-induced phenotypic plasticity in one generation of threespine stickleback. *Journal of Evolutionary Biology*, 28 (3), 667–677.

Moissidou, D., Day, J., Shin, D. H., **Bianucci, R.** (2015) Invasive versus non invasive methods applied to mummy research: will this controversy ever be solved? *BioMed Research International*, 2015:192829, 1–7.

Mysterud, A., **Byrkjeland, R.**, **Qviller, L.**, **Viljugrein, H.** (2015) The generalist tick *Ixodes ricinus* and the specialist tick *Ixodes trianguliceps* on shrews and rodents in a northern forest ecosystem – a role of body size even among small hosts. *Parasites & Vectors*, 8 (639), doi: 10.1186/s13071-015-1258-7.

Mysterud, A., **Qviller, L.**, **Meisingset, E. L.**, **Viljugrein, H.** (2015) Parasite load and seasonal migration in red deer. *Oecologia*, 108 (2), 401–407.

Nielsen, A., Lind, V., Steinheim, G., Holand, Ø. (2015) Variations in lamb growth on coastal and mountain pastures, will climate change make a difference? *Acta Agriculturae Scandinavica. Section A, Animal Science*, 64 (4), 243–252.

Norderhaug, K. M., **Gundersen, H.**, Pedersen, A., Moy, F. E., Green, N. W., Walday, M. G., Gitmark, J. K., Ledang, A. B., Bjerkeng, B., **Hjermann, D. Ø.**, Trannum, H. C. (2015) Effects of climate and eutrophication on the diversity of hard bottom communities on the Skagerrak coast 1990–2010. *Marine Ecology Progress Series*, 530, 29–46.

Nordli, Ø., **Hestmark, G.**, Benestad, R., Isaksen, K. (2015) The Oslo temperature series 1837–2012: homogeneity testing and temperature analysis. *International Journal of Climatology*, 35 (12), 3486–3504.

Novo, S. P., Leles, D., **Bianucci, R.**, Araújo, A. (2015) *Leishmania tarentolae* molecular signatures in a 300 hundred-years-old human Brazilian mummy. *Parasites & Vectors*, 8 (72), doi: 10.1186/s13071-015-0666-z.

Ohlberger, J. P., **Langangen, Ø.** (2015) Population resilience to catastrophic mortality events during early life stages. *Ecological Applications*, 25 (5), 1348–1356.

Omotoriogun, T. C., Albrecht, T., Hořak, D., Laskemoen, T., Ottosson, U., **Rowe, M.**, Sedlacek, O., Lifjeld, J. T. (2015) Sperm size evolution in African greenbuls (Passeriformes: Pycnonotidae). *Biological Journal of the Linnean Society*, 117 (2), 337–349.

Oomen, R. A., **Hutchings, J.** (2015) Genetic variability in reaction norms in fishes. *Environmental Reviews*, 23 (3), 353–366.

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Oomen, R. A., **Hutchings, J.** (2015) Variation in spawning time promotes genetic variability in population responses to environmental change in a marine fish. *Conservation Physiology*, 3, doi: 10.1093/conphys/cov027.

Orzechowski, E., Lockwood, R., Byrnes, J. E., Anderson, S., Finnegan, S., Finkel, Z. V., Harnik, P. G., Lindberg, D. R., **Liow, L. H.**, Lotze, H. K., McClain, C. R., McGuire, J. L., O'dea, A., Pandolfi, J. M., Simpson, C., Tittensor, D. P. (2015) Marine extinction risk shaped by trait-environment interactions over 500 million years. *Global Change Biology*, 21 (10), 3595–3607.

Ouwehand, J., Ahola, M. P., Ausems, A. N. M. A., Bridge, E. S., Burgess, M., Hahn, S., Hewson, C. M., Klaassen, R. H. G., Laaksonen, L., **Lampe, H. M.**, Velmala, W., Both, C. (2015) Light-level geolocators reveal migratory connectivity in European populations of pied flycatchers *Ficedula hypoleuca*. *Journal of Avian Biology*, 47, 69–83.

Pampoulie, C., Skírnisdóttir, S., **Star, B.**, **Jentoft, S.**, Jonsdottir, I. G., Hjorleifsson, E., Thorsteinsson, V., Palsson, O. K., **Berg, P. R.**, Andersen, Ø., Magnusdottir, S., Helyar, S. J., Daníelsdóttir, A. K. (2015) Rhodopsin gene polymorphism associated with divergent light environments in Atlantic cod. *Behavior Genetics*, 45 (2), 236–244.

Patin, R., **Rogers, L.**, **Ohlberger, J. P.** (2015) Using a state-space population model to detect age-dependent species interactions. *Canadian Journal of Fisheries and Aquatic Sciences*, doi: 10.1139/cjfas-2015-0004.

Pedersen, M. W., Kokkalis, A., Bardarson, H., Bonanomi, S., Boonstra, W., Butler, W. E., **Diekert, F. K.**, Fouzai, N., Holma, M. K., Holt, R., Kvile, K. Ø., Nieminen, E. E., Ottosen, K. M., **Richter, A. P.**, **Rogers, L.**, **Romagnoni, G.**, Snickars, M., Törnroos, A., Weigel, B., **Whittington, J.**, Woods, P. J., Yletyinen, J. K., Ferreira, A. S. d. A. (2015) Trends in marine climate change research in the Nordic region since the first IPCC report. *Climatic Change*, 134 (1), 147–161.

Pettersen, R. A., Mo, T. A., Hansen, H., **Vøllestad, L. A.** (2015) Genetic population structure of *Gyrodactylus thymalli* (Monogenea) in a large Norwegian river system. *Parasitology*, 142 (14), 1693–1702.

Piel, A. K., Cohen, N., Kamenya, S., **Ndimuligo, S. A.**, Pintea, L., Stewart, F. (2015) Population status of chimpanzees in the Masito-Ugalla Ecosystem, Tanzania. *American Journal of Primatology*, 77 (10), 1027–1035.

Pollo, S. M. J., Zhaxybayeva, O., **Nesbø, C. L.** (2015) Insights into thermoadaptation and the evolution of mesophily from the bacterial phylum *Thermotogae*. *Canadian Journal of Microbiology*, 61 (9), 655–670.

Qualls, C., **Bianucci, R.**, Spilde, M. N., Phillips, G., Wu, C., Appenzeller, O. (2015) Modeling clinical states and metabolic rhythms in bioarcheology. *BioMed Research International*, 2015, 1–7.

Rawlence, N. J., Perry, G. L. W., Smith, I. W. G., Scofield, R. P., Tennyson, A. J. D., Matisoo-Smith, E., **Boessenkool, S.**, Austin, J. J., Waters, J. M. (2015) Radiocarbon-dating and ancient DNA reveal rapid replacement of extinct prehistoric penguins. *Quaternary Science Reviews*, 112, 59–65.

Reuchlin-Hugenholtz, E., Shackell, N. L., **Hutchings, J.** (2015) The potential for spatial distribution indices to signal thresholds in marine fish biomass. *PLoS ONE*, 10 (3), 1–22.

Richter, A. P., Dakos, V. (2015) Profit fluctuations signal eroding resilience of natural resources. *Ecological Economics*, 117, 12–21.

Rivrud, I. M., Bischof, R., **Meisingset, E. L.**, Zimmermann, B., Loe, L. E., **Mysterud, A.** (2015) Leave before it's too late: anthropogenic and environmental triggers of autumn migration in a hunted ungulate population. *Ecology*, doi: 10.1890/15-1191, 1–27.

Romagnoni, G., Mackinson, S., Hong, J., **Eikeset, A. M.** (2015) The Ecospace model applied to the North Sea: evaluating spatial predictions with fish biomass and fishing effort data. *Ecological Modelling*, 300, 50–60.

Roney, N. E., Kuparinen, A., **Hutchings, J.** (2015) Comparative analysis of abundance–occupancy relationships for species at risk at both broad taxonomic and spatial scales. *Canadian Journal of Zoology*, 93 (7), 515–519.

Rosso, A., Di Martino, E., Sanfilippo, P., Sciuto, F., **Liow, L. H.** (2015) Resurrection of an old forgotten name: the case of the Pliocene to Recent bryozoan *Cleidochasmidra portisi* (Neviani, 1895) from the Mediterranean. *Bollettino della Societa Paleontologica Italiana*, 54, 91–102.

Rowe, M., Albrecht, T., Cramer, E. R. A., Johnsen, A., Laskemoen, T., Weir, J. T., Lifjeld, J. T. (2015) Postcopulatory sexual selection is associated with accelerated evolution of sperm morphology. *Evolution*, 69 (4), 1044–1052.

Rowe, M., Griffith, S. C., Hofgaard, A., Lifjeld, J. T. (2015) Subspecific variation in sperm morphology and performance in the long-tailed finch (*Poephila acuticauda*). *Avian Research*, 6 (23), 1–10.

Rowe, M., Pierson, K. L., McGraw, K. J. (2015) Exploratory behavior is associated with plasma carotenoid accumulation in two congeneric species of waterfowl. *Behavioural Processes*, 115, 181–190.

Runemark, A., Sagonas, K., Svensson, E. I. (2015) Ecological explanations to island gigantism: dietary niche divergence, predation, and size in an endemic lizard. *Ecology*, 96 (8), 2077–2092.

Saber, S., Macías, D., de Urbina, J. O., **Kjesbu, O. S.** (2015) Stereological comparison of oocyte recruitment and batch fecundity estimates from paraffin and resin sections using spawning albacore (*Thunnus alalunga*) ovaries as a case study. *Journal of Sea Research*, 95, 226–238.

Sandve, S. R., Marcussen, T., Mayer, K. F. X., **Jakobsen, K. S.**, Heier, L., Steuernagel, B., Wulff, B. B. H., Olsen, O.-A. (2015) Chloroplast phylogeny of *Triticum/Aegilops* species is not incongruent with an ancient homoploid hybrid origin of the ancestor of the bread wheat D-genome. *New Phytologist*, 208 (1), 9–10.

Schmid, B. V., Büntgen, U., **Easterday, W. R.**, Ginzler, C., Walløe, L., **Bramanti, B.**, **Stenseth, N. C.** (2015) Climate-driven introduction of the Black Death and successive plague reintroductions into Europe. *Proceedings of the National Academy of Sciences of the United States of America*, doi: 10.1073/pnas.1412887112.

Sengupta, S., **Ergon, T.**, Leinaas, H. P. (2015) Genotypic differences in embryonic life history traits of *Folsomia quadrioculata* (Collembola: Isotomidae) across a wide geographical range. *Ecological Entomology*, 41, 72–84.

Shelton, A. O., **Hutchings, J.**, Waples, R. S., Keith, D. M., Akcakaya, H. R., Dulvy, N. K. (2015) Maternal age effects on Atlantic cod recruitment and implications for future population trajectories. *ICES Journal of Marine Science*, 72 (6), 1769–1778.

Sirkiä, P. M., Adamik, P., Artemyev, A. V., Belskii, E., Both, C., Bures, S., Burgess, M., Bushuev, A. V., Forsman, J. T., Grinkov, V., Hoffmann, D., Järvinen, A., Kral, M., Krams, I., **Lampe, H. M.**, Moreno, J., Mägi, M., Nord, A., Potti, J., Ravussin, P.-A., Sokolov, L., Laaksonen, T. (2015) Fecundity selection does not vary along a large geographical cline of trait means in a passerine bird. *Biological Journal of the Linnean Society*, 114 (4), 808–827.

Skaugen, T., Peerebom, I. O., **Nilsson, A.** (2015) Use of a parsimonious rainfall-run-off model for predicting hydrological response in ungauged basins. *Hydrological Processes*, 29 (8), 1999–2013.

Skern-Mauritzen, M., **Ottersen, G.**, Handegard, N. O., Huse, G., Dingsør, G. E., **Stenseth, N. C.**, Kjesbu, O. S. (2015) Ecosystem processes are rarely included in tactical fisheries management. *Fish and Fisheries*, 17, 165–175.

Skjæraasen, J. E., Korsbrekke, K., Nilsen, T., Fonn, M., **Kjesbu, O. S.**, Dingsør, G. E., Nash, R. D. M. (2015) Skipped spawning in Northeast Arctic haddock *Melanogrammus aeglefinus*. *Marine Ecology Progress Series*, 526, 143–155.

Smeds, L., Warmuth, V., Bolivar, P., Uebbing, S., Burri, R., Suh, A., Nater, A., Bures, S., Garamszegi, L. Z., **Hogner, S.**, Moreno, J., Qvarnström, A., Ruzic, M., **Sæther, S. A.**, **Sætre, G.-P.**, Torok, J., Ellegren, H. (2015) Evolutionary analysis of the female-specific avian W chromosome. *Nature Communications*, 6, 1–10.

Solomon, C. T., Jones, S. E., Weidel, B. C., Buffam, I., Fork, M. L., Karlsson, J., **Larsen, S.**, Lennon, J. T., Read, J. S., Sadro, S., Saros, J. E. (2015) Ecosystem consequences of changing inputs of terrestrial dissolved organic matter to lakes: current knowledge and future challenges. *Ecosystems (New York. Print)*, 18 (3), 376–389.

Speed, J. D. M., Martinsen, V., Hester, A. J., Holand, Ø., Mulder, J., **Mysterud, A.**, Austrheim, G. (2015) Continuous and discontinuous variation in ecosystem carbon stocks with elevation across a treeline ecotone. *Biogeosciences*, 12 (5), 1615–1627.

Starrfelt, J., Saloranta, T. (2015) Simulating the uncertain effect of active carbon capping of a dioxin-polluted Norwegian fjord. *Integrated Environmental Assessment and Management*, 11 (3), 481–489.

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Stenseth, N. C., **Durant, J. M.**, Fowler, M., Matthysen, E., Adriaensen, F., Jonzén, N., Chan, K.-S., Liu, H., De Laet, J., Sheldon, B. C., Visser, M., Dhondt, A. (2015) Testing for effects of climate change on competitive relationships and coexistence between two bird species. *Proceedings of the Royal Society of London. Biological Sciences*, 282, 1–9.

Stige, L. C., **Langangen, Ø.**, Yaragina, N. A., Vikebø, F. B., Bogstad, B., **Ottersen, G.**, **Stenseth, N. C.**, **Hjermann, D. Ø.** (2015) Combined statistical and mechanistic modelling suggests food and temperature effects on survival of early life stages of Northeast Arctic cod (*Gadus morhua*). *Progress in Oceanography*, 134, 138–151.

Stokke, R., Dahle, H., Roalkvam, I., Wissuwa, J., Daae, F. L., **Tooming-Klunderud, A.**, Thorseth, I. H., Pedersen, R. B., Steen, I. H. (2015) Functional interactions among filamentous Epsilonproteobacteria and Bacteroidetes in a deep-sea hydrothermal vent biofilm. *Environmental Microbiology*, 17 (10), 4063–4077.

Stüken, A., Riobo, P., Franco, J., **Jakobsen, K. S.**, Guillou, L., Figueroa, R. (2015) Paralytic shellfish toxin content is related to genomic sxtA4 copy number in *Alexandrium minutum* strains. *Frontiers in Microbiology*, 6, 1–10.

Supraha, L., **Gerecht, A. C.**, Probert, I., **Henderiks, J.** (2015) Eco-physiological adaptation shapes the response of calcifying algae to nutrient limitation. *Scientific Reports*, 5, doi: 10.1038/srep16499.

Sørhus, E., Edvardsen, R., Karlsen, Ø., Nordtug, T., van der Meeren, T., Thorsen, A., Harman, C. P., **Jentoft, S.**, Meier, S. (2015) Unexpected interaction with dispersed crude oil droplets drives severe toxicity in Atlantic haddock embryos. *PLoS ONE*, 10:e0124376 (4), 1–21.

Tapia, G., Bøås, H., **de Muinck, E.**, Cinek, O., Stene, L. C., Torjesen, P. A., Rasmussen, T., Rønningen, K. S. (2015) Saffold virus, a human cardiovirus, and risk of persistent islet autoantibodies in the longitudinal birth cohort study MIDIA. *PLoS ONE*, 10 (8), doi: 10.1371/journal.pone.0136849.

Tarka, M., Bolstad, G. H., Wacker, S., Räsänen, K., **Hansen, T. F.**, Pelabon, C. (2015) Did natural selection make the Dutch taller? A cautionary note on the importance of quantification in understanding evolution. *Evolution*, 69 (12), 3204–3206.

Thrane, J.-E., Kyle, M., Striebel, M., Haande, S., Grung, M., Rohrlack, T., Andersen, T. (2015) Spectrophotometric analysis of pigments: a critical assessment of a high-throughput method for analysis of algal pigment mixtures by spectral deconvolution. *PLoS ONE*, 10 (9), 1–24.

Trosvik, P., **de Muinck, E.** (2015) Ecology of bacteria in the human gastrointestinal tract – identification of keystone and foundation taxa. *Microbiome*, 3 (44), 1–12.

Urra, F. A., Pulgar, R., Gutierrez, R., Hodar, C., Cambiazo, V., **Labra Lillo, A.** (2015) Identification and molecular characterization of five putative toxins from the venom gland of the snake *Philodryas chamissonis* (Serpentes: Dipsadidae). *Toxicon*, 108, 19–31.

Urra, F. A., Pulgar, R., Hodar, C., Gutierrez, R., Cambiazo, V., **Labra Lillo, A.** (2015) Identification, cloning and molecular evolution of five putative toxins from the venom gland of the rear-fanged snake *Philodryas chamissonis* (Serpentes: Dipsadidae). *Toxicon*, doi: 10.1016/j.toxicon.2015.09.032.

Vindenes, Y., **Langangen, Ø.** (2015) Individual heterogeneity in life histories and eco-evolutionary dynamics. *Ecology Letters*, 18 (5), 417–432.

Voje, K. L. (2015) Scaling of morphological characters across trait type, sex, and environment: A meta-analysis of static allometries. *American Naturalist*, 187 (1), 89–98.

Voje, K. L., **Holen, Ø. H.**, **Liow, L. H.**, **Stenseth, N. C.** (2015) The role of biotic forces in driving macroevolution: beyond the Red Queen. *Proceedings of the Royal Society of London. Biological Sciences*, 282 (1808), 1–9.

Wiebe, K., **Slagsvold, T.** (2015) Foraging trade-offs between prey size, delivery rate and prey type: how does niche breadth and early learning of the foraging niche affect food delivery? *Ethology*, 121 (10), 1010–1017.

Wu, C., Huang, X., **Yang, H.**, Lu, Q., Xu, G., Li, L., Li, J. (2015) Embodied carbon emissions of foreign trade under the global financial crisis: a case study of Jiangsu province, China. *Journal of Renewable and Sustainable Energy*, 7 (4), 1–19.

Xiao, X., **Sogge, H.**, **Lagesen, K.**, **Tooming-Klunderud, A.**, **Jakobsen, K. S.**, Rohrlack, T. (2014) Use of high throughput sequencing and light microscopy show contrasting results in a study of phytoplankton occurrence in a freshwater environment. *PLoS ONE*, 9 (8), 1–9.

Xu, L., **Schmid, B. V.**, Liu, J., Si, X., **Stenseth, N. C.**, Zhang, Z. (2015) The trophic responses of two different rodent-vector-plague systems to climate change. *Proceedings of the Royal Society of London. Biological Sciences*, 282 (1800), 1–8.

Yang, H., Andersen, T., Dörsch, P., **Tominaga, K.**, **Thrane, J.-E.**, **Hessen, D. O.** (2015) Greenhouse gas metabolism in Nordic boreal lakes. *Biogeochemistry*, 126 (1-2), 211–225.

Yang, H., Huang, X., Yang, Q., Tu, J., Li, S., Yang, D., Xia, H., Flower, R. J., Thompson, J. R. (2015) Water requirements for shale gas fracking in Fuling, Chongqing, Southwest China. *Energy Procedia*, 76, 106–112.

Yates, M., Debes, P. V., Fraser, D. J., **Hutchings, J.** (2015) The influence of hybridization with domesticated conspecifics on alternative reproductive phenotypes in male Atlantic salmon in multiple temperature regimes. *Canadian Journal of Fisheries and Aquatic Sciences*, 72 (8), 1138–1145.

Zhang, M., Huang, X., Chuai, X., **Yang, H.**, Lai, L., Tan, J. (2015) Impact of land use type conversion on carbon storage in terrestrial ecosystems of China: a spatial-temporal perspective. *Scientific Reports*, 5 (10233), doi: 10.1038/srep10233.

Zhang, Z., Yan, C., Krebs, C. J., **Stenseth, N. C.** (2015) Ecological non-monotonicity and its effects on complexity and stability of populations, communities and ecosystems. *Ecological Modelling*, 312, 374–384.

Zheng, Q., Nizzetto, L., Liu, X., Borgå, K., **Starrfelt, J.**, Li, J., Jiang, Y., Liu, X., Jones, K. C., Zhang, G. (2015) Elevated mobility of persistent organic pollutants in the soil of a tropical rainforest. *Environmental Science and Technology*, 49 (7), 4302–4309.

Books, book chapters and reports

Gautestad, A. O. (2015) *Animal Space Use: Memory Effects, Scaling Complexity, and Biophysical Model Coherence* (336 pp.). Indianapolis, USA: Dog Ear Publishing. ISBN: 978-1-4575-4180-3.

Grøntvedt, R., Nerbøvik, I. K. G., **Viljugrein, H.**, Lillehaug, A., Nilsen, H. K., Gjevre, A. G. (2015) Termisk avlusning av laksefisk – dokumentasjon av fiskevelferd og effekt. Veterinærinstituttets rapportserie, Oslo, Norway (Rapport 13–2015).

Hansen, T. F. (2015) Evolutionary constraints. In J. Losos (Ed.), *Oxford Bibliographies in Evolutionary Biology* (1–28). Oxford: Oxford University Press. ISBN 978-0-199-94172-8.

Hansen, T. F. (2015) Forståelse og misforståelse av arvelighet gjennom historien. In D. O. Hessen, T. Lie and N. C. Stenseth (Eds.), *Mendels arv – Genetikkens æra* (45–79). Oslo, Norway: Gyldendal Norsk Forlag. ISBN 978-82-05-45818-5.

Hessen, D. O., Lie, T., **Stenseth, N. C.** (Eds.). (2015) *Mendels arv – Genetikkens æra* (440 pp.). Oslo, Norway: Gyldendal Norsk Forlag. ISBN 978-82-05-45818-5.

Matschiner, M., Colombo, M., Damerau, M., Ceballos, S., Hanel, R., **Salzburger, W.** (2015) Extremophile Fishes. In R. Riesch, M. Tobler, M. Plath (Eds.), *The Adaptive Radiation of Notothenioid Fishes in the Waters of Antarctica* (35–57). Switzerland: Springer International Publishing. ISBN 978-3-319-13361-4.

Stenseth, N. C. (Ed.). (2015) *Det Norske Videnskaps-Akademi: Årbok 2014* (387 pp.). Oslo, Norway: Det Norske Videnskaps-Akademi. ISBN 978-82-7099-822-7.

Stenseth, N. C. (2015) Så godt som alt vi tar i, er et resultat av grunnleggende forskning. In *Det Norske Videnskaps-Akademi: Årbok 2014* (1–6). Oslo, Norway: Det Norske Videnskaps-Akademi. ISBN 978-82-7099-822-7.

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Talks

(Sorted alphabetically by speakers, then by date)

Aabye, I. Relationships between telomere length and measure of individual quality in blue tits. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Asmervik, I. F., Nielsen, A. Pollinator activity on soybean (Glycine max) in Argentina along a climate gradient. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Austrheim, G., Speed, J. D. M., Evju, M., Hester, A. J., Holand, Ø., Loe, L. E., Martinsen, V., Mobæk, R., Mulder, J., Steen, H., Thompson, D. B. A., **Mysterud, A.** Effects of sheep grazing on biodiversity and ecosystem services in a mountain environment: an experimental approach. *Mountains of Our Future Earth Conference, Australia*. 4–8 October.

Baalsrud, H. T., Tørresen, O. K., Malmstrøm, M., Salzburger, W., Jakobsen, K. S., Jentoft, S. The hemoglobin repertoire in the order of Gadiformes linked to depth adaptation. *European Society for Evolutionary Biology (ESEB) 2015, Switzerland*. 10–14 August.

Bahlk, S. H. Can hybridization be detected between African wolves and sympatric wolf-like canids in Africa? *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Barth, J. M. I. A genomic perspective on cod connectivity in the Skagerrak/Kattegat. *Workshop on Connectivity in the Ocean, Sweden*. 18 May.

Blanco Gonzalez, E., **Jorde, P. E., Knutsen, H.** Climate change and the development of the corkwing wrasse (*Symphodus melops*) fishery in Scandinavia: genetic population structure and potential implication of translocated cleaner fish. *3rd CLIOTOP Symposium, Spain*. 14–18 September.

Blanco Gonzalez, E., **Knutsen, H., Jorde, P. E.** Genetic and phenotypic characterization of local and translocated corkwing wrasse (*Symphodus melops*) populations. *5th International Symposium on Sea Ranching and Stock Enhancement, Australia*. 11–14 October.

Boessenkool, S. Metabarcoding of ancient DNA preserved in sediment helps define reference conditions and restoration targets. *DNA Barcoding Conference, Netherlands*. 3 June.

Boeve, J., Liow, L. H. Exploring uncharted territories: building the largest cheilostome bryozoan phylogeny to date. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Brynildsen, W. Transposable elements in *Gadus morhua*. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Cuevas Pulido, A. M. Rapid evolution in a hybrid species following recent secondary contact with one of its parent species. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Deris, L. Spatial distribution and natural mortality in fish stocks. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Di Martino, E., Liow, L. H.,Taylor, P. D., **Voje, K. L.**, Rust, S. Does competitiveness change on geological time scales? Hints from bryozoan interactions through two million years. *Geological Society of America Conference, USA*. 1–4 November.

Diekert, F. K. Threatening Thresholds? The effect of potential regime shifts on the cooperative and non-cooperative use of environmental goods and services. *Workshop on Thresholds, Tipping Points, and Regime Shifts, USA*. 27–28 July.

Diekert, F. K., Nieminen, E. E. International fisheries agreements with a shifting stock. *Annual Conference of the European Association of Environmental and Resource Economists, Finland*. 24–27 June.

Diekert, F. K., Nøstbakken, L., **Richter, A. P.** Risk and risk exposure in Norwegian fisheries. *Brownbag Seminar Handelshøyskolen NMBU, Norway*. 11 March.

Diekert, F. K., Nøstbakken, L., **Richter, A. P.** Why do fishermen comply with regulations? The role of preferences. *Havet og Kysten avslutningskonferanse, Norway*. 7–9 April.

Diekert, F. K., Nøstbakken, L., **Richter, A. P.** Why do fishermen comply with regulations? The role of preferences. *Resource Modeling Association Conference 2015, France*. 29 June–1 July.

Diekert, F. K., Nøstbakken, L., **Richter, A. P.** Why do fishermen comply with regulations? The role of preferences. *Fiskeridirektoratets Fagdag, Norway*. 29 September.

Diekert, F. K., **Rivrud, I. M.**, **Mysterud, A.**, **Richter, A. P.** Hunting: how social institutions shape selection pressure. *Resource Modeling Association Conference 2015, France*. 29 June–1 July.

Durant, J. M., Krasnov, Y. V., Nikolaeva, N. G., **Hjermann, D. Ø.** Prey abundance and competition with fish as drivers for kittiwake population in the subarctic. *2nd World Seabird Conference, South Africa*. 26–30 October.

Enevoldsen, E. Microporellid evolution – a mitochondrial story. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Eroukhmanoff, F. The evolutionary potential of a hybrid species. *Uppsala University's Young Researcher Seminar Series, Sweden*. 9 March.

Evankow, A. Genetics of Norwegian kelp forests: microsatellites reveal the genetic diversity, differentiation, and structure of two foundation kelp species in Norway. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Fashing, P. J., **Stenseth, N. C.** Opportunities and challenges of training African graduate students abroad. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Fortelius, M. Integrating biology and paleobiology to enhance conservation of terrestrial ecosystems on a rapidly changing planet. *Integrative Climate Change Biology Group (a Program of the International Union of Biological Sciences), USA*. 13–16 September.

Fortelius, M. Major transitions in human evolution. *The Royal Society of London, United Kingdom*. 22–23 October.

Fortelius, M. Integrative Climate Change Biology – Biodiversity, functional traits, and lessons from the past. *32nd IUBS General Assembly and Conference, Germany*. 14–16 December.

Felix, U., Rodrigo, P., Veronica, C., **Labra Lillo, A.** Toxinas putativas del veneno de la serpiente *Philodryas chamissonis* (Serpentes: Dipsadidae). *VI Congreso Chileno de Anfibios y Reptiles, Chile*. 11–14 November.

Fredriksen, S., **Rowe, M.** The ejaculate microbiome of birds. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Fuchs, D., **Vøllestad, L. A.** Personality traits in fish – the consistency of behavior in sea trout (*Salmo trutta*) of Southern Norway. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Graffi, G. Archaeogenetics of medieval plague: the role of the harbors in the 2nd pandemic. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Guellil, M. Evolution and paths of transmission of *Yersinia pestis* during the second plague pandemic (1346 CE–18th Century) in medieval Europe. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Guldvog, C. Ø. The repeatability of the genomic architecture in a homoploid hybrid species. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Gutema, T. M. The behavioural ecology of the African wolf (*Canis lupus lupaster*) in the Ethiopian highlands. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Hannisdal, B., **Liow, L. H.** The Poseidon adventure: richness versus commonness. *Geological Society of America Conference, USA*. 1–4 November.

Haug, S., **Karbassioon, A.**, **Brysting, A. K.**, **Nielsen, A.** Pollinator interactions with wild raspberry and the surrounding plant community along an altitudinal gradient. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Helberg, M. Do climate have an impact on survival in wintering gulls? *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Hermansen, J. S. Et forskningsprosjekt. *Skolelabben Lecture, Norway*. 12 February.

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Hermansen, J. S. PhD – dos and don'ts. *Natural History Museum PhD Forum Meeting, Norway*. 21 October.

Hermansen, J. S. The role of hybridization in evolution. *Frokost hos Kristine, UiO, Norway*. 11 November.

Hernandez-Aguilar, R. A. Dramatic population decline of Ashy red colobus monkeys (*Piliocolobus tephrosceles*) in Mbuzi Forest, Rukwa region, western Tanzania. *10th Tanzanian Wildlife Research Institute (TAWIRI) Scientific Conference, Tanzania*. 2–4 December.

Huserbråten, M. B. O. Dynamics of fjordic dispersal. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Høydalsvik, M. N., **Vøllestad, L. A.** Population dynamics in lobster: effects of marine protected areas. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Isaksen, E. T. Tragedy, property rights, and the commons. *Departmental Lunch Seminar, Department of Economics, Wageningen University, Netherlands*. 23 April.

Isaksen, E. T. Tragedy, property rights, and the commons: disentangling the two-way causality between institutions and ecosystem collapse. *European Association of Environmental and Resource Economists 2015, Finland*. 24–27 June.

Isaksen, E. T. Tragedy, property rights, and the commons: disentangling the two-way causality between institutions and ecosystem collapse. *European Association of Environmental and Resource Economists – Summer School Presentation, Italy*. 28 June–4 July.

Isaksen, E. T. Tragedy, property rights, and the commons: disentangling the two-way causality between institutions and ecosystem collapse. *Canadian Resource and Environmental Economics Study Group Annual Conference, Canada*. 2–4 October.

Isaksen, E. T. Transboundary pollution and international cooperation. *Sustainable Development Colloquium, USA*. 15 October.

Jakobsen, K. S. Store datamengder. *Apollon-lansering, UiO, Norway*. 14–15 October.

Jin, X. Can cod macrophages help us to understand the evolutionary plasticity of vertebrate immune systems? *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Juliussen, E. H., **Vøllestad, L. A.** Adaption to temperature in Atlantic cod (*Gadus morhua*) on a micro-geographic scale. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Kassie, A. M. Impact of habitat loss and fragmentation on the genetic diversity of the Bale monkey (*Chlorocebus djamdjamensis*) in the southern Ethiopian Highlands. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Knutsen, H. Leppefisknæring i vekst – flytting av fisk til hvilken pris? *Årsmøte Havforskningsinstituttet, Norway*. 6–7 January.

Kool, A., **Boessenkool, S.** Viking-assisted dispersal and the role of exhibitions in research. *Historic Seed Group Meeting Stockholm, Sweden*. 9 June.

Kopperud, B. T., **Hansen, T. F.** The ungulate brain: a comparative analysis. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Kvile, K. Ø. Disentangling the mechanisms behind climate effects on zooplankton. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Labra Lillo, A., Mario, R.-M. Interaction between calls and scents in lizard antipredator behavior. *XXV International Bioacoustics Congress, Germany*. 7–12 September.

Liljegren, M. M. Closed-system ecology and the Red Queen: molecular models and microbes. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Linløkken, H., **Mysterud, A.** Tick load and infection of tick-borne pathogens in small mammals. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Liow, L. H. Revisiting the bivalve and brachiopod saga using new tools and data: they really did not pass each other in the night. *Guest Lecture at the Geological Society of America, USA*. 1–4 November.

Liow, L. H. Estimating diversification rates and hunting for their drivers in the deep past. *Guest Lecture at the American Museum of Natural History, USA.* 23 November.

Lønaas, E. A., Lampe, H. M. Song repertoire variation in individual male pied flycatchers. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Mario, R.-M., **Labra Lillo, A.** Interacción entre el escenario químico y el tipo de llamadas de auxilio en la respuesta antidepredatoria del lagarto chillón, *Liolaemus chiliensis. XVI Congreso Argentino de Herpetología, Argentina.* 29 September–2 October.

Mario, R.-M., Valdecantos, S., Fernando, L., Felix, C., **Labra Lillo, A.** Nuevos avances en el entendimiento de la comunicación química y visual en lagartos del género *Liolaemus. II Congreso Argentino de Biología del Comportamiento, Argentina.* 26–28 August.

Mayer, C. Genotype-Phenotype Maps: exploring evolvability and robustness by using a multilinear framework combined with the idea of Boolean networks. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Mazzarella, A., Voje, K. L., Hansson, T. H., Taugbøl, A., Fischer, B. Strong and parallel salinity-induced phenotypic plasticity in a single generation of threespine stickleback. *8th International Conference on Stickleback Behavior and Evolution, USA.* 26–31 July.

Mellerud, I. K., Vøllestad, L. A. Connectivity of Atlantic cod at the Norwegian Skagerrak coast. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Moghadam, M. D., Ergon, T. Estimating the animal movements from lightbased data by using state-space modeling. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Motes-Rodrigo, A., **Labra Lillo, A., Lampe, H. M.** Testing the nutritional stress hypothesis and learning capacity in pied flycatchers. *XXV International Bioacoustics Congress, Germany.* 7–12 September.

Mutch, E. Ability to adjust breeding time to earliness of spring – a comparative study of four passerine bird species. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Nater, C. R. Impacts of environmental changes, harvesting and management strategies on a size-structured population of brown trout. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Nederbragt, A. J. Local, central or cloud – Why we chose to build our e-infrastructure for sequence analysis embedded in the University of Oslo HPC cluster. *Workshop: e-Infrastructures for Massively Parallel Sequencing, Sweden.* 19–20 January.

Nederbragt, A. J. A new, high quality reference genome assembly for Atlantic cod. *9th European Zebrafish Meeting, Norway.* 28 June–2 July.

Nederbragt, A. J. Bioinformatics breakout: recent experiences from Oslo. *Pacific Biosciences User Group Meeting, Spain.* 9–10 November.

Nielsen, A. Det usynlig mangfoldet i landbruket – pollinatorer. *Det usynlig mangfoldet i landbruket konferanse, Norway.* 18 March.

Nielsen, A. Presentasjon og diskusjon om den kommende IPBES rapporten om pollinatorer. *SABIMA Seminar, Norway.* 18 March.

Nielsen, A. Biologisk mangfold i landbruket – pollinatorer. *Biologisk mangfold i landbruket konferanse, Norway.* 1 September.

Nielsen, A. Plant-pollinator interactions and climate change. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Nielsen, A., Hegland, S. J. Pollination; an ecosystem service affected by climate change. *Biannual Conference of the Norwegian Ecological Society, Norway.* 12–13 March.

Nistelberger, H. M. Introduction to Vikings as Vectors project. *Introduction to Vikings as Vectors Project Seminar, Norway.* 20 April.

Nistelberger, H. M. Vikings as Vectors. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Norderhaug, K. M., Fagerli, C., Andersen, G. S., Christie, H., Moy, F. E., **Gundersen, H.**, Bekkby, T., Rinde, E., Fredriksen, S., Pedersen, M. F., Dahl, K. Regime shifts in Norwegian kelp forests. *European Marine Biology Symposium, Germany.* 21–25 September.

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Olsen, L. N. Genetic structure of diploid (2n = 12, 14) scurvygrasses (Cochlearia) with emphasis on Icelandic populations. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Oomen, R. A. The transcriptomic response of cod to temperature. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Oomen, R. A., **Knutsen, H.**, Olsen, E. M., **Jentoft, S.**, **Stenseth, N. C.**, **Hutchings, J.** Genetic variability in population responses of Atlantic cod to environmental change and the transcriptomic response to temperature. *Canadian Conference for Fisheries Research, Canada*. 9 January.

Oomen, R. A., **Knutsen, H.**, Olsen, E. M., **Jentoft, S.**, **Stenseth, N. C.**, **Hutchings, J.** Genetic variability in population responses of Atlantic cod to temperature. *European Marine Biology Symposium, Germany*. 24 September.

Oomen, R. A., **Knutsen, H.**, Olsen, E. M., **Jentoft, S.**, **Stenseth, N. C.**, **Hutchings, J.** The transcriptomic response of cod to temperature. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Ottersen, G. Sea fisheries and the ecosystem approach to marine management. *Forelesning Bio4150/9150, UiO, Norway*. 13 March.

Ottersen, G. Marine ecosystems climate effects and management. *UiO International Summer School – A Changing Arctic, Norway*. 30 June.

Paus Knudsen, J., **Nielsen, A.** Effects of pesticides on bumblebee behaviour (*Bombus terrestris*). *Vintermøtet – Norsk selskap for farmakologi og toksikologi, Norway*. 29 January–1 February.

Paus Knudsen, J., **Nielsen, A.** Effekter av plantevernmidler på adferd hos humler (*Bombus terrestris*). *Møte med Miljødirektoratet, Norway*. 10 March.

Reitan, T. The nature of unexplained variation in flower visitation data. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Reitan, T. Further revisiting the bivalve and brachiopod saga; beyond pairwise analysis. *Geological Society of America 2015 Annual Conference, USA*. 1–4 November.

Reyes, C., Nelson, V., Mario, P., Peter, N., **Labra Lillo, A.** Evaluación de la sensibilidad timpánica en el lagarto llorón (*Liolaemus chiliensis*). *VI Congreso Chileno de Anfibios y Reptiles, Chile*. 11–14 November.

Richter, A. P. When kindness generates unkindness. Why positive framing cannot solve the tragedy of the commons – an experimental investigation. *Annual Conference of the European Association of Environmental and Resource Economists, Finland*. 24–27 June.

Riiser, E. S. The Atlantic cod microbiome project. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Rinvoll, A. W., **Nielsen, A.** Pollinator activity under climate change. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Rivrud, I. M. Delimiting functional management units for partially migratory deer populations (DeerUnit). *Miljø2015: Stipendiat- og postdocsamling, Norway*. 12 May.

Roell, M.-S., Noordzij, H. T., **Skar Mjønes, C.**, Boye, O., Levchenko, V., Kimara, C., **Ramberg, S.**, Lycke, M., Mathiesen, B. E., **de Muinck, E.**, Grini, P. E., Linke, D. Methane Incorporated – iGEM Lecture. *iGEM Jamboree Boston, USA*. 24–30 September.

Rogers, L. Growth, recruitment, and population spatial structure: lessons from coastal Atlantic cod. *National Oceanic and Atmospheric Administration FOCI Seminar, USA*. 19 August.

Rogers, L. Spatial patterns of risk to species and fishing communities from climate change. *American Fisheries Society Annual Meeting, USA*. 19 August.

Rogers, L., Griffin, R., St. Martin, K., Young, T., Fuller, E., Pinsky, M. Spatial patterns in the vulnerability of New England fish and fishing communities to climate change. *National Oceanic and Atmospheric Administration NWFSC MonsterJam Seminar, USA*. 5 November.

Romagnoni, G., **Diekert, F. K.**, **Eikeset, A. M.**, Lindroos, F. Exploring population-specific management for North Sea cod meta-population. *ICES Annual Science Conference, Denmark*. 25 September.

Roney, N., **Hutchings, J.** Within-spawning season temporal and individual variation of reproductive success and offspring quality in Norwegian Skagerrak coastal cod. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Rowe, M. Sperm wars: the role of bacteria in the evolution of avian ejaculates. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Schmid, B. V. The climatic pulse of Asia, the Black Death and successive plague reintroductions into Europe. *Disease and Global History Symposium, United Kingdom*. 22 May.

Skar Mjønes, C., **Mysterud, A.** Developing a DNA-based mass spectrometry approach determining last blood meals in ticks. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Skaraas, C., **Slagsvold, T.** Personality and natal dispersal in great tits *Parus major*. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Slagsvold, T. On the significance of early social learning in titmice. *Association for the Study of Animal Behaviour (ASAB) Winter Meeting, United Kingdom*. 3–4 December.

Solbakken, I., **Lampe, H. M.** Winter flocking titmice communities in natural versus plantation forests, a comparison. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Speed, J. D. M., Martinsen, V., Hester, A. J., Holand, Ø., Mulder, J., **Mysterud, A.**, Austrheim, G. Carbon storage across the alpine treeline ecotone: thresholds and impacts of climatic and land-use change. *Mountains of Our Future Earth Conference, Australia*. 4–8 October.

Starrfelt, J. TRiPS, SQS, ACE and Chaos; evaluating the accuracy and precision of species richness estimators in paleobiology. *Palaeontological Association Annual Meeting 2015, United Kingdom*. 16 December.

Starrfelt, J., **Liow, L. H.** Inferring true number of dinosaur species by estimating fossil sampling probabilities. *Geological Society of America Conference, USA*. 1–4 November.

Stenseth, N. C. Climate change and impact on emerging infectious diseases. *Guest Lecture at the Department of Ecology and Evolutionary Biology, Princeton University, USA*. 6 January.

Stenseth, N. C. Pandemics and climate change. *8th Meeting of Tuanshan Hill Anti-EID Forum, Chinese Centre for Disease Control and Prevention, China*. 15 January.

Stenseth, N. C. Norge er avhengig av fremragende forskningsmiljøer. *Arbeiderpartiets utvalg for høyere utdanning, Norway*. 22 February.

Stenseth, N. C. Prosjektledelse. *Samling for unge forskertalenter, Norway*. 18–19 March.

Stenseth, N. C. Climate change and impact on emerging infectious diseases. *Guest Lecture at Zhejiang University, China*. 26 March.

Stenseth, N. C. Climate change and impact on emerging infectious diseases. *Guest Lecture at the Recanati Kaplan Centre, University of Oxford, United Kingdom*. 9 April.

Stenseth, N. C. Hva er fremragende forskning og hvordan kommer man dit? *Nasjonal forskerskole i farmasi, Norway*. 28 April.

Stenseth, N. C. Sustainable management of renewable resources in a changing environment: an integrated approach across ecosystems (SUSTAIN). *Oppstartsmøte, Norway*. 6 May.

Stenseth, N. C. Concept presentation: International Masters of Science programme. *University of Agder Seminar, Norway*. 13 May.

Stenseth, N. C. Hvordan bidrar SFF-ordningen til å gjøre utdanningen bedre? *NOKUT-konferansen, Norway*. 19 May.

Stenseth, N. C. IUBS International Union of Biological Sciences. *IUPESM 2015 World Congress on Medical Physics and Biomedical Engineering 2015, Canada*. 8 June.

Stenseth, N. C. Climate change and impact on emerging infectious diseases. Plague as an example. *Guest Lecture at the GIS and Health Workshop, China*. 16 June.

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Stenseth, N. C. Pandemics and climate change. *ISSMF 4205: International Community Health, Oslo Summer School Course, Norway*. 29 June.

Stenseth, N. C. Advice to young scientists. *Moscow Summer Academy on Economic Growth and Governance of Natural Resources, Russia*. 20 July–1 August.

Stenseth, N. C. Er norske universiteter og høyskoler gode nok i den internasjonale konkurransen? *Arendalsuka, Norway*. 17 August.

Stenseth, N. C. Plague and its ecological diversity. *The Plague Workshop in Xian, China*. 28 August.

Stenseth, N. C. Integrating ecology and evolution. *CEES Colloquium 4 Kick-off Meeting, Norway*. 31 August.

Stenseth, N. C. Where paleobiology meets conservation biology: connecting micro- and macroevolution through ecology. *ICCB Symposium and Workshop on Integrating Biology and Paleobiology to Enhance Conservation of Terrestrial Ecosystems on a Rapidly Changing Planet, USA*. 14 September.

Stenseth, N. C. Climate change and impact on emerging infectious diseases. Plague as an example. *Guest Lecture at the Norwegian University of Science and Technology, Norway*. 25 September.

Stenseth, N. C. The family of MARmaED: NorMER and GreenMAR. *The MARmaED Kick-off Meeting, Norway*. 30 September.

Stenseth, N. C. Medieval plague pandemics in Europe: repeated climate-driven introductions from Central Asia. *Guest Lecture at the Academiegebouw, Netherlands*. 13 October.

Stenseth, N. C. Var Svartedauden og pestutbruddene i middelalderens Europa forårsaket av en asiatisk klimapuls? *Akademi-møte, Norway*. 22 October.

Stenseth, N. C. Sustainable aquatic food production under climate change. *Transatlantic Science Week 2015, USA*. 5 November.

Stenseth, N. C. Climate change and impact on emerging infectious diseases. *Guest Lecture at the Department of Biology and Biochemistry, University of Bath, United Kingdom*. 17 November.

Stenseth, N. C. Ecological and evolutionary dynamics in marine systems under anthropogenic influence. *Canadian Marine Biodiversity Seminar, Canada*. 26–28 November.

Stenseth, N. C. The 21st century is the century of biology: from Darwin to the DNA helix and beyond. *32nd IUBS General Assembly and Conference, Germany*. 14 December.

Stenseth, N. C. Concluding remarks for the Symposium on the Biological Consequences of Global Change. *32nd IUBS General Assembly and Conference, Germany*. 15 December.

Stenseth, N. C., Schmid, B. V. The climate pulse of Asia: the Black Death and successive plague reintroductions into Europe. *Guest Lecture at the Oxford Centre for Global History, University of Oxford, United Kingdom*. 22 May.

Stige, L. C. Climate effects on ecosystem dynamics in the Barents Sea. *Tømte Symposium, Norway*. 1 October.

Sørhus, E., Edvardsen, R., Karlsen, Ø., Sørensen, L., Nordtug, T., van der Meeren, T., Thorsen, A., **Jentoft, S.**, Incardona, J., Vikebø, F. B., Thorbjørnsen, M., Meier, S. Linking mechanisms of PAH cardiotoxicity, morphogenetic defects and cardiac gene expression in Atlantic haddock. *18th International Symposium on Responses of Marine Organisms. (PRIMO 18), Norway*. 24–27 May.

Taylor, P. D., Dennis, G., Jaeger, M., **Liow, L. H.**, Waeschenbach, A., Zibrowius, H. Symbiosis between serpulid polychaetes and hydroid cnidarians: 187 million years of biotic interaction. *Geological Society of America Conference, USA*. 1–4 November.

Toljagic, O. Ungulate evolution in the slow lane. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Trovum, M. K., Sætre, G.-P. Adaptation to insularity in a hybrid and a nonhybrid species. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

Valseth, K. Next generation sequencing on soil samples from Etosha National Park: diversity studies of an anthrax reservoir. *CEES Annual Student Conference 2015, Norway*. 14–15 October.

van Leeuwen, C. Multi-purpose migration in a freshwater salmonid. *NoWPaS International Network Meeting on Migratory Salmonids, United Kingdom*. 7–10 April.

van Leeuwen, C. Direct and indirect effects of river fragmentation for spring and autumn spawning fish. *World Fish Passage Conference, Netherlands.* 22–24 June.

Varadharajan, S. The grayling genome – comparative genomics of salmonids. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Vike, B. K., **Mysterud, A.** Red deer migration and dietary quality: testing the role of landscape characteristics for the forage maturation hypothesis. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Vikingsdal Seland, I., **Mysterud, A.** The distribution of ticks and tick-borne pathogens from coast to inland in south-east Norway. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Vindenes, Y., **Langangen, Ø.**, Winfield, I. J., **Vøllestad, L. A.** Relative fitness consequences of early life conditions and maternal length in Windermere pike. *EIFAAC 2015 "Managing Freshwater Fisheries in an Era of Change", Norway.* 15–17 June.

Vindenes, Y., **Langangen, Ø.**, Winfield, I. J., **Vøllestad, L. A.** Relative fitness importance of a size-mediated maternal effect – an integral projection model approach. *Ecological Society of America Conference 2015, USA.* 9–14 August.

Vindenes, Y., **Langangen, Ø.**, Winfield, I. J., **Vøllestad, L. A.** Fitness consequences of early life conditions and maternal size effects in pike (*Esox lucius*). *Annual Meeting of the Evolutionary Demography Society, Netherlands.* 5–7 October.

Vogt, R. D., An, W., Andersen, T., Bin, Z., Deng, X., Jiahua, P., Johnsen, R. K., Lu, X., Luo, J., Meng, L., Ming, S., Mohr, C. W., Naustdalslid, J., Orderud, G., Peng, Q., Røyset, O., Tian, B., **Tominaga, K.**, Wang, T., Wibetoe, G., Yang, M. SinoTropia – Watershed Eutrophication management in China through system oriented process modelling of pressures, impacts and abatement measures. *SinoTropia Final Conference, China.* 24–25 March.

Voje, K. L. Tempo does not infer mode in evolution. *European Society for Evolutionary Biology (ESEB) 2015, Switzerland.* 10–14 August.

Voje, K. L. Mode does not correlate with tempo in evolution. *Geological Society of America Congress 2015, USA.* 1–4 November.

Vøllestad, L. A. Effects of environmental variation on the population structure of grayling *Thymallus thymallus*. *Advances in the Population Ecology of Stream Salmonids, Spain.* 25–29 May.

Walle, E., **Durant, J. M.** Investigating the effect of changes in the timing of fishing on the breeding success of a South African seabird. *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Whittington, J. The added value of Nordic cooperation. *Nordforsk 10-Year Anniversary Conference, Norway.* 8–9 October.

Winter, A.-M. Impact of fishing, climate and Allee effect on the collapse and recovery of Atlantic cod (*Gadus morhua*). *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Wortel, M. T. The rich evolutionary dynamics of metabolic interactions: is the Red Queen one of them? *CEES Annual Student Conference 2015, Norway.* 14–15 October.

Posters

(Sorted alphabetically by speakers, then by date)

Barth, J. M. I. A genomic perspective on Atlantic cod connectivity. *European Society for Evolutionary Biology 2015, Switzerland.* 10–14 August.

Boessenkool, S., **Star, B.**, **Trucchi, E.**, Merilä, J., **Vøllestad, L. A.** Whole genome analysis of threespine stickleback populations from the Mediterranean to Northern Europe. *Annual Meeting of the Society for Molecular Biology and Evolution, Austria.* 12–16 July.

Brandrud, M. K., Paun, O., Nordal, I., **Brysting, A. K.** Polyploidy and ecological adaptation in Cochlearia in Northern Norway. *Mechanisms of Plant Speciation, Norway.* 9–13 June.

Diekert, F. K., **Richter, A. P.** Stabilizing and de-stabilizing effects of multi-species interactions above and beneath the sea surface. *Havet og Kysten avslutningskonferanse, Norway.* 7–9 April.

Evankow, A. M., Fredriksen, S., Christie, H. C., Junge, C., **Brysting, A. K.** Genetic tools reveal diversity and structure of kelp forests in Norway. *50th European Marine Biology Symposium, Germany.* 21–25 September.

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Evankow, A. M., Fredriksen, S., Christie, H. C., Junge, C., **Brysting, A. K.** Population genetic diversity and structure of two kelp species (Laminariales) in Norway. *50th European Marine Biology Symposium, Germany*. 21–25 September.

Haverkamp, T. H. A., Zhaxybayeva, O., Geslin, C., Lossouarn, J., Kublanov, I. V., **Nesbø, C. L.** Pangenomic analysis of *Thermosipho* reveals limited gene flow between species but high within-species similarity. *6th European Conference on Prokaryotic and Fungal Genomics, Germany*. 29 September–2 October.

Lampe, H. M., **Labra Lillo, A.** Exploring the relationship between song characteristics of fathers and sons in pied flycatchers. *XXV International Bioacoustic Congress, Germany*. 7–11 October.

Malmstrøm, M., Sydenham, M. A. K., **Nielsen, A.** CEES, its people and machines – a goldmine for genetic studies. *Biology and Genomics of Social Insects, USA*. 2–5 May.

Matschiner, M. Inversions or introgression: the origin of high-divergence genomic regions in Atlantic cod. *European Society for Evolutionary Biology 2015, Switzerland*. 10–14 August.

Mayer, C., **Hansen, T. F.** Genotype–phenotype maps: exploring evolvability and robustness by combining a multilinear framework with Boolean networks. *Annual Meeting of the Society for Molecular Biology and Evolution 2015, Austria*. 12–16 July.

Mayer, C., **Hansen, T. F.** Modeling genotype–phenotype maps by combining a multilinear model with Boolean networks. *Inaugural 2015 Meeting Pan-American Society for Evolutionary Developmental Biology, USA*. 5–9 August.

Mazzarella, A., **Boessenkool, S.**, **Østbye, K.**, **Vøllestad, L. A.**, **Trucchi, E.** Genomic signatures of the plateless phenotype in the threespine stickleback. *8th International Conference on Stickleback Behavior and Evolution, USA*. 26–31 July.

Nederbragt, A. J. Active learning strategies for bioinformatics teaching. *FEBS-IUBMB Workshop on Education in Molecular Life Sciences, Norway*. 18–19 September.

Reitan, T., **Nielsen, A.** Do not divide count data with count data; a story from pollination ecology. *Biennial Conference of the Norwegian Ecological Society, Norway*. 12–13 March.

Riiser, E. S., **Star, B.**, **Jentoft, S.** The Atlantic cod microbiome project. *Centre for Computational Inference in Evolutionary Life Science (CELS) Seminar, Norway*. 9 February.

Rogers, L., Griffin, R., St. Martin, K., Young, T., Fuller, E., Pinsky, M. Vulnerability of fish and fishing communities to climate change. *NorMER Annual Meeting, Sweden*. 28 September.

Star, B., **Jentoft, S.**, **Matschiner, M.**, **Nederbragt, A. J.**, **Kjesbu, O. S.**, **Berg, P. R.**, Bradbury, I. R., Pampoulie, C., **Hansen, M. H. S.**, **Skage, M.**, **Jakobsen, K. S.**, **Stenseth, N. C.** Does historic DNA provide genomic evidence for recent selection in Atlantic cod? *Annual Meeting of the Society for Molecular Biology and Evolution 2015, Austria*. 12–16 July.

Tarka, M., Pelabon, C., **Hansen, T. F.**, Sæther, B.-K. Intralocus sexual conflict and the evolution of sexual dimorphism. *European Society for Evolutionary Biology 2015, Switzerland*. 10–14 August.

Taugbøl, A., **Arntsen, T.**, **Østbye, K.**, **Vøllestad, L. A.** Small changes in gene expression of targeted osmoregulatory genes when exposing marine and freshwater threespine stickleback (*Gasterosteus aculeatus*) to abrupt salinity transfers. *8th International Conference on Stickleback Behavior and Evolution, USA*. 26–31 July.

Pollinator observations in a soybean field in Argentina. The PolliClim project is studying, in collaboration with our partner at the University of Buenos Aires, how soybean pollination might change along a latitudinal gradient.
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