


CEES

Centre for Ecological and
Evolutionary Synthesis

2014 | 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 picture: A female house sparrow (*Passer domesticus*), Moskenes, Lofoten, Norway. By means of genetic analyses CEES researchers have shown that the hybrid Italian sparrow is reproductively isolated from its parent species, the house sparrow and the Spanish sparrow. © Julia M. I. Barth.



CEES IN BRIEF

In 2014, CEES consisted of 161 members (including Core staff, Postdocs and researchers, PhDs, research assistants, technical and administrative staff, and Master's students). In addition, 15 guests stayed for more than one month, and 21 guests for less than one month. The members and guests represented 34 nationalities. The Centre has a core group of 16 employees (two are employed by the Department of Mathematics, one by the Department of Economy and one by the Institute of Marine Research). One employee is a visiting scientist at the University of Alberta, Canada. CEES is chaired by Professor Nils Chr. Stenseth.

CEES supervised 34 Master's and 29 PhD students in 2014, and was also involved in the teaching of 7 PhD/Master's courses and 3 Bachelor's courses. 7 new PhD students were employed, and 4 PhD students and 13 Master's students completed their degrees. The CEES graduate school held its annual conference at Holmen Fjordhotell with 137 delegates.

Approximately 94 MNOK of the total budget of 152 MNOK came from the 56 externally funded research projects conducted by CEES in 2014. Most of these were funded through the Research Council of Norway. CEES is also involved in various EU-funded projects. 17 new projects were started.

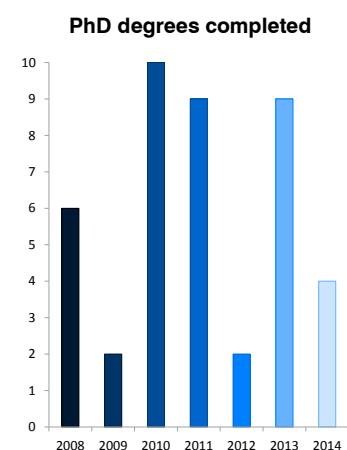
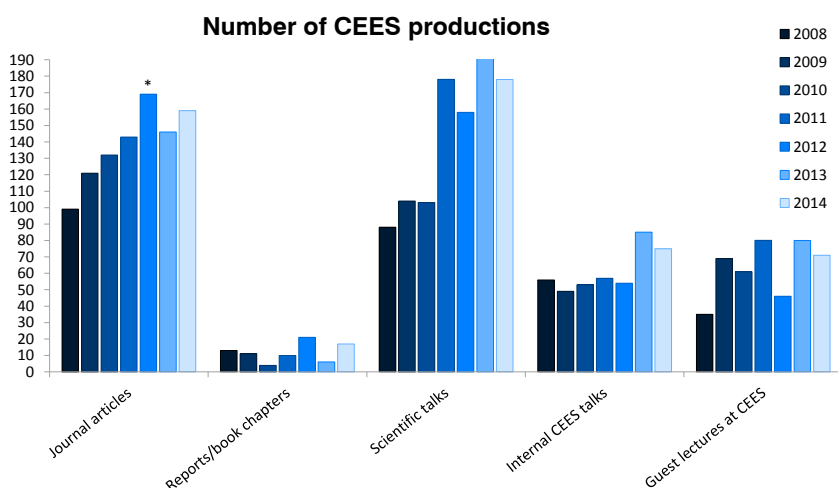
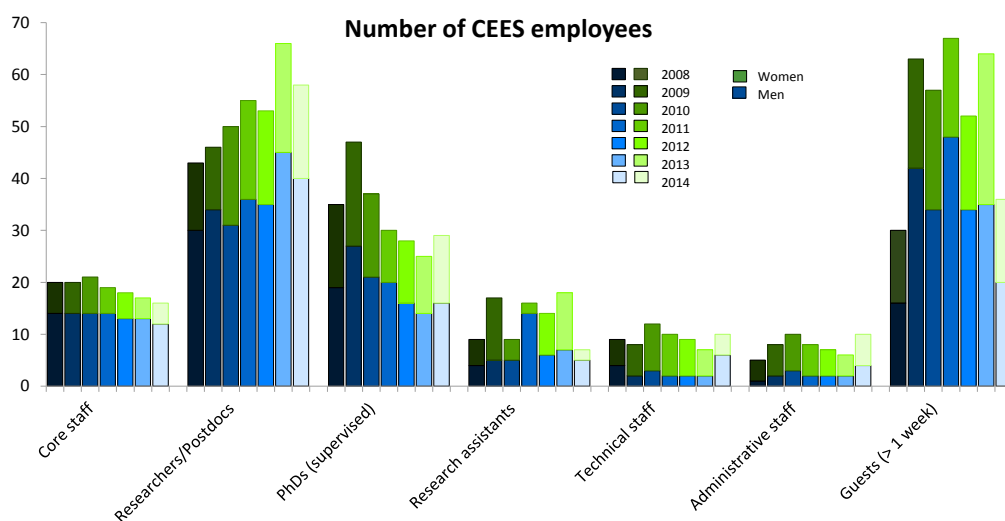
CEES members published 159 articles in peer reviewed journals and 17 books/book chapters/reports in 2014. The majority of these results lie within the core scope of CEES. 178 talks at conferences were conducted. The Centre hosted 71 guest speakers, primarily from abroad.

The work of CEES is structured into *Colloquia* and *Themes*, the former being focused projects each lasting for three years and the latter consisting of on-going, 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.

White-tailed eagle (or sea eagle, *Haliaeetus albicilla*) on the island Runde, Møre og Romsdal, Norway.
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The CEES administration.

CEES IN BRIEF CONT.



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

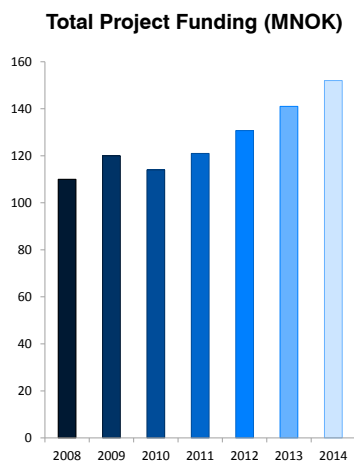
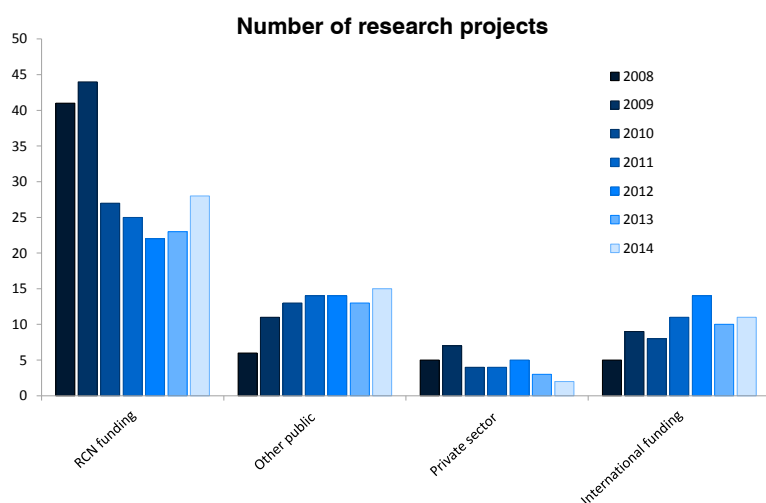


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1 THE CHAIR'S COMMENTS

We have now only three more years to go as a Centre of Excellence (CoE) within the current 2007–2017 funding period. I am pleased to see that all indicators show promise for what we might expect during the latter part of this 10-year period – and beyond. We continue to keep up our good publication record and to obtain good external financial support for our work: in short, we keep delivering high-quality and internationally highly visible scientific work. It seems clear to me that we will complete the full 10-year period very successfully. In particular, the integration of the many disciplines and foci within the Centre continues, all of which provides the basis for the continued existence of CEES beyond 2017. The planning for such a continued existence as an excellent research and training centre is well under way. Besides aiming at a new CoE period, we are also working towards funding through the European Research Council (ERC) – be it Starting Grants, Consolidator Grants or Advanced Grants – as well as Horizon 2020.

Excellence starts with people – without great people a great vision (as we have) is irrelevant. At CEES we have an extraordinarily good group of people – highly talented and very social – sharing ideas in the pursuit of excellence in science. In 2014, CEES had 157 members (including core staff, postdocs and researchers, PhD students, research assistants, technical and administrative staff, and Master's students). The number of people working at CEES keeps increasing annually, though at any given time the number of people on staff remains rather stable. This implies that we have an increasing number of visitors working with us for a period of a few weeks to several months.

Projects and funding. Approximately 94 MNOK of the total budget of 152 MNOK came from the 56 externally funded research projects conducted by CEES in 2014. Most of these were funded through the Research Council of Norway (RCN). CEES is also involved in various EU-funded projects. In total, 17 new projects were started. We keep securing increasingly more external funding – all of which is coming through fewer (hence larger) grants.

Our work on hybrid speciation (two different species breeding with each other, resulting in a new species) in sparrows resulted in a paper (in *PLoS Genetics*, highlighted by *Science*) demonstrating the mechanisms by which the hybrid Italian sparrow is reproductively isolated from its parent species. We have secured new funding for this research through the RCN-project led by professor Glenn-Peter Sætre “On the role of hybridisation in evolution – the case of Eurasian *Passer* Sparrows”.

The “Sustainable management of renewable resources in a changing environment: an integrated approach across ecosystems” (SUSTAIN) was also among the grants obtained at the end of 2014, linking us closer to strong ecology and evolution groups in Trondheim and Tromsø.

Walter Salzburger (CEES and University of Basel, Switzerland) was awarded an ERC consolidator grant (CICHLIDX). The aim of CICHLIDX is to understand the adaptive radiation (a process in which organisms diversify rapidly into a multitude of new forms) of cichlid fishes in East African Lake Tanganyika. This will be done by combining in depth assessments of taxonomy, morphology and ecology with whole genome sequencing. A major part of the sequencing effort will be conducted at the Norwegian Sequencing Centre.

Several of our young researchers have been awarded grants this year. I would like to congratulate Sanne Boessenkool (“Tracking Viking-assisted dispersal of biodiversity using ancient DNA”), Pål Trosvik (“Modeling microbial dynamics of the human infant gut”), Fabrice Eroukhmanoff (“Evolvability of genomic architecture during hybrid speciation”), and Yngvild Vindenes (“Managing ecosystems in an increasingly variable world”). These are young researchers who have a high potential for success as independent researchers, supervisors and managers.

Promoting young researchers. CEES continues to be a group of rather young and very ambitious scientists

– the median age is 38 years (not including Master's students and guests). The CEES members are, as I see it, highly ambitious, but very cooperative and sharing – both of which are key elements for a successful research and training centre. I would like to thank the young and highly talented people working at CEES for carrying out all your good work – you are the key to the success of the Centre – and for contributing to making CEES a very nice place to be, both scientifically and socially.

The Scientific Advisory Board (SAB) continues to provide encouraging feedback through critical and constructive advice. I am happy to see that they find our development to be excellent. I'd like to thank the SAB for helping us further develop CEES as a good working place – a good place to carry out excellent work in an excellent intellectual and social atmosphere.

The Board serves a very good function, not the least with helping us further develop a good relationship with our host institution, the Department of Biosciences and the Faculty of Mathematics and Natural Sciences. The Board is also good at helping us work out plans for how to develop CEES further after its 10-year CoE period. I'd like to thank the Board for helping us keep on track.

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 carry out field-, lab- and theoretical work. As we move towards the end of our 10-year period, I'm very much looking forward to the results: much exciting work is currently emerging from these two colloquia. I'm sure I will return to these results in future annual reports.

This year it will suffice to mention two things relating to *Colloquium 3*: Wendy Turner, who spent two years with us on funding from The National Science Foundation (NSF, USA), published an important paper in *Proceedings of the Royal Society B (PRSB)*: “Fatal attraction: vegetation

responses to nutrient inputs attract herbivores to infectious anthrax carcass sites”. The publication reports the result of a 3-year experimental study of anthrax in a guild of mammalian herbivores in Etosha National Park, Namibia. It was also awarded the front page of the journal issue it appeared in.

In November 2014 we organised an international meeting on plague in the Norwegian Academy of Science and Letters (partly funded by the Academy, by MLS and Med-Plag): “The Past Plague Pandemics in Light of Modern Molecular Life Science Insights”. Here various kinds of biologists met with historians to discuss the past plague epidemics. This was a fascinating meeting which will, I'm sure, serve as a platform for further interdisciplinary work at CEES.

Strategy for CEES beyond 2017. We contribute profoundly to the department (see figure below). Our ambition is to continue to do so.

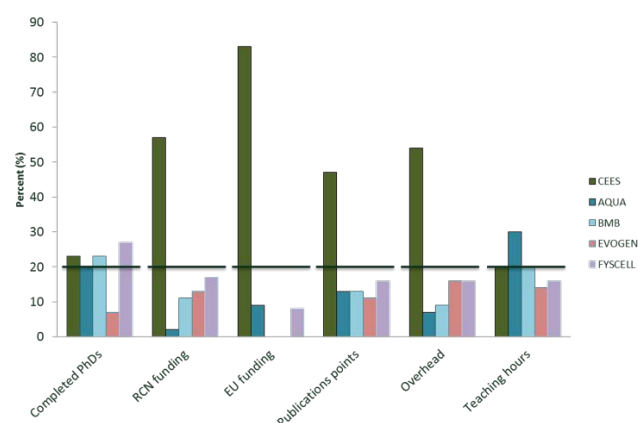


Figure showing the performance of CEES relative to other sections of our host department, IBV. (Data from 2013.)

1 THE CHAIR'S COMMENTS

During the next few years, we aim to:

1. Have each member contribute at least one paper to top international journals per year (as we currently do: if CEES was a journal, it would have an impact factor corresponding to those of *Ecology* and *Evolution* (the two major journals within our fields) and slightly below that of *PRSB* (a general journal covering our fields))
2. Be clearly visible both within and beyond the scientific community (newspapers, general lectures, etc.)
3. Bring in considerable external funding (at a level corresponding to at least what we do today)
4. Contribute to the teaching program at the department (at a level corresponding to what we do today)
5. Attract good candidates from all over the world
6. Be a stimulating academic environment as well as a good social environment
7. Improve the gender balance among the more senior scientists at CEES.
6. To maintain a strong scientific leadership
7. To maintain a strong administrative support unit close to the researchers.

Specifically, our goal is for CEES to continue as an umbrella organisation – to accomplish this we aim to:

1. Develop the multidisciplinary Centre for Computational Inference in Evolutionary Life Science (CELS – a “endringsmiljø”) to a CoE
2. Develop a CoE on epidemic diseases with an environmental reservoir
3. Partner with the Institute of Marine Research (IMR) and the University of Agder (UiA) to establish a CoE on marine ecology and evolution
4. Further develop our Nordic and European funding platform
5. Develop a research school within the field of ecology and evolution.

Our strategy to reach these goals is:

1. To continue as a section within the department beyond 2017 (and thereby capitalise on the trademark CEES has become)
2. To contribute to teaching at all levels within our focal fields
3. To transfer our non-permanent personnel into permanent positions (either on internal department funding or on external funding)
4. To maintain excellent laboratory facilities (including sequencing facilities and the ancient DNA laboratory)
5. To have senior members mentor younger members to become excellent project leaders

In order to achieve these aims we need to have the support of the department, as well as on the above levels.

Congratulations to our award recipients. I would like to congratulate those members of CEES who distinguished themselves in 2014 as award recipients, and to certain individuals in particular who stood out. Kristina Ø. Kvile won the “Best Poster Award” at the PhD Day, arranged by the university’s Faculty of Mathematics and Natural Sciences. Co-authors Esben M. Olsen and Halvor Knutsen won the 2014 award for best paper at the Institute of Marine Research (Even Moland *et al.* Proc. R. Soc. B, 2013). Last, but not least, eight CEES researchers were authors on two papers that were acknowledged as being among the best IBV papers published in 2014: Ola T. Westengen, Siri Birkeland, Siri D. K. Khalsa, and Anne K. Brysting (Westengen *et al.* PNAS), and Cassandra N.

Trier, Jo S. Hermansen , Glenn-Peter Sætre and Richard I. Bailey (Trier & Hermansen *et al.* PLoS Genetics). Congratulations to all of you on your accomplishments.

Thanks. I would like to thank Sissel Jentoft for being an excellent Deputy Chair, helping me make CEES an excellent place to work on bringing ecology, classical evolutionary biology and genomics together. 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.

Nils Chr. Stenseth



Chair Nils Chr. Stenseth © Eva C. Simensen.



A European herring gull (*Larus argentatus*) with its single chick on the island Grønningen, Norway. © Julia M. I. Barth.

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

The Centre is run on a daily basis by the Chair, the Deputy Chair and the CEES administrative team. Running and strategic issues are dealt with at weekly meetings. The Chair and Deputy Chair communicate on a daily basis regarding scientific progress within the Centre. 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, 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 budget and accounting, coordinating funding proposals and reporting (RCN, EU and other), employment, and facilitating a good reception and stay for the CEES guest researchers. 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, the RCN and the media goes through the CEES administration.

Chair	Nils Chr. Stenseth, Professor
Deputy Chair	Sissel Jentoft, Researcher and Project Coordinator
Administrative team	Gry Gundersen, Senior Adviser Kari B. Rygg, Senior Adviser Tore Wallem, Adviser Delphine C. Nicolas, Senior Executive Officer Camilla S. Thomsen, Higher Executive Officer Alexander E. Egidius, Executive Officer
Lab Board	Anne 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 CEES has a flat organisational structure where the responsibilities are divided among the persons in the administrative team. For instance, Human Resources is Gry Gundersen's responsibility, while CEES finances and budgeting are Kari B. Rygg's responsibility. Thus, each member of the administrative team has the primary responsibility for selected tasks, and all members of the administrative team contribute towards tasks associated with the daily running of the Centre. This organisational model functions very well, due to the high level of competence among the administrative staff and their frequent interaction with the Chair and Deputy Chair at CEES.

The CEES Core consists of the faculty members that have committed to allocating their research time to the Centre. The Core serves as an advisory group for the Chair. Core members are responsible for the scientific progress within their respective *Themes/Colloquia*.

The formal administrative support required for students (from the Bachelor's to the PhD level) and the general IT support is provided by the Department of Biosciences.



The University of Oslo's annual cycling day. From left to right: Kyrre Grøtan and Kjetil Bråthen from the IBV administration, and Kari B. Rygg, Camilla S. Thomsen, Gry Gundersen and Tore Wallem from the CEES administration.

2 MANAGEMENT AND ADMINISTRATION

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 2014, on 20 March and on 27 November. The agendas included economy reports, reports on applications and funding, and discussions on strategic issues like the continuation of CEES activities past 2017.

As revealed by the economy reports, the Centre's economy is sound and well managed, and the long-term budget indicates a satisfactory economy also for the years to come. Nevertheless, continued work on 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. In 2014, a total of about 40 grant applications were sent to the Research Council of Norway (RCN), the European Research Council (ERC), and other funding agencies.

The Board has also observed that the Centre maintains a high level of activity with various seminars, conferences and scientific meetings. An impressive number of foreign guests have visited the Centre, and additionally, the annual Darwin Day event and the Kristine Bonnevie lectures have been well organised and well attended.

The Board has noted the remarks and suggestions of the Scientific Advisory Board (SAB). In general, the SAB describes the professional development as very satisfactory. The SAB also points to areas where continued attention is necessary, including the importance of educating next-generation key scientific investigators. Not least, the potential of the talented young women researchers at CEES should be creatively utilised.

A very significant event last year was the establishment of the ancient DNA laboratory with the potential to reveal evolutionary histories, including those of pathogenic bacteria such as *Yersinia pestis*. As the SAB points out, this opens up opportunities for further strengthening evolutionary research and also the important synthesis of ecology and evolution that is underway at CEES.

Other very important opportunities will emerge in the upcoming period, with the announced establishment of new CoEs. The Board is pleased to observe the preparations of new applications addressing very promising scientific questions.

The Board wants to congratulate all members of CEES and its management team with a very successful year.

Knut Liestøl

The CEES Scientific Advisory Board (SAB) has been appointed by the CEES Board. The SAB has an annual meeting, and gives invaluable feedback on the research carried out at CEES. In 2014, the SAB meeting was held in conjunction with the CEES Student Conference, 21–22 October.

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 Centre for Ecological and Evolutionary Synthesis (CEES) was established “to foster the concept of ecology as a driving force of evolution via selective pressures, with a corresponding influence of evolutionary changes on ecology”. This objective embraces the view articulated by G. Evelyn Hutchinson that the world is an ecological system within which evolution is at work. The establishment of CEES, therefore, was timely because ecological research has not always been integrated with evolution as fully as it should be. Since evolution often occurs rapidly and understanding the dynamics of ecological systems is enhanced by understanding the change in attributes of ecological components over space and time, integration and synthesis can induce a paradigm shift in both fields. The productivity and dynamism of CEES has grown significantly since its inception and this past year has, indeed, been highly successful.

Attendance of the SAB at the CEES Annual Student Conference at Holmen Fjordhotell, 21–22 October 2014, provided valuable insight into the range of research being

carried out at the Centre. The vibrant academic environment was obvious in the young researchers presenting their findings. The depth and breadth of research conducted by graduate students was exciting, including work on genomic signatures of divergence in birds and fascinating work on red queen dynamics. Most impressive was the increasing integration of the excellent genome sequencing facility into the entire range of the research groups, notably those focused on ecology are now including molecular aspects as well. The genome facility team deserves praise for pursuing their vision of greater synthesis between ecology and evolution by applying genomic technology to a set of research questions that encompasses birds, fish, plants, and microorganisms. The establishment of the ancient DNA laboratory is another shrewd strategic development and an area of promise for understanding evolutionary histories, notably the pathogenic bacteria as an initial focus. A striking feature of this conference was the high proportion of women students participating, in contrast to the paucity of senior women in CEES. Although CEES continues to mentor and support women scientists as they progress in their careers, the imbalance in the senior ranks suggests creative solutions are needed. It would be useful to

2 MANAGEMENT AND ADMINISTRATION

invite speakers who have explored the causes and consequences of the attrition of women in science. It would be useful, also, to increase the fraction of senior women affiliated with CEES.

Because CEES from its inception used as its foundation the expertise within relevant departments at the University of Oslo, supplemented by scientists from sister institutions and postdoctoral researchers recruited to projects within CEES, its research collaborations integrated ecology and evolution quickly from the beginning. An example is the ongoing research on the ecology and evolution of infectious diseases, which has been nicely integrated into CEES. Projects subsequently initiated by CEES have varied in their integrative nature, and the extent to which ecology and evolution have been integrated presents a challenge, as well as an opportunity for *Colloquium 4* and for the final three years of the 10-year span of CEES. The following recommendations are offered by the SAB for CEES to continue in its highly successful research work.

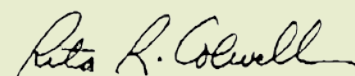
With respect to the sequencing facility and high volumes of genomic data being generated by the sequencing team and researchers, more resources should be channelled into the establishment of data management and archiving platforms. This will maximize utilization of data by CEES researchers, but also by the scientific community at large, immediately and far into the future. It is important, also, that CEES assess its overall contribution to its goal of enhancing understanding of both ecology and evolution through their integration. Assessment of what new insights and scientific frontiers to which CEES has contributed at the interface between ecology and evolution would be valuable at this stage of its successful research performance and education of future scientists. Additional topics for research over the remaining years should be identified, particularly at the interface of disciplines. Such an assessment would be extremely valuable, including the degree to which ecology and evolution have been integrated worldwide, the key questions relative to the synthesis of ecology and evolution that need to be asked, and what should be the contribution of CEES in providing answers. By integrating pathogen ecology and evolution, CEES has already taken the lead in framing a new and exciting agenda for the study of

pathogens, many of which have their natural reservoirs in other species, from which they transfer to humans. CEES has gathered extensive information about plague and has generated enough information about other pathogenic species to undertake a comparative assessment of what it has learned, and to provide direction for itself and others to follow for promising future research. This model could well apply to other projects underway within CEES.

Workshops might be a scientifically profitable activity to provide greater attention to the integration of ecology and evolution, particularly by including animal behavior where integration of ecology and evolution can be valuable. *Colloquium 4* could benefit by considering the investigation of paleoecological communities to advance understanding of interactions between ecology and evolution. Fossil communities (bryozoan and others) may well be useful in elucidating understanding interactions of ecology and evolution. The ancient DNA laboratory will certainly provide an important tool for investigating questions of evolution. In summary, CEES researchers have already made many significant contributions. Now is the time for CEES to devote effort to integrating these insights and to synthesize them into an overview that will stimulate future research and ensure its international leadership.

Advice and suggestions offered by the SAB previously have been heeded and changes have been made to accommodate those suggestions. It is clear that excellent synthesis of ecology and evolution is underway at CEES. It would be helpful over the next year to have some reflection on the synthesis contributions of the Centre. The conclusion of the SAB is that the research environment at CEES is highly positive and all members and affiliates of CEES and its management team are to be congratulated on a very successful year.

Written by the SAB Chair and members.



3 SCIENTIFIC ACTIVITY

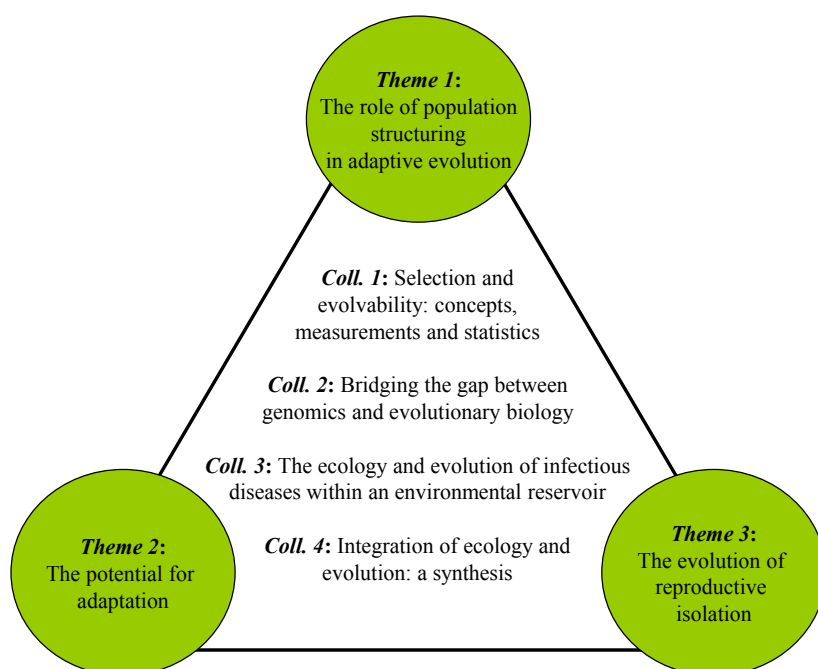
The synthesis

“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. The decision to establish a modern ancient DNA laboratory, to be officially opened April 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.

3 SCIENTIFIC ACTIVITY

Scientific highlights

2007–2014

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

Another highlight of our **marine research** is the study to determine whether genetic changes resulting from fishing pressure have significant economic effects (e.g. Eikeset *et al.* 2013 *PNAS*). We showed that for Atlantic cod, evolutionary changes allow the individual fish to grow faster and mature earlier, which increases stock productivity and revenue for the 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*).

Other highlights include empirical and theoretical molecular biology work exploring the molecular evolution, persistence, and distribution of disease pathogens (the main focus of *Colloquium 3*). An international collaboration on the dynamics of the plague bacterium (*Y. pestis*) – still a global health problem and potential bioterrorism threat – has been established.

Colloquium 4, focusing on the Red Queen type of co- and macroevolution, progresses well. This is to be the pinnacle of the centre, linking ecological and evolutionary thinking conceptually closer together than typically seen in the literature today.

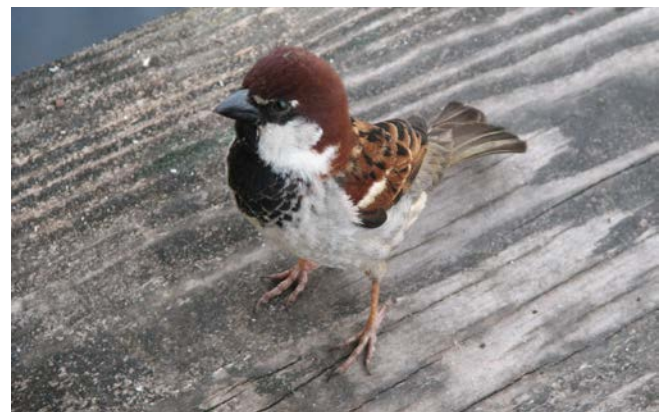
Scientific highlights in 2014

The evolution of reproductive isolation during hybrid speciation

Natural hybridization is currently receiving much attention in evolutionary biology. Aided by novel sequencing technologies, researchers are discovering that a great number of sexually reproducing taxa previously thought to be good biological species¹ exhibit genetic signals of admixture, and that the levels of gene exchange in natural systems are higher than previously appreciated. Even our own species has been shown to harbour a complex reticulate history involving several admixture events with archaic humans, including the Neanderthals whose genetic material some of us still carry with us today.

Among the more spectacular outcomes of natural hybridization is hybrid speciation. During this process a novel taxon arises through interbreeding between existing taxa, and develops reproductive barriers against them. Though recognised as a potentially vital contributor to biological diversification, questions regarding how reproductive isolation can develop during this mode of speciation and whether “special” and possibly unlikely circumstances are required, have made its evolutionary importance unclear.

In two recent papers published in *PLoS Genetics* (Trier & Hermansen *et al.* 2014) and *Molecular Ecology* (Hermansen *et al.* 2014), CEES researchers have shed important light on this problem. By means of genetic analyses they have shown that the hybrid Italian sparrow (*Passer italiae*) is reproductively isolated from its parent species, the house sparrow (*Passer domesticus*)



Male Italian sparrow, photographed by former CEES MSc student Elin Hjelle. © Elin Hjelle.



The Sparrow Group conducting fieldwork at the Chokpak ringing station, Kazakhstan. Here they are catching a flock of migrating *Passer domesticus bactrianus*. © Tore O. Elgvin.

and the Spanish sparrow (*Passer hispaniolensis*), through the sorting of preexisting genetic incompatibilities in the form of sex-linked and mito-nuclear incompatibilities. In short, a subset of the incompatibilities that separate the parent species from each other has become sorted in the hybrid genome in such a way that they act as reproductive barriers against the house sparrow, while another subset is acting as reproductive barriers against the Spanish sparrow.

This is the first time post-zygotic barriers in the form of genetic incompatibilities have been shown to isolate a hybrid taxon. The studies therefore show that hybrid speciation may be driven by mechanisms similar to those involved in non-hybrid speciation, but with the formation of two geographically separated species boundaries instead of one. Hence, hybrid speciation can occur without the need of invoking “special” processes, and may therefore be more important for the diversification of life on earth than has previously been thought.

Interestingly, the findings presented in the two papers suggest that the mito-nuclear incompatibilities that contribute to isolation between the hybrid taxon and one of its parents, as well as between the parent species, result from genomic conflict in the form of the so-called ‘mother’s curse’. ‘Mother’s curse’ is the phenomenon that female beneficial mutations in mitochondria that

are harmful to males can spread due to the maternal inheritance of mitochondria. This sets up a selective sieve that allows for the build-up of male-detrimental mutations, which in turn selects for suppressor alleles that restore male fitness. Mismatches between mitochondrial alleles and nuclear suppressor alleles lead to detrimental effects in hybrids whose parents differ in mito-nuclear system. In female-heterogametic taxa (ZZ/ZW), Z-linked genes spend two-thirds of their time in the male lineage, and suppressor alleles are therefore expected to be disproportionately situated on the Z chromosome. Such an overrepresentation of Z-linked genes with mitochondrial function among the candidate reproductive isolation loci shifting alongside the mitochondria at species range boundaries is exactly what the CEES researchers have found. As such, in addition to adding to our understanding of hybrid speciation, these papers also add to our understanding of reproductive isolation in general as they are the first to empirically indicate a direct role for ‘mother’s curse’ in the origin of any species, hybrid or not.

Phenotypic variation and species interactions in a hybrid species complex

One of the most famous examples of adaptive radiations, the case of Darwin’s finches (*Geospiza*), has long fascinated biologists. In particular, the pronounced diversity in beak morphology of the different species

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that occupy the Galapagos archipelago and its role in species interactions, via competition and hybridization, confirm the functional versatility and evolutionary significance of the avian beak.

Previously, in a paper published in *Heredity* (Eroukhmanoff *et al.* 2013), CEES researchers similarly emphasised the importance of beak morphology in local adaptation to environmental pressures in the Italian sparrow. Beak dimensions covary strongly with precipitation regimes. However, little was known about the role of beak morphology in the context of species interactions in this hybrid species complex. In a recent paper published in *Evolutionary Biology* (Eroukhmanoff *et al.* 2014), CEES researchers show that, in two different contact zones, one between the hybrid Italian sparrow and one of its parent species, the Spanish sparrow, and one between the two parent species, the architecture of beak morphology changes in sympatry in both the parent and the hybrid species. Phenotypic integration between beak dimensions decreases significantly where two species co-occur. Hence, these beak dimensions may effectively be able to respond in an independent fashion to different selective pressures and allow for rapid changes in overall shape of the beak in sympatry.

Although beak integration is generally conserved across species, interactions between closely related species can apparently lead to a redistribution of variation between beak dimensions relative to allopatric populations of the same species. Such a flexible architecture of beak morphology may promote the coexistence of these species when they overlap geographically, through divergence in beak shape that reduces niche overlap and hence competition.

Summarised by Jo Skeie Hermansen and Fabrice Eroukhmanoff.

Further reading:

Eroukhmanoff, F., Hermansen, J. S., Bailey, R. I., Sæther, S. A., Sætre, G.-P. (2013) Local adaptation within a hybrid species. *Heredity*, 111 (4), 286–292.

Eroukhmanoff, F., Elgvin, T. O., Rojas, M. F. G., Haas, F., Hermansen, J. S., Sætre, G.-P. (2014) Effects of species interactions on beak integration in an avian hybrid species complex. *Evolutionary Biology*, 41 (3), 452–458.

Hermansen, J. S., Haas, F., Trier, C. N., Bailey, R. I., Nedderbragt A. J., Marzal, A., Sætre, G.-P. (2014) Hybrid speciation through sorting of parental incompatibilities in Italian sparrows. *Molecular Ecology*, 23 (23), 5831–5842.

Trier, C. N*, Hermansen J. S*, Sætre, G.-P., Bailey, R. I. (2014) Evidence of mito-nuclear and sex-linked reproductive barriers between the hybrid Italian sparrow and its parent species. *PLoS Genetics*, 10 (1), doi: 10.1371/journal.pgen.1004075. *Shared first authors.



GENETICS

Origins of Sparrow Speciation

Homoploid hybrid speciation is the result of hybridization between two parental species without a change in chromosome number. Such speciation is relatively rare, however, because it requires the rapid establishment of reproductive isolation of the new species from that of its parents. Trier *et al.* examine the origins of the Italian sparrow, which originated as a result of hybridization between the house and Spanish sparrows. Transcriptome analysis of the parental sparrows identified 86 species-specific SNPs. This allowed tracing of the genetic ancestry within the Italian sparrow and identified some ongoing, but limited, gene flow between the parental species and the Italian sparrow. Mosaic ancestry of the Italian sparrow sex chromosomes was evidenced by a cline analysis framework. This identified ancestry of both house and Spanish sparrow sex chromosome-linked loci that exhibited allele frequency shifts. Mitochondrial and nuclear encoded mitochondrial genes exhibited similar divergences. These results suggest that mito-nuclear interactions may also be a factor in isolating the Italian sparrows from their parental species and that reproductive isolation may be evolving as a result of mito-sex chromosome interactions. — LMZ

PLoS Genet. 10, e1004075 (2014).

BIOMATERIALS

The Heart of the Matter

A common problem after a serious wound or injury is the formation of scar tissue that prevents the full restoration of functionality. Scarring can occur rapidly, so there is a need for a quick and easy way to deliver protective materials to damaged tissues. After myocardial infarction (MI), otherwise known as a heart attack, there is an expansion of the infarct site in the left ventricle (LV) that is caused by the healing process. A key component of this adverse LV remodeling is the family of extracellular proteases known as the matrix metalloproteinases (MMPs), which are regulated by the presence of tissue inhibitors of MMPs (TIMPs). In an effort to modulate the balance of MMPs and TIMPs to prevent LV expansion after MI, Eckhouse *et al.* developed an injectable degradable hydrogel based on hyaluronic acid that was loaded with recombinant TIMP-3. Using a porcine model, which has a similar coronary anatomy to humans, the hydrogel was locally injected into the heart after MI. After 7 days, TIMP-3 was specifically localized to the injection sites. More importantly, in comparison to the control animals, the gel-injected pigs showed a reduction in the infarct size, improved remodeling of the LV, and increased cardiac function. — MSL

Sci. Transl. Med. 6, 223ra21 (2014).

ENGINEERING

Spore Work Pays Off

The presence or absence of water on a surface or surrounding a cell can have a strong influence on its mechanical properties. This response to water gradients is useful in applications such as microfluidics or for transpiration in plants, but in principle can also generate work that might be harvested as electrical power. Chen *et al.* show



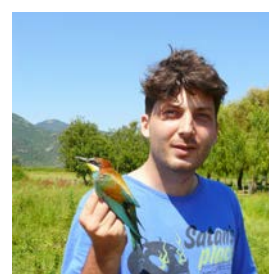
to recruit neutrophils and helper macrophages. Helper macrophages did not directly combat bacteria like neutrophils, but did produce the cytokine tumor necrosis factor as a "helper signal," which allowed the sentinel macrophages to produce the chemokine CXCL2. CXCL2 in turn induced the secretion of matrix metalloproteinase-9, which allowed neutrophils to enter the uroepithelium to combat the bacteria. Thus, the antibacterial phagocyte response is not simply a disorganized tissue invasion of neutrophils and macrophages that clear the bacteria by eating them, but instead a highly coordinated process involving the exchange of information between three phagocyte subsets with distinct immunological tasks. — SMH

Cell 156, 456 (2014).

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Trier & Hermansen *et al.* in *PLoS Genetics* was the "Editor's Choice" in *Science* 21 Feb. 2014.



Fabrice Eroukhmanoff



Jo Skeie Hermansen

Weather, space use and harvesting of red deer

Most cervid¹ populations in Europe and North America are managed through some form of selective harvesting, which has a large influence on the population growth rate. Management actions such as age- and sex-specific quotas give rise to most of the selectivity, but hunter preferences also play a role. In addition, harvesting selectivity may arise indirectly, i.e. through animal behaviour, where the differential use of open and closed habitats can make the animals more or less prone to being harvested. As the different sexes and age groups are expected to behave differently, the differential movement patterns can give rise to variation in their associated probabilities of being harvested. Open habitats such as farmland are more exposed to harsh weather, and periods of heavy precipitation or low temperatures can cause cervids to seek cover in closed habitats and thus utilise open habitat to a lesser extent. For hunters, periods of extreme cold or heavy precipitation can constitute less attractive hunting weather than warmer and drier conditions. Moonlight is also known to influence hunting success in predator-prey interactions, and may also affect harvesting vulnerability in cervids, as well as hunter effort through increased invisibility. However, how prevailing weather affects harvesting selectivity and off-take indirectly through changes in individual animal and hunter behaviour has received little attention in the literature.

We used harvest data from red deer (*Cervus elaphus*) to investigate how weather and habitat characteristics affect behavioural decisions of animals and their hunters throughout the hunting season. More specifically, we looked at how sex and age class, temperature, precipitation, moon phase and day of week affect the probability of being harvested on farmland (open habitat), hunter effort, and the overall harvest numbers.

In general, the effect of fall weather conditions and habitat characteristics on hunter effort and harvest numbers varied through the season. I.e., the effect of temperature on total harvest numbers was negative mid- and late-season, with no effect early in the season. We also found higher harvest numbers (figure 1) and hunter effort during the full moon late in the season, as well as a consistently higher hunter effort during weekends than on weekdays (figure 2). Yearlings showed the highest variation in the probability of being harvested on farmland through the season, and the results were similar for both males and females.

This study is among the first to highlight that weather may affect harvesting patterns and off-take indirectly through animal and hunter behaviour. The interaction effects of weather and space use on hunter behaviour

are complicated, yet nevertheless seem less important than hunter preference and quotas in determining hunter selection and harvest off-take. We argue that taking into consideration the variation in hunter behaviour is important when forming management rules for sustainable harvesting.



Two young red deer males in Surnadal, Møre og Romsdal, Norway. © Erling L. Meisingset.

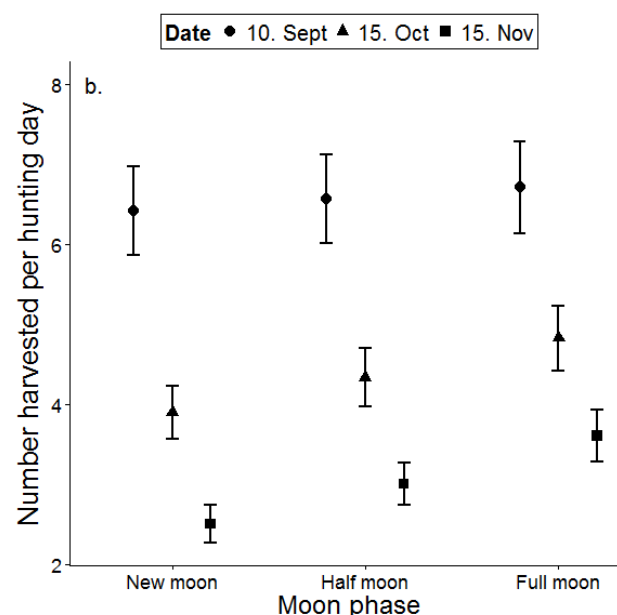


Figure 1: The total daily harvest numbers of red deer through the hunting season \pm SE, for three different moon phases (Rivrud et al. 2014).

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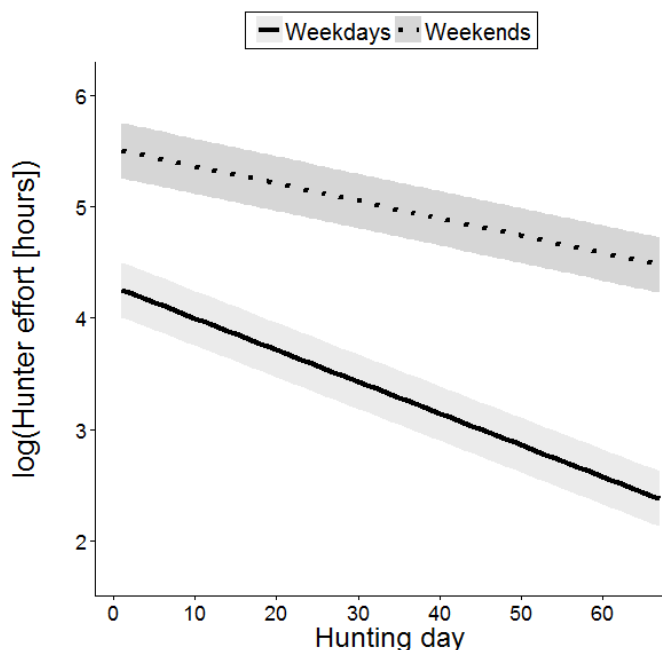


Figure 2: The total daily hunter effort (log of number of hunters participating in a reported hunting session times the length of the hunting bout in hours) \pm SE, for day of week (solid line: Monday-Friday; dotted line: Saturday-Sunday) through the hunting season (Rivrud *et al.* 2014).

Summarised by Inger Maren Rivrud and Atle Mysterud.

Further reading:

Rivrud, I. M., Meisingset, E. L., Loe, L. E., and Mysterud, A. (2014) Interaction effects between weather and space use on harvesting effort and patterns in red deer. *Ecology and Evolution*, 4 (24), 4786–4797.



Atle Mysterud



Inger Maren Rivrud

Climate warming could lead to more intermediate-sized pike

Freshwater ecosystems are particularly vulnerable to climate change, because of the high pressure from other human activities and because freshwater species have limited possibilities to adjust by migration. Temperate Northern lakes have shown a warming trend over the last decades, and climate models project a continued increase in average temperatures. Pike (*Esox lucius*) is a large top predator in freshwater ecosystems across the Northern hemisphere, and is considered a keystone species in these ecosystems. We have investigated the population dynamical and life history responses to climate warming in a pike population from the lake Windermere, UK (Vindenes *et al.* 2014). The data set is unique both in quantity and quality, as individual life history data are available since the 1940s for thousands of individuals, together with important abiotic variables such as the surface temperature of the lake.

In the absence of migration, individual processes of survival and reproduction determine population growth. As in many aquatic species, for pike these processes are largely determined by body size, although other factors such as temperature can also be important. In general, “bigger is better” for pike: large individuals tend to have a higher survival, being less prone to predation and aggression, and large females have a higher fecundity because egg number is limited by body size.

To understand how individual-level processes of growth, survival, and fecundity shape the population dynamics and size structure, as well as their responses to warming, we developed and analysed an integral projection model (IPM), a flexible demographic model framework. Using regression we estimated the four main vital rates (survival, growth, fecundity, and offspring size) as functions of body length and temperature. From the resulting model we calculated the long-term population growth rate (a measure of average fitness), the stable size structure, and other parameters as functions of temperature. We then decomposed the thermal sensitivity of the population growth rate into contributions from each of the four vital rates across body size, to reveal underlying mechanisms.

Although the mean population growth rate was predicted to increase with warming, the decomposition of its thermal sensitivity revealed complex and opposite responses through each underlying vital rate across body length (figure 1). Medium-sized pike were overall negatively affected by warming, because positive effects through growth and offspring size were overwhelmed by a negative effect through survival. In small pike, the

overall effect was positive through survival and growth. In large pike the overall effect was also positive, but in this case because negative effects of warming through survival and growth were overwhelmed by positive effects through fecundity and offspring size. The body size distribution in the population was also expected to shift with warming, towards relatively fewer large and small pike, and more intermediate-sized pike (figure 2). This happens due to a positive effect of temperature on early growth that increases the numbers of intermediate-sized pike, together with a negative effect on survival and growth in the largest pike.

This study shows that although the overall population response to climate change may be positive, the underlying mechanisms can be complex, and many individuals may still respond negatively. Demographic modelling is a useful tool to understand the underlying mechanisms to population responses, yielding important knowledge to conservation and management. This study has been followed up by further work, expanding the model to include individual heterogeneity in somatic growth and survival (Vindenes & Langangen 2015), and to evaluate the relative importance of maternal and cohort effects in early life history on population dynamics and fitness.

Summarised by Yngvild Vindenes.

Further reading:

Vindenes, Y., Edeline, E., Ohlberger, J., Langangen, Ø., Winfield, I. J., Stenseth, N. C., Vøllestad, L. A. (2014) Effects of climate change on trait-based dynamics of a top predator in freshwater ecosystems. *American Naturalist*, 183, 243–256.

Vindenes, Y., Langangen, Ø. (2015) Individual heterogeneity in life histories and eco-evolutionary dynamics. *Ecology Letters*, doi: 10.1111/ele.12421.



Windermere, home of the pike study population.
© Ian J. Winfield.



Illustration of the study species, pike (*Esox lucius*). © U.S. Fish and Wildlife Service, Timothy Knepp.

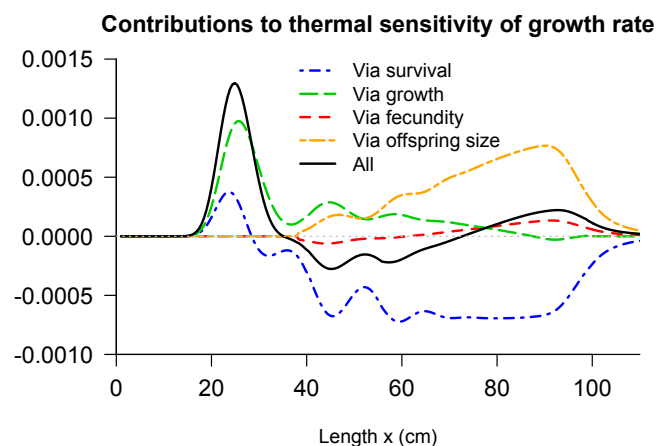


Figure 1: Decomposition of the thermal sensitivity of the mean population growth rate into contributions from each of the four main vital rates, as a function of body length (black line shows the total sensitivity). Modified from Vindenes et al. 2014.

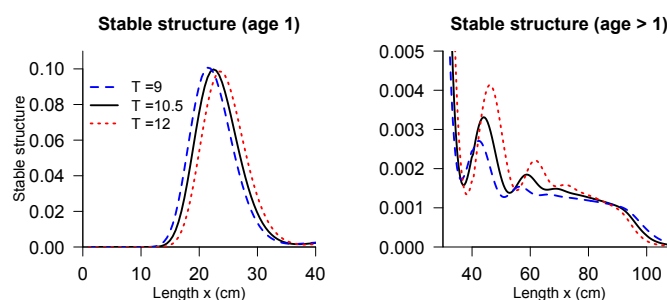


Figure 2: Shift in the stable size distribution of pike with temperature. The left panel corresponds to age 1 (offspring), while the right panel corresponds to older ages. Modified from Vindenes et al. 2014.



Yngvild Vindenes

3 SCIENTIFIC ACTIVITY

Ancient DNA analysis of highly exploited Atlantic cod populations

Ancient genomics, whereby whole genome sequence data are obtained from historical biological material, can provide a unique snapshot of past genetic variation. Such data can be used to detect signatures of natural selection, allowing an improved understanding of the processes that underlie genetic adaptation in wild populations. We have formed an international collaboration with the Institute of Marine Research (Norway), Fisheries and Oceans (Canada), and the Marine Research Institute (Iceland) to investigate the potential of natural selection in highly exploited Atlantic cod populations using ancient DNA (aDNA) samples (e.g. figure 1) of up to 100 years old.

Working with aDNA samples is not always straightforward. For instance, it is well recognised that systematic sequence bias in aDNA data can be introduced due to laboratory protocols and postmortem degradation. Postmortem degradation leads to cytosine deamination and increased fragmentation at purine positions, and choice of polymerase affects GC content and fragment length. Additionally, specific ligation protocols select against DNA fragments that start with a thymine residue, and can promote hairpin formation leading to palindromic sequence artifacts (Star *et al.* 2014). Nevertheless, species-specific genome architecture is not often considered to affect aDNA data.

We observed an unusually high proportion of simple AC and AG microsatellite dinucleotide repeats when analysing Atlantic cod aDNA data from samples over 70 years old, with up to 40% of all bases solely consisting of repeats (Star *et al.* 2014). These microsatellites are problematic as they lead to reduced alignment success and decrease the economy of sequencing aDNA samples. We investigated the natural abundance of these specific re-



Figure 1: Historic specimen of a juvenile Atlantic cod (*Gadus morhua*).

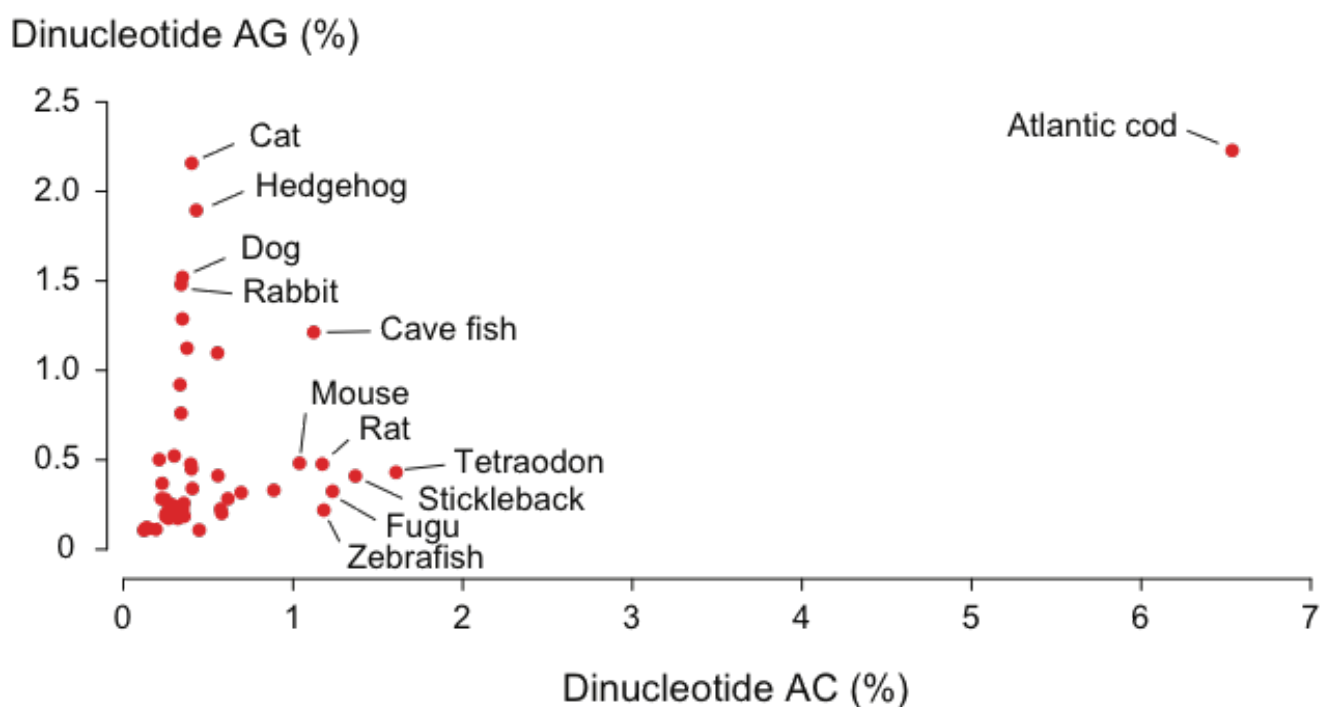


Figure 2: Dinucleotide repeat content in vertebrate assemblies. The amount of AC and AG dinucleotide repeats was obtained using Tandem Repeat Finder (TRF, version 407b) in 63 vertebrate genome assemblies (Ensembl, release 76). Estimates were divided by total assembly size, excluding undetermined bases. Assemblies with more extreme repeat content are indicated. (Star *et al.* submitted).

peats in the Atlantic cod genome (Star *et al.* 2011) and found that it contains an order of magnitude more (nearly 9%) of these repeats than other species (figure 2). We therefore wondered if this high endogenous repeat content was causal for its overrepresentation in the aDNA sequencing data. In a recent paper (Star *et al.* submitted), we show that amplification conditions strongly influence the relative proportion of these types of repeats. Moreover, the proportion of these repeats can be altered through the inclusion of artificially made repetitive oligonucleotides during the amplification of WGS libraries generated from aDNA samples. Based on these results, we propose that self-priming of short, fragmented repeats is the predominant process leading to the preferential amplification of AC and AG repeats. Our data provide a fundamental observation that the specific genome architecture of a particular species – in this case Atlantic cod – interferes with a widely used aDNA library preparation protocol.

Summarised by Bastiaan Star.

Further reading:

Star, B., Hansen, M. H. S., Skage, M., Bradbury, I. R., Gødiksen, J. A., Kjesbu, O. S., Jentoft, S. High endogenous levels of microsatellite DNA promote self-priming during next generation sequencing library creation of ancient DNA. In review for *Molecular Biology and Evolution*.

Star, B., Nederbragt, A. J., Hansen, M. H. S., Skage, M., Gilfillan, G. D., Bradbury I. R., Pampoulie, C., Stenseth, N. C., Jakobsen K. S., Jentoft, S. (2014) Palindromic sequence artifacts generated during next generation sequencing library preparation from historic and ancient DNA. *PLoS ONE*, 9 (3), doi: 10.1371/journal.pone.0089676.

Star, B., Nederbragt, A. J., Jentoft, S., Grimholt, U., Malmstrøm, M., Gregers, T. F., Rounge, T. B., Paulsen, J., Solbakken, M. H., Sharma, A., Wetten, O. F., Lanzén, A., Winer, R., Knight, J., Vogel, J.-H., Aken, B., Andersen, Ø., Lagesen, K., Tooming-Klunderud, A., Edvardsen, R. B., Tina, K. G., Espelund, M., Nepal, C., Previti, C., Karlsen, B. O., Moum, T., Skage, M., Berg, P. R., Gjøen, T., Kuhl, H., Thorsen, J., Malde, K., Reinhardt, R., Du, L., Johansen, S. D., Searle, S., Lien, S., Nilsen, F., Jonassen, I., Omholt, S. W., Stenseth, N. C., Jakobsen, K. S. (2011) The genome sequence of Atlantic cod reveals a unique immune system. *Nature*, 477, 207–210.



Bastiaan Star

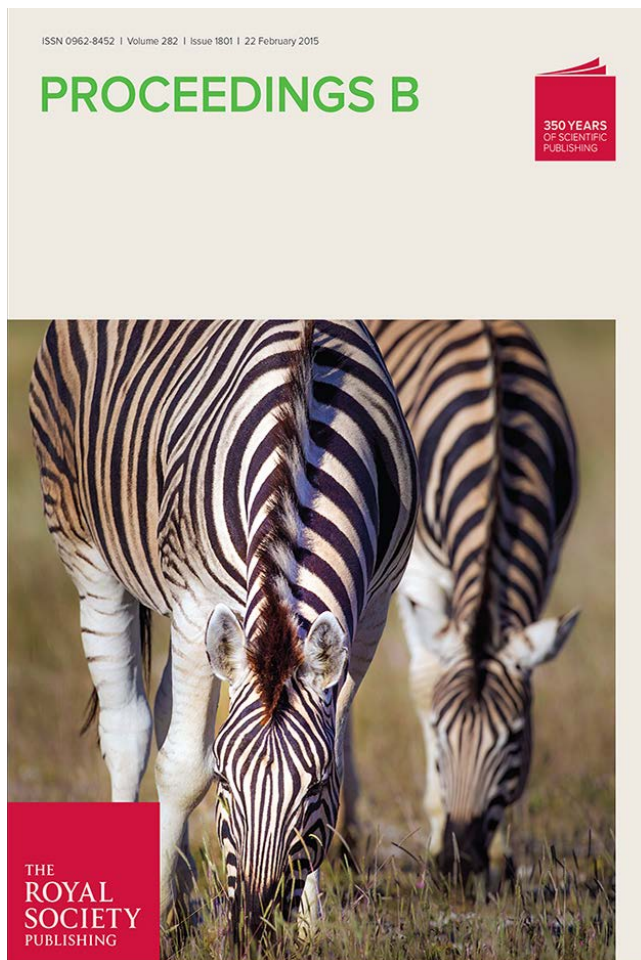
Anthrax transmission in grazing wildlife

Animal carcasses can alter the local environment, creating nutrient hotspots that persist for several years, improving soil fertility and vegetation quality. Though carcass effects have been noted in several ecosystems, no studies had yet assessed how herbivores respond to these nutrient hotspots. Understanding herbivore responses to carcass sites is important: in cases where the animal died of an infectious disease, these sites may serve as pathogen reservoirs for future transmission events. At carcass-generated nutrient hotspots, foraging herbivores thus face a trade-off between increased nutrient intake and a risk of exposure to pathogens in the environment. Avoidance of or attraction to carcass sites, and the relative time scales of these behaviours, could strongly influence pathogen transmission rates.

We evaluated how this trade-off may influence disease transmission in a three-year experimental study of anthrax in a guild of mammalian herbivores in Etosha National Park, Namibia. Anthrax is a highly lethal disease caused by the bacterium *Bacillus anthracis*, a spore-forming microbe that can persist for years in the environment. At plains zebra (*Equus quagga*) carcass sites we assessed the effect and duration of 1) carcass nutrient on soils and grasses, 2) concentrations of *B. anthracis* on grasses and in soils, and 3) herbivore grazing behaviour, compared with grassland control sites, using motion-sensing camera traps.

Despite the hypothesised importance of grazing in *B. anthracis* transmission, this was the first study to examine levels of *B. anthracis* contamination on grasses in the environment. We found that the above ground component of grasses holds *B. anthracis* spores, and one year after death, the concentrations on grasses were as high as in soil. However, although spore concentrations remained high in soil and on grass roots over the three years of study, concentrations on grasses above ground

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Turner et al. was highlighted on the front cover of *Proceedings of the Royal Society B* (22 Feb. 2015). The photograph of the plains zebras (*Equus quagga*) grazing in Etosha National Park, Namibia, was taken by Yathin S. Krishnappa.

quickly dropped off after the first year. This indicates that herbivores can be exposed to relatively high concentrations of *B. anthracis* from grazing at carcass sites in the first year, when nutrient-rich vegetation has regenerated. If herbivores consume grass roots, as well as above ground components when grazing, they can also be exposed to high *B. anthracis* concentrations beyond the first year. This opens the door to species-specific and seasonal differences in exposure to *B. anthracis* based on foraging ecology.

Carcasses positively altered the environment in ways that were attractive to some, but not all herbivore species. There were signs of early avoidance of carcass nutrient patches after death in all species, the length of which

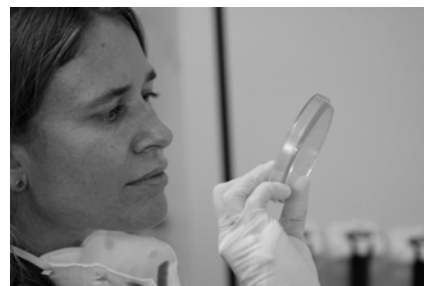
is likely to depend upon when the first rainfall, and thus plant regrowth, occurs relative to the time of death. Host foraging responses to carcass sites shifted from avoidance to attraction, and ultimately to no preference, with the strength and duration of these behavioural responses varying among herbivore species. Plains zebra, the species most commonly found dead of anthrax, exhibited the strongest attraction to carcass sites, where individuals were up to four times as likely to graze at a carcass site than a control site.

The time scales of peak site infectivity and attractiveness coincide in the first year after death – evidence that selective foraging may be particularly important in sustaining *B. anthracis* transmission in endemic anthrax areas. The initial avoidance period may be sufficient to reduce contact with pathogens that only persist for short times in the environment. However, for long-persisting disease agents, like *B. anthracis* or prions, the ability to survive beyond the initial period of carcass site avoidance may lead to more transmission events than would be expected by chance. These results demonstrate how host foraging ecology and behaviour can affect host-parasite contacts and, ultimately, transmission of environmental parasites in a multi-host natural disease system.

Summarised by Wendy Turner.

Further reading:

Turner, W. C., Kausrud, K. L., Krishnappa, Y. S., Cromsigt, J. P. G. M., Ganz, H. H., Mapaire, I., Cloete, C. C., Havarua, Z., Küsters, M., Getz, W. M., Stenseth, N. C. (2014) Fatal attraction: vegetation responses to nutrient inputs attract herbivores to infectious anthrax carcass sites. *Proceedings of the Royal Society B*, 281, doi: 10.1098/rspb.2014.1785.



Wendy Turner.
© W. Ryan Easterday



Jinshanling, China. CEES has an increasing co-operation with China on plague. © Julia M. I. Barth.

3 SCIENTIFIC ACTIVITY



Nordic Centre for Research on Marine Ecosystems and Resources under Climate Change A Nordic Centre of Excellence.

NorMER is a Nordic Centre of Excellence that brings together the expertise of leading research groups from all Nordic countries, and several North American institutions, to implement a collective and multidisciplinary research strategy to explore the biological, economic, and management consequences of global climate change on fisheries resources. It will achieve this through a unique program of primary research, implemented by PhDs and postdocs in a system of collaborative projects, with focus on the Atlantic cod (*Gadus morhua*). Though our Nordic focus is on cod, this research is intended to be a platform to extend this knowledge to other marine systems.

The aims and corresponding actions of NorMER are:

- 1. Perform effect studies to: 1) evaluate climate effects on Nordic marine ecosystems, 2) build new tools for predicting biological consequences of climate change, and 3) quantify impacts on profit, employment, and harvesting.**

Actions: PhDs are co-supervised internationally, and postdocs collaborate internationally. Leading senior scientists and climate researchers provide expert input.

- 2. Create an effective training environment for young researchers.**

Actions: Annual meetings, graduate courses, and special workshops focus on transferable and interdisciplinary skills. Regular interaction between students and international experts in climate- and marine ecosystem-related fields further strengthen NorMER's training program.

- 3. Develop a team of outstanding global quality.**

Actions: Research institutions from every Nordic country are partners. International researchers and industry representatives are invited to annual meetings. A 7-member Centre Advisory

Panel (CAP), consisting of an interdisciplinary mix of globally leading researchers participate at all annual meetings. Annually, one internationally distinguished researcher is selected as the honoured Johan Hjørt Chair to participate at the annual meeting to share expertise with NorMER partners and students.

- 4. Link to industry and policy managers.**

Actions: Industry and Policy representatives from each of the Nordic countries are encouraged to attend annual meetings for discussing societal/economic effects of climate change, and to learn more about NorMER work. PhD students will be encouraged to visit marine industries or participate in commercial fishing. A strong bio-economic focus within NorMER will facilitate transference of results to fisheries managers.

- 5. Update marine ecosystem management policies to sustain healthy fisheries.**

Actions: NorMER is a research based program to evaluate the effects of climate variability on marine ecosystems and how fisheries management can be adapted to maintain sustainable harvest levels. We hope to produce strong results, built on solid fundamental science, that will be applied to real systems in the Nordic region.

NorMER is primarily supported with funding from Nordforsk, on behalf of the Top-level Research Initiative (TRI), and from each of the main partners.

NorMER is administered by CEES.
Website: normer.uio.no.



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

GreenMAR is a project funded by NordForsk that studies the complexities of the marine systems in the Nordic region using multiple interacting approaches. This region is host to some of the largest commercial fish stocks in the world. These fish stocks are not only important for coastal communities, but for the Nordic societies as a whole, and indeed on a global scale.

More specifically, GreenMAR investigates to what extent the ecological and social components of complex marine systems are capable of adapting to growing stress factors. Marine ecosystems are under particular pressure due to fishing and increased human activity, such as maritime transport, oil exploitation, and coastal development. Overfishing, habitat destruction, nitrification and freshwater run-off are just a few examples of man-made stress factors that act in concert with climate change and threaten the viability of our oceans. By furthering our understanding of these issues, GreenMAR seeks to provide corresponding management recommendations in order to improve harvesting strategies and ensure green growth. The fundamental challenge of green growth is to use renewable natural resources more efficiently, while ensuring that they retain their functionality.

In order to achieve its aims, GreenMAR relies on both multidisciplinary and interdisciplinary approaches. As an interdisciplinary Nordic research team, GreenMAR joins forces with researchers in the USA, Russia, and the Netherlands, along with one of the largest Nordic fishing companies. Climatologists and oceanographers provide state-of-the-art models on how climate affects sea surface temperature, ocean circulation and freshwater run-off. These models will be combined with large-scale ecological time-series to unravel ecological key mechanisms and detect critical thresholds. Sociologists will perform in-depth studies in order to quantify fishermen's knowledge about the marine system and ability to adapt to changes. 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.

GreenMAR is administered by CEES.

Website: greenmar.uio.no.

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 2014, CEES's permanent scientific staff contributed to the teaching of 3 Bachelor's courses and 7 Master's/PhD courses. 34 Master's students were supervised by CEES members, and 13 completed their degrees in 2014. 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 21–22 October at Holmen Fjordhotell with 143 delegates. For the first time, the CEES Scientific Advisory Board (SAB) was present at the conference. Including a few talks by senior scientists, 65 talks were given.

Journal clubs and discussion groups

CEES arranges several different journal clubs, e.g. the MaEcovo (on macroevolution, macroecology, comparative phylogenetics and paleobiology, 31 sessions in 2014), the Genomic Analyses Club (13 sessions), and the Speciation Journal Club (18 sessions). Participating students select relevant papers that focus on scientific challenges within the field of ecology and evolution. The journal



Master's student Luka Olsen collecting flower buds from Scurvygrass at Dyrhólaey in Iceland. Her talk at the Annual Student Conference was titled "Icelandic Cochlearia (Scurvy-grasses) – Arctic or European, or both?" © Anne K. Brysting.

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. There are three types of LLT: Regular (most common), PUB talks (a collection of recent CEES publications) and Concept Battle (an occasional exercise where basic concepts and buzz words in biology are scrutinised). 19 sessions were held in 2014.



Delegates at the Annual CEES Student Conference, Holmen Fjordhotell. © 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.

During the eight years that CEES has been running, we have had 121 researchers/postdocs as members of the Centre, and 37% of these have been women. Of 68 PhD positions, 44% have been held by women. We have continuously awarded scholarships for transitional engagements for young women, enabling the candidates to further their scientific careers. So far, 28 young women researchers have received such support from CEES, for periods ranging from 2 to 12 months. In 2014, Inger Maren Rivrud received 4.5 months of transitional funding. She thereafter managed to get a 3-year RCN funded researcher position at CEES.

Both the CEES Board and the Scientific Advisory Board are chaired by women scientists. The Deputy Chair is a woman, two of the three *Themes* are co-chaired by women scientists, and one of the four *Colloquia* will be chaired by a woman scientist.

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. In 2014,

CEES developed a big and ambitious proposal to be submitted to the NordForsk Programme; Nordic Centres of Excellence in Arctic Research. An excellent young woman researcher, Anne Maria Eikeset, was strategically chosen as the Principal Investigator of this prestigious project. The more natural choice would have been the Chair of CEES, Nils Chr. Stenseth, but he instead took on a mentoring role in this project. CEES has the greatest intention of being a breeding hub for young talents. We believe that in the future we will see more projects based on the “young talent + senior mentor” model.

In collaboration with CEES, the Department of Biosciences submitted a proposal to the UiO gender balance funds (“UiO sentrale likestillingsmidler”) in early 2014. The proposal was granted close to half a million NOK to perform several measures that we are looking forward to initiating in 2015. All women at the Department of Biosciences holding a PhD degree, but without a permanent position (this constitutes approx. 40 persons), will be offered 2 hours of career prospects guidance with a hired professional consultant in collaboration with different resource persons from the department. The intention is to identify the parts of their track record and CV that can be improved and then tailor a plan of action to reach strategic goals that will hopefully increase their competitiveness in obtaining research funds and positions. Some will find that they would profit from a research stay abroad, others that they need teaching or supervising experience, etc. Around 20 young women at CEES are in the target group for this action, and will thus be contacted in the beginning of 2015.



Three common copepod species found in the Barents Sea: The herbivorous *Calanus finmarchicus* and *C. hyperboreus*, and the predator *Paraeuchaeta*.



Egg-bearing copepod caught during fieldwork in the Barents Sea. © Kristina Ø. Kvile, PhD student at CEES and NorMER.

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 with 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 ninth 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 2014, the topic for Darwin Day (12 February) was "The major transitions in evolution: From the origin of life to the emergence of language", and featured lectures by Stefan Bengtson, Terrence W. Deacon, William F. Martin, Adam Rutherford, Nathan Sanders and Eörs Szathmáry. **The Kristine Bonnevie Lecture on Evolutionary Biology** (2 September) by Hopi Hoekstra from Harvard University



Hopi Hoekstra gave the The Kristine Bonnevie Lecture on Evolutionary Biology. Photo from oeb.harvard.edu.

was titled "Digging for genes that affect behavior". It was preceded by the lecture "On the relationship between science and philosophy" by Massimo Pigliucci from The City College of New York. Massimo Pigliucci also gave a lecture at the House of Literature, titled "Pseudoscience: Why Bother?"

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 2014, 34 such seminars were held.



Massimo Pigliucci and the audience at the House of Literature. © CEES.

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, contribute extensively towards communicating their research.

Social media

Scientists, academic organisations and research groups increasingly use social media to broadcast their work, and CEES is no exception. CEES has several active bloggers (see the list at www.mn.uio.no/cees/english/out-reach), and is active on Facebook (www.facebook.com/pages/CEES-Centre-for-Ecological-and-Evolutionary-Synthesis/295891987141021) and Twitter (username @CEESUiO). For an in-depth presentation of the use of social media by CEES members, see the 2013 report, page 32, written by Lex Nederbragt.



Master's student and blogger Ann Marie Evankow collecting samples in Bergen for a population genetic survey of kelp forests along the Norwegian coast. © Hildur Magnúsdóttir.



Speakers at Darwin Day 2014 (left to right): William F. Martin, Stefan Bengtson, Eörs Szathmáry, Nils Chr. Stenseth, Terrence W. Deacon, Nathan Sanders and Adam Rutherford. © CEES.



The Nordenskiöld glacier, Svalbard. © Julia M. I. Barth.

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 2014, 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 ABI lab was a Sanger sequencing DNA sequencing core facility at the Department of Biosciences situated at CEES and functioning as a sequencing service lab for all research groups at the Department of Biosciences, as well as other institutes at UiO, within Norway, and abroad. The ABI-service lab had operated since July 2005, and was closed in April 2014. January–April 2014 the lab sequenced 8600 samples, and had a turnover of 310 000 NOK.

A new CEES lab – the ancient DNA lab for serving interdisciplinary life science research at UiO

The fast development within high throughput sequencing has made it possible to analyse historic and ancient DNA (aDNA) in a far more reliable way than before. 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 usually 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.

Currently no state-of-the-art laboratories capable of handling both human and non-human aDNA exist at UiO. CEES has therefore taken the initiative to establish a new

aDNA lab located at the Department of Biosciences. The aDNA lab project was coordinated by Cecilie Mathiesen and Nanna W. Steen. This lab has been made possible through a tight and successful collaboration with IBV/CEES, the Museum of Cultural History (KHM) and the Natural History Museum (NHM), as well as by strong support from the Faculty of Mathematics and Natural Sciences, the Medical Faculty and the Estate Department. We have in addition received 2 million NOK in funding from the UiO programme for research infrastructure, in order to equip the aDNA lab with state-of-the-art instrumentation.

When operative, the aDNA lab will be run by CEES, in collaboration with our partners from NHM and KHM, and so the project as a whole is a prime example of interdisciplinary collaboration across faculties at UiO. 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 project. The demand for the aDNA lab is driven by ongoing and newly funded projects at CEES. Most importantly, the ERC funded project of Barbara Bramanti on medieval *Yersinia pestis* outbreaks has been 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 an 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 Boeskenkol involving collaborations between CEES, NHM and KHM.

When the aDNA lab is available to researchers, UiO will have gained infrastructure at the international forefront of aDNA research. This will attract scientists not only from UiO, but also from other Norwegian universities as well as internationally.

Summarised by Kjetill S. Jakobsen.

(Re-printed from the 2013 annual report. That report stated that the lab was expected to be ready in the fall of 2014, but the opening was delayed until April 2015).

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 is from 2014 on the National Roadmap for research infrastructures and large national projects, thanks to large funding from the National Financing Initiative for Research Infrastructure (INFRASTRUKTUR) of the Research Council of Norway.

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.

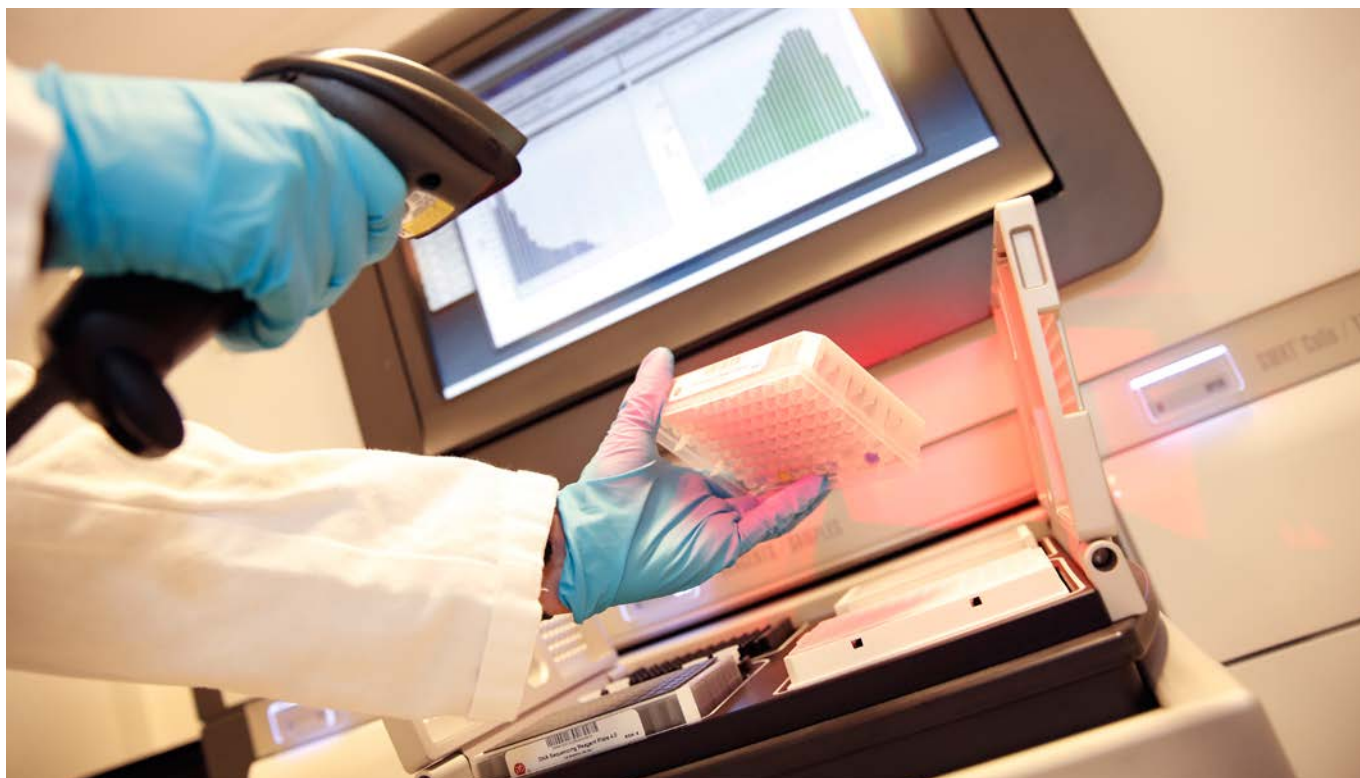
Platform updates: In 2014, two Illumina HiSeq2500s were purchased for the CEES node, and a HiSeq2000 and a NextSeq500 for the OUS node. These provide higher sequencing throughput and more flexibility in handling different projects. At present, we have the following instruments available: 3 x Illumina HiSeq 2500, 1 x Illumina HiSeq2000, 1 x Illumina NextSeq500, 3 x Illumina MiSeq, and 1 x Pacific Biosciences RSII. This is by far the largest instrument park for HTS in Norway. In addition, the NSC has a considerable infrastructure of supporting hardware to increase throughput and automation (Hamilton robot, Beckmann Biomek FX robot, Beckmann SpriWorks robot, two Pippin Prep instruments, Covaris DNA sonicators, etc.). We have also acquired a Laboratory Information Management System (LIMS). The LIMS is a web and GUI based software that is used for sample tracking, automation, and reporting. Installation and

training will commence early in 2015. Finally, two new staff members were hired in 2014 in order to strengthen the NSC team at CEES.

Instrument upgrades: HTS technology is developing fast, 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.

Decommissioning GS FLX from Roche/454: NSC has decommissioned its two 454/Roche GS FLX instruments in May 2014, due to high cost per base, laborious preparation procedures, and decreased interest from our users. As alternatives to 454 sequencing, we offer Pacific Biosciences RS II (long reads), and Illumina MiSeq (amplicons).

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.



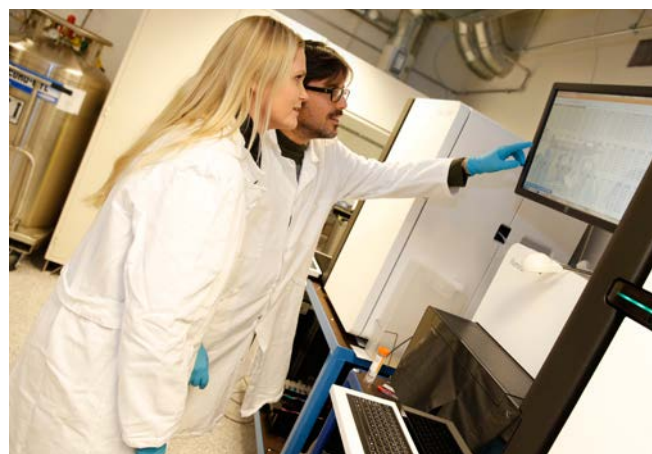
A NSC technician is preparing to run the Pacific Biosciences RS II long read sequencing instrument. © UiO/Terje Heiestad.

Sequencing activity: In 2014, the total number of samples sequenced almost doubled, compared to 2013. In total, about 6500 different samples were sequenced at NSC, representing samples from close to 250 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 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, but will remain a large focus for NSC in 2015. We anticipate that large projects will be increasingly important for NSC in the future, and for the next year we have several such projects in the pipeline – both within biomedical and biological research.

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

Summarised by Lex Nederbragt with help from the NSC team at CEES.



Marianne Helén S. Hansen and Spyridon Kollias in front of an Illumina HiSeq 2500 instrument in the NSC sequencing laboratory. © UiO/Terje Heiestad.

8 COMPUTATIONAL AND BIOINFORMATIC RESOURCES

2014 saw a continued increase in the bioinformatics activities at CEES. This was again largely driven by the analysis of high-throughput sequencing data for several projects, although other types of analyses have contributed to the growth as well.

Infrastructure

At CEES, we use a combination of self-owned servers, and CPU hours we have applied for on the UiO super-computer '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 on the self-owned servers, as well as on Abel. For storage ('project disk space') 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. The following computational infrastructure is available to CEES: (i) two servers with 24 CPUs and 128 GB of RAM, and around 1 TB disk space; (ii) two high-memory servers with 64 CPUs and 512 GB of RAM, and around 24 TB disk space each. On the university computer cluster Abel, we have allocations through the national HPC infrastructure through Notur (notur.no), for CPU-intensive computations. In 2013, a large new Notur application was granted, enabling CEES-researchers to use more than 2 million CPU hours per

half year. CEES bioinformaticians use 40 TB of project disk space with another 30 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. In 2013, a group of researchers started 'the Genome Analysis Club' (TGAC) to discuss papers and programmes focussing on analytical methods for whole genome data (including whole genome sequencing, SNPs, RADtags, etc.). 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) eukaryote genome sequencing projects (fish, birds, rodents); (ii) the RAD-seq platform at CEES (SNP detection and genotyping by sequencing); resequencing projects for SNP detection and typing (fish, birds); (iii) de novo genome assembly of bacterial genome using Illumina and Pacific Biosciences data; (iv) transcriptomics analysis pipelines for differential gene expression studies; (v) ecological modelling.

Outlook

With support from the faculty of Mathematics and Natural Sciences, and in collaboration with the Norwegian Sequencing Centre and the Aqua Genome project, we were able to order hardware to completely renew, as well as extend, the computer resources of CEES. From early 2015, we will have access to three high-memory servers with 1.5 TB RAM and 64 CPUs. These servers come with considerable local disk space (64 TB per server). In addition, we will have access to 224 regular 'grid' CPUs (providing us with the equivalent of close to 2 million CPU hours).



Summarised by Lex Nederbragt.



The 'cod3' high-memory server. © Lex Nederbragt.

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 2014, and the budget for 2015.



After the catch: cod heads hanging out to dry in Nusfjord, Lofoten, Norway. © Julia M. I. Barth.

Revenues and expenditures 2014/Budgeted revenues and expenditures 2015

Total funding				Accounted revenues				Revenues not in account							
		2014	Budget 2015	Figures 2014		Budgeted figures 2015		Revenues not in account 2014 ¹		Revenues not in account 2014 ¹					
			7 001	9 200	7001	9 200									
RCN-CoE															
UiO			31 173	9 251	10 048	9 251				21 125					
RCN – CEES related projects			49 660	47 848	49 660	47 848									
Other public sector based projects			5 718	4849	5 718	4 849									
International funding			38 322	19 588	24 676	19 588				13 646					
Private sector based projects			488	109	488	109									
Transferred revenues			19 836	22 909	19 836	22 909									
Total funding			152 198	113 754	117 427	113 754				34 771					
Accounted expenses 2014 (Acc 14)/Budgeted expenses 2015 (Bud 15)															
		Total	RCN-CoE		UiO		RCN projects		Other public sector based pro.		International funding		Private sector based projects		
		Acc 14	Bud 15	Acc 14	Bud 15	Acc 14	Bud 15	Acc 14	Bud 15	Acc 14	Bud 15	Acc 14	Bud 15	Acc 14	Bud 15
	Salary expenses	36 952	41 661	6 497	7 820	13 565	15 546	3 970	15 546	6 897	10 579	251			
	Indirect costs	10 770	11 706	910	1 095	5 331	6 163	1 495	6 163	1 439	2 160	96			
	R&D services	18 771	20 861			13 353	11 385	210		5 208	9 476				
	Equipment	16 992	8 171			16 842	8 071	11		139	100				
	Running costs	9 869	15 070	409	1 200	4 510	5 280	341	1 960	2 371	3 721	229			109
	Travel and representation ²	1 164		355											
	Total	94 518	97 470	8 171	10 115	53 601	46 446	6 027	5 515	16 054	26 036	576			109
Expenses not in account 2014 (Nacc 14)															
		Nacc 14	Bud 15	Nacc 14	Bud 15	Nacc 14	Bud 15	Nacc 14	Bud 15	Nacc 14	Bud 15	Nacc 14	Bud 15	Nacc 14	Bud 15
	Salary expenses	25 171				15 164				10 007					
	Indirect costs	9 600				5 962				3 638					
	Total ³	34 771				21 126				13 645					
Balance 2014/Budgeted balance 2015															
		2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
	Revenues	132 362	90 485	7 001	9 200	49 660	47 848	5 718	4 849	38 322	19 588	488			109
	Transf. revenues	19 836	22 909	1 620	450	4 147	206	1 367	1 058	11 955	20 578	121			33
	Total expenses	129 289	97 470	8 171	10 115	53 601	46 446	6 027	5 515	29 699	26 036	576			109
	Balance	22 909	16 284	450	-465	206	1 608	1 058	392	20 578	14 130	33			33

All figures are given in 1000 NOK.

1) Not posted revenues for 2014. 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 2014.

10 APPENDICES

CEES-members

Core scientific staff

Name	Nationality	Position	Period	Funding 2014	CEES share (%)
Brysting, Anne K.	Norway	Professor	Oct. 2007–	UiO-IBV	75
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
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
Nesbø, Camilla L.	Norway	Researcher	Oct. 2007–Dec. 2014	Univ. of Alberta/ RCN	83
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
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, L. Asbjørn	Norway	Professor	Oct. 2007–	UiO-IBV	75

Postdocs and Researchers

Name	Nationality	Position	Period	Funding 2014	CEES share (%)
Atickem, Anagaw M.	Ethiopia	Researcher	Apr. 2013–Dec. 2014	RCN-CoE	15
Bakanidze, Lela	Russia	Researcher	Jul.–Aug. 2014	ERC	1.6
Bailey, Richard I.	United Kingdom	Postdoc res. fellow	Aug. 2011–Aug. 2014	RCN	62.5
Barth, Julia M. I.	Germany	Postdoc res. fellow	Jan. 2014–Jan. 2017	UiO-IBV	50
Bianucci, Raffaella	Italy	Researcher	Jul. 2013–Jun. 2015	ERC	100
Bitadze, Liana	Russia	Researcher	Jul.–Aug. 2014	ERC	1.6
Boessenkool, Sanne	The Netherlands	Researcher	Dec. 2012–Feb. 2018	RCN	33
Bramanti, Barbara	Italy	Researcher	Jun. 2013–May 2018	ERC	100
Cadahia, Luis	Spain	Researcher	Sep.–Nov. 2014	UiO-MN	31
de Muinck, Eric	USA	Researcher/Postdoc res. fellow	Mar.–May 2014 Jun. 2014–May 2017	RCN/UiO-IBV	20 50
Diekert, Florian	Germany	Postdoc res. fellow	Oct. 2011–Oct. 2015	NORDFORSK	100
Durant, Joël M.	France	Researcher	Oct. 2007–	RCN	100
Easterday, William R.	USA	Postdoc res. fellow	Jan. 2012–Dec. 2014	UiO-IBV	100
Eikeset, Anne Maria	Norway	Researcher/Postdoc res. fellow	Oct. 2007–	NORDFORSK/ RCN	71
Eroukhmanoff, Fabrice	France	Postdoc res. fellow	Jan. 2013–Dec. 2017	EU-MC*	100
Fischer, Barbara	Austria	Postdoc res. fellow	Oct. 2010–Mar. 2015	UiO-IBV	100
Haverkamp, Thomas H. A.	The Netherlands	Postdoc res. fellow	Jun. 2012–Oct. 2015	RCN	100
Helberg, Morten	Norway	Researcher	Aug. 2010–Aug. 2014	RCN/UiO-MN	50
Hermansen, Jo S.	Norway	Researcher	Sep. 2009–Feb. 2015	NORDFORSK	20
Hjermann, Dag Ø.	Norway	Researcher	Oct. 2007–Jan. 2015	RCN-CoE	30
Holen, Øistein H.	Norway	Researcher	Oct. 2007–Dec. 2016	RCN-CoE	100
Hutchings, Jeffrey	Canada	Researcher	Sep. 2010–Dec. 2015	RCN-CoE	20
Hänsch, Stephanie	Germany	Postdoc res. fellow	Jun. 2013–May 2016	ERC	100
Jorde, Per Erik	Norway	Researcher	Oct. 2007–Jun. 2015	RCN-IMR	100
Kausrud, Kyrre	Norway	Postdoc res. fellow	Jul. 2010–Mar. 2016	RCN	62.5
Kjesbu, Olav S.	Norway	Professor	Sep. 2012–Aug. 2015	NORDFORSK	20
Knudsen, Endre	Norway	Postdoc res. fellow	May 2011–May 2014	RCN	45

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Knutsen, Halvor	Norway	Researcher	Oct. 2007–Dec. 2015	RCN	20
Labra, Antonieta	Chile	Postdoc res. fellow	Sep. 2009–Sep. 2014	RCN-CoE	45
Langangen, Øystein	Norway	Researcher	Sep. 2010–Mar. 2015	RCN, IMR	100
Liow, Lee Hsiang	Singapore	Researcher	Oct. 2007–Jul. 2018	RCN	100
Malmstrøm, Martin	Norway	Postdoc res. fellow	Sep. 2009–Feb. 2017	RCN	33
Martinsen, Lene	Norway	Researcher/Postdoc res. fellow	Oct. 2007–Aug. 2014	RCN	66.5
Matschiner, Michael	Germany	Postdoc res. fellow	Sep. 2013–Sep. 2016	RCN	100
Nielsen, Anders	Norway	Researcher	Oct. 2013–Jan. 2017	RCN-CoE/RCN	100
Nilsson, Anna	Sweden	Researcher	Sep. 2013–Sep. 2016	RCN	50
Olsen, Esben Moland	Norway	Researcher	Oct. 2007–Dec. 2015	RCN	20
Orr, Russell	United Kingdom	Researcher	Sep. 2013–Mar. 2014	RCN-CoE	8
Reitan, Trond	Norway	Researcher	Oct. 2013–Aug. 2018	RCN	22.5
Richter, Andries P.	Germany	Postdoc res. fellow	Mar. 2010–Apr. 2015	RCN	20
Rivrud, Inger Maren	Norway	Researcher/Postdoc res. fellow	Sep. 2008–May 2017	RCN-CoE/RCN	100
Rogers, Lauren	USA	Postdoc res. fellow	Aug. 2011–May 2016	NORDFORSK	47.5
Rueness, Eli K.	Norway	Researcher	Oct. 2007–Feb. 2015	RCN-CoE	80
Salzburger, Walter	Austria	Researcher	Sep. 2012–Aug. 2015	RCN-CoE	20
Schmid, Boris	The Netherlands	Researcher/Postdoc res. fellow	Apr. 2012–May 2016	RCN-CoE/EU-MC*	100
Star, Baastian	The Netherlands	Researcher/Postdoc res. fellow	Sep. 2008–Mar. 2017	RCN	100
Starrfelt, Jostein	Norway	Postdoc res. fellow	Oct. 2014–Sep. 2017	RCN	25
Stige, Leif Chr.	Norway	Researcher	Oct. 2007–Oct. 2016	RCN	32.5
Svennungsen, Thomas	Norway	Postdoc res. fellow	Aug. 2011–Oct. 2015	RCN-CoE	100
Trosvik, Pål	Norway	Researcher	Apr. 2012–Mar. 2015	RCN	100
Trucchi, Emiliano	Italy	Researcher	Feb. 2011–Mar. 2014	RCN-CoE	25
van Leeuwen, Casper	The Netherlands	Postdoc res. fellow	Sep. 2013–Sep. 2015	RCN-NINA	100
Vik, Unni	Norway	Researcher	May 2010–Mar. 2016	RCN	62.5
Vindenes, Yngvild	Norway	Researcher	Apr. 2011–Feb. 2016	RCN	100
Voje, Kjetil L.	Norway	Researcher/Postdoc res. fellow	Aug. 2007–Jan. 2017	RCN	100
Whittington, Jason	USA	Postdoc res. fellow	Sep. 2013–Aug. 2015	RCN/NORDFORSK	100
Wojewodzic, Marcin	Poland	Researcher	Oct. 2007–Apr. 2014	RCN	6
Østbye, Kjartan	Norway	Researcher	Oct. 2007–Feb. 2015	RCN	56

* Marie Curie Individual Fellowship

PhD students

Name	Nationality	Position	Period	Funding 2014	CEES share (%)
Areskoug, Veronika	Sweden	Research fellow	Sep. 2009–Jul. 2014	UiO-IBV	58
Athumani Ndmuligo, Sood	Tanzania	Research fellow	Aug. 2012–Jul. 2015	Quota Scheme	100
Baalsrud, Helle T.	Norway	Research fellow	Sep. 2012–Sep. 2016	UiO-IBV	100
Berg, Paul R.	Norway	Research fellow	Oct. 2010–Mar. 2015	UiO-IBV	100
Berihun, Mewicha	Ethiopia	Research fellow	Jan. 2009–Dec. 2015	Quota scheme	100
Beyene, Cherie E.	Ethiopia	Research fellow	Aug. 2012–Jul. 2016	Quota scheme	100
Cloete, Claudine C.	Namibia	Research fellow	Sep. 2013–Aug. 2016	RCN	100
Delkaso, Dereje Tesfaye	Ethiopia	Research fellow	Aug. 2014–Jul. 2017	Quota scheme	41
Elgvin, Tore O.	Norway	Research fellow	Jul. 2011–Jun. 2015	RCN	75
Gutema, Tariku Mekonnen	Ethiopia	Research fellow	Jan. 2014 –Dec. 2016	Quota scheme	100
Hermansen, Jo S.	Norway	Research fellow	May 2010 –Feb. 2015	UiO-IBV	66
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	41
Kvile, Kristina Ø.	Norway	Research fellow	Aug. 2012–Jul. 2015	NORDFORSK	100
Liljegren, Mikkel	Norway	Research fellow	Oct. 2012–Sep. 2016	UiO-IBV	100
Malmstrøm, Martin	Norway	Research fellow	Jan. 2009–Jun. 2014	UiO-IBV	50
Mazzarella, Anna V. B.	USA	Research fellow	Nov. 2010–Sep. 2014	RCN	75
Nilsson, Pernille	Norway	Research fellow	Aug. 2013–Jul. 2017	UiO-IBV	100
Qviller, Lars	Norway	Research fellow	Sep. 2010–Aug. 2014	UiO-IBV	66
Riiser, Even Sannes	Norway	Research fellow	Oct. 2014–Sep. 2017	UiO-IBV	25
Romagnoni, Giovanni	Italy	Research fellow	Sep. 2011–Aug. 2015	UiO-IBV	100
Solbakken, Monica H.	Norway	Research fellow	Jun. 2010–Oct. 2015	RCN	41
Toljagic, Olja	Serbia	Research fellow	Sep. 2013–Aug. 2017	UiO-IBV	100
Trier, Cassandra N.	USA	Research fellow	Sep. 2012–Oct. 2016	UiO-IBV	100
Tørresen, Ole Kristian	Norway	Research fellow	Sep. 2011–Dec. 2015	UiO-IBV	100
Varadharajan, Srinidhi	India	Research fellow	Sep. 2014–Sep. 2018	UiO-IBV	25
Winter, Anna-Marie	Germany	Research fellow	Sep. 2014–Sep. 2017	NORDFORSK	29
Worku, Ejigu Alemayehu	Ethiopia	Research fellow	Aug. 2014–Jul. 2017	Quota scheme	41

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Research Assistants

Name	Nationality	Position	Period	Funding 2014	CEES share (%)
Cunningham, Sari	USA/Belgium	Senior Executive Officer	Mar. 2014–Apr. 2014	RCN-CoE	8
Henriksen, Jostein S.	Norway	Higher Executive Officer	Jan. 2014–Feb. 2014	RCN	4
Kristiansen, Jakob B.	Norway	Research Assistant	May–Aug. 2014	UiO-IBV	2
Kvernhaugen, Jørgen N.	Norway	Research Assistant	Aug. 2014	RCN	2
Shala, Nita	Norway	Research Assistant	Feb.–Dec. 2014	RCN	50
Skau, Lars Fredrik	Norway	Research Assistant	Jan.–July 2014	RCN	10
Stigum, Vette M.	Norway	Research Assistant	Mar.–May 2014	RCN	25

Administrative and technical support staff

Name	Nationality	Position	Period	Funding 2014	CEES share (%)
Cadahia, Luis L.	Spain	Researcher/Adviser	Sep. 2014–Mar. 2015	RCN/NORDFORSK	4
Egidius, Alexander E.	Norway	Executive Officer	Aug. 2014–Aug. 2015	NORDFORSK	8
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–Aug. 2014	RCN-CoE	100
Jogi, Suresh K.	Ireland	Senior Executive Officer	Jun. 2013–Mar. 2015	RCN-CoE	20
Kollias, Spyridon	Greece	Head Engineer	Dec. 2014–Dec. 2017	RCN	8
Mazzarella, Anna V. B.	USA	Executive Officer	Oct. 2014–Jun. 2016	RCN/NORDFORSK	25
Nederbragt, Alexander	The Netherlands	Senior Engineer	Oct. 2007–Dec. 2015	RCN	80
Nerli, Emelita R.	Norway	Senior Engineer	Oct. 2007–	UiO-IBV	50
Nicolas, Delphine C.	France	Senior Executive Officer	Mar. 2014–Mar. 2017	RCN-CoE/UiO-IBV	41
Rydbeck, Kjell Halfdan	Sweden	Senior Engineer	Apr. 2008–Nov. 2017	RCN	8
Rygg, Kari B.	Norway	Senior Adviser	May 2008–	UiO-IBV	100
Skage, Morten	Norway	Senior Engineer	May 2008–May 2015	UiO-IBV	100
Steen, Nanna W.	Norway	Staff Engineer	Oct. 2007–	UiO-IBV	100
Šupraha, Luka	Croatia	Research Technician	Oct. 2013–Mar. 2014	RCN	12.5
Thomsen, Camilla S.	Denmark	Senior Executive Officer	Nov. 2012–Nov. 2016	RCN-CoE	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 2014

Longer research visits (more than one month)

Name	Nationality	Home institution	Period
Barcelo, Caren	USA/Uruguay	Oregon State University, USA	Oct.–Nov. 2014
Catarino, Diana	Portugal	University of the Azores, Portugal	Feb.–May 2014
DeFaveri, Jacquelin	Canada	University of Helsinki, Finland	Jan.–May 2014
Grabowski, Mark	USA	Fulbright Scholar and visiting researcher	December 2014
Hernandez-Aguilar, Adriana R.	Mexico		Jan.–Dec. 2014
Highland, Steven	USA	Utah State University, USA	Oct.–Nov. 2014
Marí-Mena, Neus	Spain	University of Coruña, Spain	April–Oct. 2014
Merilä, Juha	Finland	University of Helsinki, Finland	Jan.–April 2014
Ohlberger, Jan	Germany	VISTA, Norway	Jan.–Nov. 2014
Oomen, Rebekah	Canada	Dalhousie University, Canada	February 2014
Ottesen, Vibeke	Norway		Jan.–Dec. 2014
Rowe, Melissah	Australia	University of Oslo, Natural History Museum	Aug.–Dec. 2014
Runemark, Anna	Sweden	University of Lund, Sweden	Jan.–Dec. 2014
Strand, Sofia A.	Sweden	University of Gothenburg, Sweden	Jan.–Dec. 2014
Wiebe, Karen L.	Canada	University of Saskatchewan, Canada	Mar.–April 2014

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

Name	Nationality	Home institution	Period
Bonachela, Juan	Spain	University of Strathclyde, UK	May 2014
Bonanomi, Sara	Italy	DTU, Denmark	Jan.–Feb. 2014
Botsford, Louis	USA	University of California, Davis, USA	June 2014
Damerau, Malte		Thünen Institute, Germany	Nov.–Dec 2014
Devoto, Mariano	Argentina	University of Buenos Aires, Argentina	April 2014
Dubyanskiy, Vladimir	Russia	Stavropol Plague Control Research Institute, Russia	May 2014
Fortelius, Mikael	Finland	University of Helsinki, Finland	September 2014
Galván Candela, Juan Diego	Spain	Swiss Federal Institute for Forest, Snow and Landscape Research, Switzerland	Mar.–April 2014
Gouveia, Ana Rita	Portugal	University of Aveiro, Portugal	Feb.–March 2014
Haase, David	Germany	Helmholtz Centre for Ocean Research Kiel, Germany	March 2014
Hutchings, Jeffrey	Canada	Dalhousie University, Canada	April 2014
Lei, Xu	China	Chinese Centre for Disease Control and Prevention, China	Aug.–Sep. 2014
Llope, Marcos	Spain	Spanish Institute of Oceanography, Spain	May 2014, Jul.–Aug. 2014
Miller, Jason	USA	J. Craig Venter Institute, USA	June 2014
Nichols, Ruth	USA	Swedish University of Agricultural Sciences, Sweden	January 2014
Orians, Gordon	USA	Washington State Academy of Sciences, USA	October 2014
Patin, Rémi	France	École Normale Supérieure & University Pierre and Marie Curie, France	February 2014
Pennell, Matthew	Canada	University of Idaho, USA	May 2014
Polinska, Eva	Poland	University of Lund, Sweden	January 2014
Shahraki, Abdolrazagh Hashemi	Iran	Pasteur Institute of Iran, Iran	November 2014
Sørhus, Elin	Norway	Institute of Marine Research, Norway	Sep.–Oct. 2014, November 2014

Research projects

RCN projects				
Name	Project leader	Funding	Start	End
Tracking viking-assisted dispersal of biodiversity using ancient DNA	Boessenkool, Sanne	RCN	2014	2018
Phytoplankton size: Climate adaptation and long-term evolution	Henderiks, Jorijntje	RCN	2010	2014
Effects of climate change on boreal lake ecosystems: productivity and community responses (ECCO)	Hessen, Dag O.	RCN	2013	2016
BiodivERsA Behavioral responses to risk and uncertainty among Norwegian fishers	Hessen, Dag O.	RCN	2013	2015
Genetic variability in population responses of Atlantic cod to environmental change	Hutchings, Jeff	RCN	2014	2015
Translating the cod genome for aquaculture	Jakobsen, Kjetill S.	RCN	2010	2014
Norwegian High-Throughput Sequencing Centre	Jakobsen, Kjetill S.	RCN	2010	2014
Functional and comparative immunology of a teleost's world without MHC II	Jakobsen, Kjetill S.	RCN	2013	2017
The Aqua Genome project	Jakobsen, Kjetill S.	RCN	2013	2017
The Norwegian Sequencing Centre – Phase II	Jakobsen, Kjetill S.	RCN	2014	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
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	2014
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
LAND: Pollination; an ecosystem service affected by climate change	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	2014
Flexibility and constraints in animal movement pattern: ecology, evolution and annual cycles	Stenseth, Nils Chr.	RCN	2010	2014
Fisheries induced evolution in Atlantic cod investigated by ancient and historic samples	Stenseth, Nils Chr.	RCN	2011	2015
ADCAP – Strengthening the adaptive capacity of institutions in fisheries	Stenseth, Nils Chr.	RCN	2012	2015
Bringing together evolution and ecology – Bringing together evolution and ecology through the Red Queen Perspective	Stenseth, Nils Chr.	RCN	2012	2016
Climate Changes and Zoonotic Epidemiology in Wildlife Systems (ZEWS)	Stenseth, Nils Chr.	RCN	2013	2016
ERC-Stenseth Red Queen coevolution in multispecies communities: long-term evolutionary consequences of biotic and abiotic interactions	Stenseth, Nils Chr.	RCN	2013	2017
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
Tracking signatures of adaptive diversification during postglacial colonization: the build-up of genomic isolation in three spine stickleback	Vollestad, L. Asbjørn	RCN	2010	2015

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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
Application of a new principle to combat infectious salmon anemia (ISA)	Grimholt, Unni	RCN/NVI	2011	2014
Miljødirektoratet: Miljøgifter i en urban fjord	Helberg, Morten	NIVA	2014	2014
Urbane Populasjoner 2014	Helberg, Morten	Fylkesmannen	2014	2014
Instrumentering av gråmåker og sildemåker i Vest-Agder 2014	Helberg, Morten	Norwegian Polar Institute	2014	2014
Biodiversity management and the Water Framework Directive under climate change (BiWA)	Hessen, Dag O.	RCN/NINA	2013	2016
CodS – restaurering och förvaltning av torsk i Skagerrak/Kattegat	Jentoft, Sissel	INTERREG	2013	2014
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
Managing ecosystem services in low alpine cultural landscapes through livestock grazing	Mysterud, Atle	RCN/NTNU Museum of Natural History and Archaeology	2012	2014
ADMAR Adaptive management of living marine resources by integrating different data sources and key ecological processes	Stenseth, Nils Chr.	RCN/IMR	2010	2015
Assessment of the effects of oil exposure on the population dynamics and abundances of Atlantic cod and haddock using state-space models – VISTA 6159	Stenseth, Nils Chr.	VISTA	2012	2014
Codflict: Managing Skagerrak cod – Managing resource and area conflicts in the coastal zone, exemplified by cod on the Skagerrak coast	Stenseth, Nils Chr.	RCN/IMR	2012	2014
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
IRIS: Link populations to food-chain in an Integrated Model System	Hjermann, Dag Ø.	RCN/IRIS	2012	2014
SYMBIOSES – Constructing an integrated modelling framework for decision support in ecosystem-based management: case study Lofoten/Barents Sea	Stenseth, Nils Chr.	RCN/ Akvaplan-NIVA	2011	2014

International projects				
Name	Project leader	Funding	Start	End
MedPlag – The medieval plagues: ecology, transmission modalities and routes of the infections	Bramanti, Barbara	ERC EU	2013	2018
NCoE Planning grant – Meeting Challenges of a Changing Arctic: biology, economy, society and policy	Eikeset, Anne Marie	Nordforsk	2014	2015
INTERACT - International Network for Terrestrial Research and Monitoring in the Arctic	Ergon, Torbjørn Håkon	EU/Kungliga Vetenskaps-akademien	2011	2014
AutoMAT – Anpassung und Weiterentwicklung von innovativen, nicht invasiven Monitoringsystemen und Auswerteverfahren für die Fischereiforschung	Jentoft, Sissel	Johann Heinrich von Thünen-Institute, Germany	2013	2014
ERC 617585 CICHOLIDX – An integrative approach towards the 650159	Salzburger, Walter	EU/University of Basel	2014	2019
PIEF-GA-2010-273986 Climate-induced phenological change and its consequences for bird populations (Bird Populations)	Stenseth, Nils Chr.	EU	2011	2014
PlagueEco2Geno – Reconstructing the imprint of ecology on the genetic phylogeography of the Plague in Central Asia and China	Stenseth, Nils Chr.	EU	2012	2015
Climate Change Effects on Marine Ecosystems and Resources Economics – TFI NCoE Programme	Stenseth, Nils Chr.	Nordforsk	2011	2016
ARCHIGENE – The genetic architecture of secondary sexual traits during hybrid speciation	Stenseth, Nils Chr.	EU	2012	2014
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

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Seminars with invited speakers

Friday seminars and Extra seminars		
Name	Title	Date (Venue: CEES)
Merete Eggesbø	Gut microbiota and environmental toxicants. Infants under double attack?	24 January
Wolfram M. Kürschner	Palaeopolyploidy in fossil plants: evidence from 200 million year old pollen tetrads	31 January
Jakob Hemmer Hansen	Adaptive divergence in marine fishes; genomic signatures with implications for fisheries management	7 February
Bart Pollux	The evolution of the placenta causes a conflict-driven shift in sexual selection in the livebearing fish family Poeciliidae	14 February
Gilles Guillot	Statistical methods for genetic data in ecology: four ways to take into account spatial information, and four ways not to	21 February
Ana Gouveia	Long-term pattern of population dynamics in the field vole from central Europe: cyclic pattern with dampening amplitude	28 February
Anna Gårdmark	Regime shifts in exploited marine food-webs: detecting mechanisms underlying alternative stable states using size-structured community dynamics theory	28 February
David Sloan Wilson	The New Social Darwinism	6 March
Ioan Negrutiu	From flower evo-devo to biomass geopolitics	14 March
Mikael Pontarp	On the origin of phylogenetic structure in competitive metacommunities	17 March (Presentations from the Theoretical population ecology and evolution group at Lund University)
Jörgen Ripa	Niche conservatism through extinction-speciation cycles	
Jacob Johansson	Adaptation of timing of reproduction in resident birds with social dominance hierarchies	
Nadiah Kristensen	Eco-evolutionary model for arrival and laying time in migratory birds	
Per Lundberg	The evolution of partial migration	
Nicholas Salamin	Modeling the mode and tempo of species evolution	21 March
Juha Merilä	Detecting footprints of adaptive phenotypic differentiation in the wild	28 March
Christos Lynteris	Reconsidering the social ecology of plague on the Russian-Chinese border	4 April
Asta Audzijonyte	Small fish, big fish: modelling ecological consequences of life-history evolution in harvested stocks	29 April
Sonja J. Vermeulen	Agriculture and food in the new IPCC report: a turning point for science?	2 May
Mark Thomas	Detecting signals of recent selection using ancient DNA data	9 May
Matthew Webster	A worldwide survey of genome sequence variation reveals the evolutionary history of the honeybee <i>Apis mellifera</i>	14 May
Per Ahlberg	The Placoderm Romundina and the Origin of the Gnathostome Face	16 May
Anna Iglikowska	Stranded: The conquest of fresh water by marine ostracods	23 May
Bill Hanage	Population genomics of pneumococcus: data to models and back	3 June
Timothy D. Read	Superbugs, antibiotics and genome-wide association	4 June
Melissah Rowe	Sperm wars and the evolution of avian ejaculates	11 June
Louis W. Botsford	Fishing and environmental variability: Hjort's third idea, the one that got away	20 June
Jason Miller	De Novo Genome Assembly with PacBio Reads	26 June
Moritz Muschick	Genomic divergence and the speciation continuum in the adaptive radiation of <i>Timema</i> stick insects	27 June
Monica Hagedorn	Autophagy seals mycobacteria egress sites	3 July
Arnar Pálsson	On rapid and repeated evolution via transcriptional cooption and decay	29 August
Andrea Waeschenbach	Convergent evolution as the rule, not the exception	19 September
Lars Werdelin	The origin of the Anthropocene? Carnivore extinctions and human evolution in eastern Africa	26 September
Horacio Schneider	Phylogeny of Sciaenidae fishes from Western Atlantic - a case study	3 October
Charles Krebs	Seven Questions about the 10-year Cycle of Snowshoe Hares in Canada's Yukon	17 October
Thomas Marcussen	Detecting and dating homoploid hybridisation using large sequence datasets: an example from wheat	31 October
Annelise Binois	The archaeology of epizootic disease: identification and diagnosis of ovine mass mortalities in archaeological deposits	14 November
Arnaud Le Rouzic	Estimating the strength of natural selection from evolutionary time series and population genetic models	28 November

Darwin Day 2014: The major transitions in evolution – from the origin of life to the emergence of language		
Name	Title	Date and venue
Nils Chr. Stenseth	Introduction	12 February 2014 Helga Engs hus, Blindern, Oslo
Adam Rutherford	4 billion years of creation	
William F. Martin	Hydrothermal vents and the origin of life	
Stefan Bengtson	Origins of multicellularity: clues from the fossil record	
Nathan Sanders	The rise (and fall?) of Darwin's special problems: the causes and consequences of ant dominance in a changing world	
Eörs Szathmáry	Bayes, Hebb and Darwin: toward a truly Darwinian view of the brain	
Terrence W. Deacon	How language evolution exemplifies the interplay of emergence and natural selection	

Workshop on visualisation of scientific data. A collaboration between CEES and the think tank TAU		
Name	Title	Date and venue
Will Stahl-Timmins	Visualisation of scientific data: Need help with your posters, graphs or big data sets?	11 March CEES
Angela Morelli		
Kathrine Frøslie		

Open seminar at the House of Literature		
Name	Title	Date and venue
Massimo Pigliucci	Pseudoscience: Why Bother?	1 September 2014 House of Literature (Litteraturhuset), Oslo

The Kristine Bonnevie lectures on evolutionary biology		
Name	Title	Date and venue
Ole Petter Ottersen	Opening remarks	2 September 2014 Georg Sverdrups hus, Blindern, Oslo
Massimo Pigliucci	On the relationship between science and philosophy	
Hopi Hoekstra	Digging for genes that affect behavior	
Nils Chr. Stenseth	Debate and closing remarks	

Seminar co-organised with The Natural History Museum (NHM) in connection with the conferment of an honorary doctoral degree awarded to Prof. Eske Willerslev by the University of Oslo: Ancient and environmental DNA studies		
Name	Title	Date and venue
Ole Petter Ottersen	Introduction	3 September 2014 Tøyen hovedgård, Oslo
Eske Willerslev	What we can learn from ancient genetics and genomics	
Barbara Bramanti	Ancient DNA studies and the pandemics of the past	
Pierre Taberlet	The future of DNA metabarcoding	

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Open seminar co-organised with The Natural History Museum (NHM) as part of “Forskningsdagene”: Sex and evolution of modern humans

Name	Title	Date and venue
Jan T. Lifjeld	Introduction	28 September 2014 House of Literature (Litteraturhuset), Oslo
Patricia L. R. Brennan	Wild sex: Lessons from the animal kingdom	
Virpi Lummaa	Why your grandmother matters: sex differences in evolutionary potential and selection on longevity in Finland	
Randy Thornhill	The evolution of women's dual sexuality: estrus and extended sexuality	
Nils Chr. Stenseth	Panel discussion and questions	

2-day conference on the history of plague, organised by CEES, with funding from Molecular Life Sciences (MLS), The Norwegian Academy of Science and Letters (DNVA), and MedPlag (ERC Advanced project): The Past Plague Pandemics in Light of Modern Molecular Life Science Insights

Name	Title	Date and venue
Nils Chr. Stenseth	Opening remarks	19 November 2014 The Norwegian Academy of Science and Letters (DNVA), Oslo
Lars Walløe	Introduction to the history of plague	
Herwig Leirs	Introduction to the biology of plague	
Session 1: Plague and mortality within European cities		
Neil Cummins	Spatial and temporal patterns of birth and death in London from 1560 to 1665, a period dominated by outbreaks of plague	
John Henderson	Death rates in the lazaretto, the parishes and mass graves of Florence during the plague of 1630–31	
Session 2: The role of plague vectors in transport and disease characteristics		
Anne Karin Hufthammer	Rats cannot have been intermediate hosts for <i>Yersinia pestis</i> during medieval plague epidemics in Northern Europe	
Robert Hymes	Introducing the inaugural issue of the Medieval Globe, and his work therein on the dispersal of 13th Century plague from the Qinghai-Tibet Plateau	
Samuel Cohn	The different disease expressions of <i>Y. pestis</i> , from historical medical descriptions of plague patients	
George Christakos	Spatiotemporal modeling of bubonic plague epidemics	
Dionysios Stathakopoulos	Traveling with the plague in the Byzantine empire	
Mauro Rubini	Presenting their work on paleopathology and plague surveillance, respectively	
Abdolrazagh Hashemi		
Session 3: Plague persistence and pandemics		
Barbara Bramanti	The current genetic evidence for sites of the origin of the three plague pandemics	
Christos Lynteris	The perception of the plague epidemic in northern China	
Viveka Vadyvaloo	Persistence and re-emergence of the plague using both fleas and protozoa as host models	
Eva Panagiotakopulu	Pharaonic Egypt and the Origins of Plague	
Jared Diamond	Evolution of human infectious diseases	
Nils Chr. Stenseth	Closing remarks	

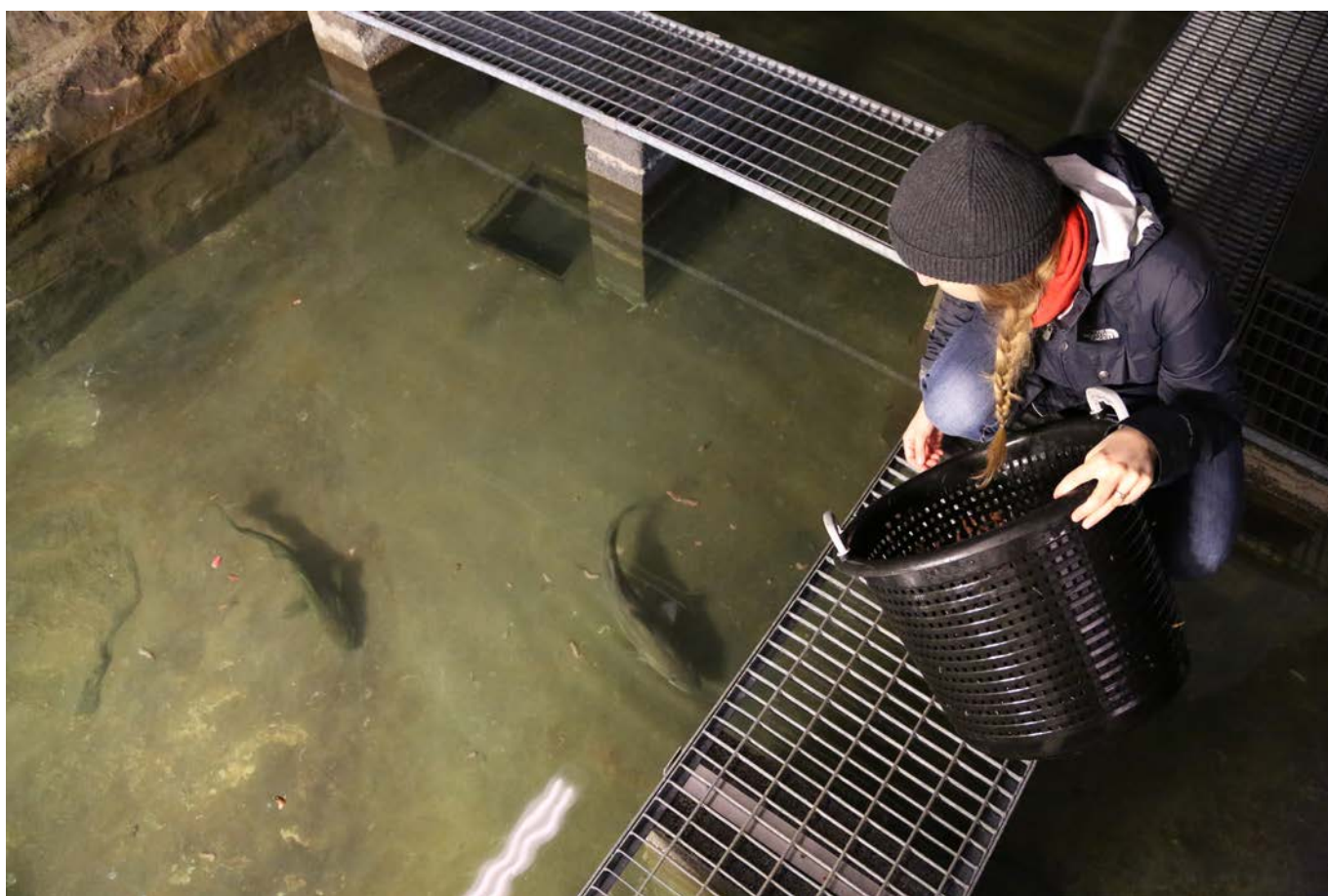
PhD thesis defences

Ola T. Westengen. 2 May. *Seeds of adaptation.*
Supervisors: Anne Krag Bryisting and Nils Chr. Stenseth.

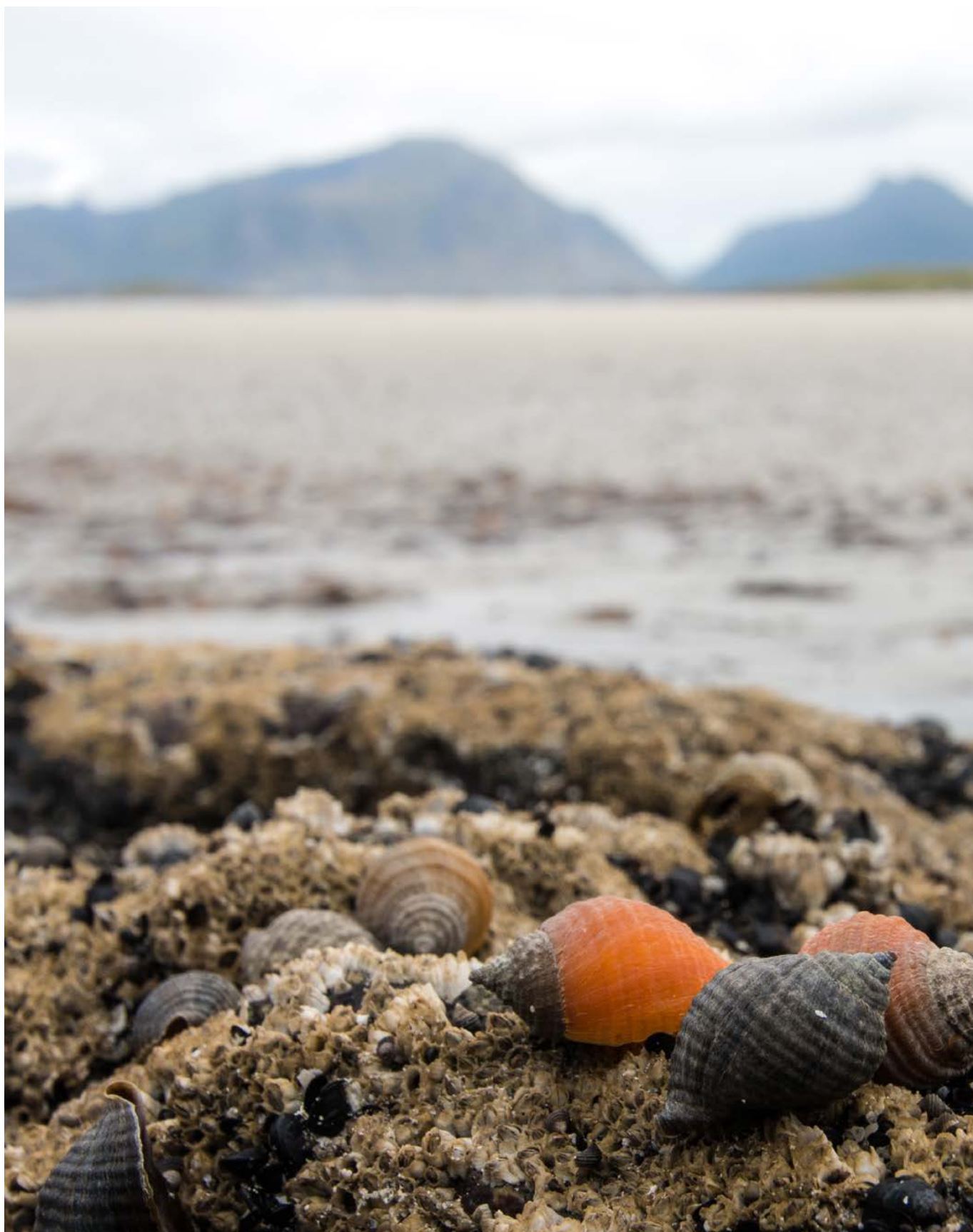
Huma Siddiqui. 15 May. *Urinary DNA analyses – approaches towards non-invasive, high throughput molecular analyses and diagnostics.* Supervisors: Kjetill S. Jakobsen, Lex Ned-erbragt and Karin Lagesen.

Martin Malmström. 17 June. *On the origin and evolution of the alternative adaptive immune system in Order Gadiformes.* Supervisors: Kjetill Sigurd Jakobsen and Nils Chr. Stenseth.

Lars Qviller. 14 November. *The distribution of ticks and large hosts relations in a northern forest ecosystem.* Supervisors: Atle Mysterud, Hildegunn Viljugrein and Bjørnar Ytrehus.



PhD student Rebekah Oomen feeding Skagerrak coastal cod at the Flødevigen Research Station for her research on thermal adaptation among Norwegian cod populations © Espen Bierud, Institute of Marine Research.



Moskenesøya, Lofoten. © Julia M. I. Barth.

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Production

Contributors affiliated with CEES in bold.

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- Durant, J. M.** Harvesting and population structure effect on population growth. *144th American Fisheries Society Annual Meeting, Canada*. 17–21 August.
- Durant, J. M., Ottersen, G.** Match-mismatch and climate warming, what can we expect? *Hjort Symposium, Norway*. 7–9 October.
- Elgvin, T. O., Trier, C. N., Tørresen, O. K., Lien, S., Jensen, H., Sætre, G.-P.** Sparrows, scaffolds and pseudo-chromosomes. *CEES Annual Student Conference 2014, Norway*. 21–22 October.
- Enevoldsen, E., Liow, L. H., Voje, K. L., Orr, R., Shalchian-Tabrizi, K., Krabberød, A. K.** Macroevolution through molecular and morphological lenses: a history of micro-porellids. *CEES Annual Student Conference 2014, Norway*. 21–22 October.
- Ergon, T.** Ghosts, demons and elusive species; adaptive multi-method occupancy sampling for monitoring of multiple species. *4th International Statistical Ecology Conference, France*. 1–4 July.
- Eroukhmanoff, F.** Long-term persistence of genetic incompatibilities and genomics constraints in a hybrid species. *Evolutionary Genetics and Genomics Symposium, UK*. 18 March.
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- Fischer, B.** Adaptive integration in the human pelvis. *Euro Evo Devo Conference, Austria*. 22–25 July.
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Richter, A. P. Understanding complexity in social-ecological systems. *IndoMareclim Workshop, India*. 5–9 October.

Rivas Sánchez, D. F., Olsen, E. M., Eikeset, A. M., Stenseth, N. C. Cod fishing with passive gear: selecting against the fittest? *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Romagnoni, G., Diekert, F. K., Lindroos, M., Eikeset, A. M. Spatial management strategies for populations of cod (*Gadus morhua*) in the North Sea. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Salvanes, A. G. V., Seivåg, M. L., Taha, Y., Christiansen, H., Kjesbu, O. S., Folkvord, A., Utne-Palm, A. C., Ekau, W., van der Plaz, A., Neumann, A., Henseler, C. Reproduction and growth of the suboxia tolerant bearded goby on the Namibian shelf. *Future Oceans – Research for marine sustainability: multiple stressors, drivers, challenges and solutions, Norway*. 23–27 June.

Schmid, B. V. Climate effects on host and vector population dynamics leads to Darwinian selection on the pathogen *Yersinia pestis*. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Skar Mjones, C., Easterday, W. R., Mysterud, A. Developing a targeted method for capturing DNA from ticks for genome sequencing of *Borrelia*. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Skaraas, C., Slagsvold, T., Lampe, H. M. Personality and natal dispersal in great tits *Parus major*. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Speed, J. D. M., Austrheim, G., Hester, A. J., Holand, Ø., Mysterud, A. The impact of herbivory within the treeline ecotone. *Ecological Society of America Annual Meeting, USA*. 10–15 August.

Stenseth, N. C. Kvalitet på marin forskning: hvor gode er vi? “Marin innovasjon og kunnskap: utnytter vi potensialet?”, *Norway*. 22 January.

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Stenseth, N. C. Insentiver ved MatNat Fakultet – positive, negative eller skjulte. *MatNatFak styreseminar, Norway.* 27 January.

Stenseth, N. C. Opening remarks. *Darwin Day 2014, Norway.* 12 February.

Stenseth, N. C. Recent work on the plague eco-evolutionary system: extending our work from Central Asia to Caucasus and China. *Institute of Theoretical Astrophysics' Colloquium, Norway.* 14 February.

Stenseth, N. C. Genomics – the ideal tool box to advance the marine sector. *Marine Innovation Day, Norway.* 4 March.

Stenseth, N. C. Ancient DNA laboratoriet ved University i Oslo. *Museenes naturmangfoldsseminar, Norway.* 1 April.

Stenseth, N. C. Climate change and impact on emerging infectious diseases: plague as an example. *9th Conference Louis Pasteur "Emerging Infectious" Diseases, France.* 11 April.

Stenseth, N. C. "Enabling early career researchers – needs for training of a new generation". *The European Federation of Academies of Science and Humanities, Norway.* 24 April.

Stenseth, N. C. Opening remarks. *GreenMAR Kick-off Meeting, Norway.* 26 May.

Stenseth, N. C. Presentation of CEES. *GreenMAR Kick-off Meeting, Norway.* 26–27 May.

Stenseth, N. C. Overview presentation on the Kavli Prizes. *Kavli Prize Lecture, Norway.* 30 May.

Stenseth, N. C. Ecology, evolution & society. *BioResources & BioDiversity, France.* 2 June.

Stenseth, N. C. Opening remarks. *VISTA Scholar Meeting, Norway.* 10 June.

Stenseth, N. C. Opening remarks. Facilitating Excellence in Science in Norway. *ERC plenary meeting, Norway.* 17 June.

Stenseth, N. C. Open Access and scientific excellence. *ERC – DNRF Joint Workshop "Fostering academic excellence in a changing world", Denmark.* 22 June.

Stenseth, N. C. Introduction speech. *Euroscience Open Forum, Denmark.* 23 June.

Stenseth, N. C. ERC grants. *Writing Successful ERC Advanced Grant Proposals (In House Training), Norway.* 24 June.

Stenseth, N. C. Climate change and impact on emerging infectious diseases: plague as an example. *Seminar at Chinese CDC, China.* 10 August.

Stenseth, N. C. "Skagerrakinitiativet": forskningssamarbeid mellom UiO, UiA og HI. *Nasjonal strand- og kystsonekonferanse, Norway.* 12 August.

Stenseth, N. C. Pandemics and climate change: plague as an example. *World Science Week, New Zealand.* 29 August.

Stenseth, N. C. Introduction speech. *Kavli Laureate Lecture, Norway.* 11 September.

Stenseth, N. C. Research and educational activities. *UiA Board Meeting, Norway.* 17 September.

Stenseth, N. C. Hvordan kommunisere forskning? *Norden i fokus, Norway.* 26 September.

Stenseth, N. C. Coevolution in multispecies communities: the Red Queen perspective. *Russia Science Festival, Russia.* 12 October.

Stenseth, N. C. The Chair's annual report: update and the path forward. *CEES Scientific Advisory Board Meeting, Norway.* 21 October.

Stenseth, N. C. Red Queen and Court Jester: biotic and abiotic interactions in ecology and evolution. *74th Annual Meeting of the Society of Vertebrate Paleontology, Germany.* 5–8 November.

Stenseth, N. C. Introduction speech. *Kavli Prize Lecture, Norway.* 6 November.

Stenseth, N. C. Global plague transmission and occurrence: intrinsic and extrinsic drivers. *6th International Symposium of Integrative Zoology, China.* 24–25 November.

Stenseth, N. C. The zoologist Charles Elton: lemmings and the start of empirically based population biology. *6th International Symposium of Integrative Zoology, China.* 24–25 November.

Stenseth, N. C. Introduction speech. *Kavli Laureate Lecture, Norway*. 9 December.

Stenseth, N. C. Presentation of CEES. *RCN site-visit, Norway*. 12 December.

Stenseth, N. C. “Kunnskap trumfer alt”. *Tekreal personal-seminar, Norway*. 15 December.

Stenseth, N. C. Hvordan kan og bør universitetene bidra til “excellence in science”? Hva skal til for å utvikle verdensledende forskningsmiljøer? *Forskningspolitisk møte, The Norwegian Academy of Sciences and Letters, Norway*. 16 December.

Stenseth, N. C., Elverhøi, A. VISTA Strategy 2014–2019. *VISTA Scholar Meeting, Norway*. 10 June.

Stenseth, N. C., Paasche, Ø. “Connecting the seas of Norden”. *The Nordic Seas – Gold mines for the future?, Norway*. 28 November.

Stenseth, N. C., Voje, K. L., Holen, Ø. H., Liow, L. H., Trosvik, P. Biotic and abiotic interactions in evolution: the Red Queen perspective on evolution in biotic communities. *Species, Climate, and Traits: Integrative Climate Change Biology iCCB Meeting, USA*. 6 April.

Stenseth, N. C., Voje, K. L., Holen, Ø. H., Liow, L. H., Trosvik, P. Coevolution in multispecies communities: the Red Queen perspective. *Fisher Lecture, UK*. 21 July.

Stræte, T. Ø., Slagsvold, T., Lampe, H. M. Consistency between personality traits in wild great tits *Parus major*. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Svoen, M. E., Brysting, A. K. Population dynamics of *Silene acaulis* in the High Arctic. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Sørhus, E., Edvardsen, R., Karlsen, Ø., Nordtug, T., van der Meeren, T., Thorsen, A., Maksan, D., Thorbjørnsen, M., Harman, C. P., Jentoft, S., Meier, S. Interaction between pelagic fish embryos and dispersed oil droplets. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Sørhus, E., Meier, S., Thorsen, A., Edvardsen, R., Jentoft, S., Nordtug, T., Maksan, D., Thorbjørnsen, M., Harman, C. P., van der Meeren, T., Karlsen, Ø. Interactions between pelagic fish embryos and dispersed oil droplets. *SETAC North America 35th Annual Meeting, Canada*. 9–13 November.

Thorsteinsen, C., Slagsvold, T., Lampe, H. M. Reproductive success in great tits (*Parus major*) in relation to individual personality. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Toljagic, O. Evolutionary rates in ungulates. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Toljagic, O. Evolutionary rates in ungulates: a two-pronged approach. *North American Paleontology Conference, USA*. 15–18 February.

Trosvik, P., de Muinck, E. Biotic interactions and temporal dynamics of the human GI microbiota. *2nd World Congress on Targeting Microbiota, France*. 16–17 October.

Turner, W. C. Indirect effects of a lethal pathogen deter then attract herbivorous hosts to anthrax carcass sites. *Ecological Society of America Annual Meeting, USA*. 1–4 June.

Turner, W. C. Indirect effects of a lethal pathogen deter then attract herbivorous hosts to anthrax carcass sites. *Wildlife Society Annual Conference, USA*. 26–29 October.

Tørresen, O. K., Jentoft, S., Star, B., Sandve, G. K. F., Skage, M., Hansen, M. H. S., Tooming-Klunderud, A., Jakobsen, K. S., Nederbragt, A. J. A new, high quality reference genome assembly for Atlantic cod. *CEES Annual Student Conference 2014, Norway*. 21–22 October.

Tørresen, O. K., Walenz, B., Grove, H., Lien, S., Knight, J., Star, B., Lagesen, K., Sandve, G. K. F., Skage, M., Hansen, M. H. S., Klunderud, A. T., Miller, J. R., Jentoft, S., Jakobsen, K. S., Nederbragt, A. J. A new, high quality reference genome assembly for Atlantic cod. *SocBiN Bioinformatics, Norway*. 11–13 June.

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Valseth, K., Espelund, M., **Haverkamp, T. H. A., Stenseth, N. C.** Next generation sequencing on soil samples from Etosha National Park: diversity studies of an anthrax reservoir. *CEES Annual Student Conference 2014, Norway.* 21–22 October.

Vike, B. K., Mysterud, A., Meisingset, E. L., **Rivrud, I. M.** Red deer migration and dietary quality: testing the forage maturation hypothesis. *CEES Annual Student Conference 2014, Norway.* 21–22 October.

Vikingsdal Seland, I., Mysterud, A., Viljugrein, H. The distribution of ticks and tick-borne pathogens from coast to inland in south-east Norway? *CEES Annual Student Conference 2014, Norway.* 21–22 October.

Vindenes, Y. Advancing integral projection models for size-structured populations. *Netherlands Annual Ecology Meeting, Netherlands.* 11–12 February.

Voje, K. L. Rates of evolution in fossil time series. *CEES Annual Student Conference 2014, Norway.* 21–22 October.

Vøllestad, L. A. Atlantic salmon *Salmo salar*. Analysis of the Norwegian catch statistics. *Invitert foredrag, Norway.* 17 January.

Vøllestad, L. A. Hva er det med laksen? *Seminar om villaks på Stortinget, Norway.* 25 March.

Vøllestad, L. A. Norske ferskvannsfisk – utbredelse, biologi og utfordringer. *Kurs i anvendt fiskebiologi, Norway.* 26 May.

Vøllestad, L. A. Population differentiation and diversification: rapid and small scale? *Ecology of Fish in Lakes and Reservoirs.* 8 September.

Vøllestad, L. A. Climate effects on fish migration: eel and salmon as examples. *Swedish Marine Sciences Conference, Sweden.* 10–12 November.

Vøllestad, L. A. Contemporary evolution in grayling *Thymallus thymallus*. *Internt seminar, Norway.* 3 December.

Whittington, J. Acoustic features of display calls may reveal breeding status and individual quality in emperor penguins. *33rd SCAR Biennial Meeting and Open Science Conference, New Zealand.* 23 August–3 September.

Winter, A.-M. How fishing pressure and climate variability impact Allee effect dynamics and the recovery of fish populations. *CEES Annual Student Conference 2014, Norway.* 21–22 October.



Raspberry fields at one of our focal farms in Leikanger, Sogn, Western Norway. The berries are grown in the open, but also within plastic growing tunnels. In the project PolliClim we study how climate change might affect plant-pollinator interactions. © Anders Nielsen.

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