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ECOLOGY AND EVOLUTIONARY BIOLOGY IN FINLAND 2006–2010

EVALUATION REPORT

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Members of the Evaluation Panel

Ray Callaway
Robert D Holt
Mari Källersjö
David A MacLean
Anne Magurran
Allen Moore
Brian Moss
Björn-Erik Saether
Nina Wedell
Kathy Willis

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DESCRIPTION

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Abstract

This report presents the findings of an international panel convened to evaluate the research fields of ecology and evolutionary biology in Finland. The evaluation covers 14 units active in the fields of ecology and evolutionary biology and the years 2006–2010. The assessment is based on interviews with and back-ground material provided by each unit. In the evaluation, the panel looked at research quality, research environment (incl. infrastructure), funding and the training of young researchers.

The Finnish scientific community makes fundamental contributions to many areas of research in ecology and evolution. Many researchers across the country are internationally recognised for their achievements and this is reflected in a strong record of excellent publications in high-quality journals. Every unity contains examples of high-quality research and, in some subdisciplines, Finnish scientists are truly outstanding, indeed at the top of their fields worldwide. There is also a strong record of graduate training. Overall, the panel applauds Finland for its outstanding achievements in ecology and evolutionary biology.

The panel also identified strategies that should be considered for Finland to maintain and build on its inter-nationally recognised strengths in ecology and evolution. There seem to be lost opportunities for synergistic research and educational endeavours across institutions in a number of key areas: peatland ecology; forest ecosystem ecology; theoretical and empirical population genetics; theoretical and quantitative ecology; freshwater and marine ecology. Finland has an enviable record of developing long-term datasets. These are national assets, which the panel applauds and urges to be maintained.

The network of field stations, museums and botanical gardens is immensely important, and should be sustained. The institutions must ensure that there is adequate administrative support available to researchers, both during preparation of EU and other international proposals and after the funding has been granted. Graduate education in general appears to be good, but there are some challenges that should be faced. The current move towards university-based graduate schools has many merits, but there is a danger that some unique advantages currently present in the national schools will be diminished or lost. Greater reliability in the funding of doctoral candidates would be desirable. Postdoctoral fellows are an increasingly evident dimension of research institutions, and formal mechanisms for fostering this aspect of developing and sustaining this tool of human talent should be developed.

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Tekijä(t)	Arviointipaneeli	
Julkaisun nimi	International Evaluation of Ecology and Evolutionary Biology in Finland 2006–2010. Evaluation Report	
Tiivistelmä	Raportti esittelee kansainvälisen arviointipaneelin tekemän Suomen ekologian ja evoluutiobiologian tutkimuksen arvioinnin. Arvioinnin kohteena oli neljätoista suomalaista ekologian ja evoluutiobiologian tutkimusyksikköä kattaen vuodet 2006–2010. Arviointiraportti perustuu paneelin tekemiin haastatteluihin sekä yksiköiltä saatuun taustamateriaaliin. Paneelin tuli kiinnittää huomiota alan tutkimuksen laatuun, tutkimusympäristöihin (ml. infrastruktuurit), rahoitukseen ja tutkijankoulutukseen. Arviointiryhmä toteaa raportissaan, että suomalainen tiedeyhteisö on tehnyt uraauurtavaa työtä monilla ekologian ja evoluutiobiologian aloilla. Useat tutkijat ovat saaneet kansainvälistä tunnustusta työlleen, tästä ovat osoituksena lukuisat artikkelit erittäin korkeatasoissa kansainvälisissä julkaisusarjoissa. Kaikissa arvioiduissa yksiköissä tehdään korkeatasoista tutkimusta, joillakin aloilla suomalainen tutkimus on erittäin merkittävää, tutkimusalansa ehdotonta kärkeä. Suomalainen tutkijankoulutus on vahvaa. Kaiken kaikkiaan paneeli arvostaa erittäin paljon suomalaisen ekologisen ja evoluutiobiologisen tutkimuksen saavutuksia. Paneeli ehdottaa toimenpiteitä, joiden avulla Suomi voi ylläpitää ja kehittää kansainvälisesti tunnustettuja osa-alueita ekologian ja evoluutiobiologian tutkimuksessa. Yksiköt eivät ole hyödyntäneet täysimääräisesti yhteistyömahdollisuuksia tutkimuksessa ja opetuksessa keskeisillä tutkimusalueilla kuten suo- ja metsäekosysteemien tutkimuksessa, teoreettisessa ja populaatiogenetiikassa, teoreettisessa ja kvantitatiivisessa ekologiassa sekä sisävesien ja merien ekologiassa. Suomalaisella alan tutkimusyhteisöllä on käytössään ainutlaatuisia pitkiä aikasarjoja monilta tutkimusaloilta. Nämä aikasarjat ovat paneelin mukaan osa kansallisomaisuutta, joiden kehittämiseen ja ylläpitoon pitäisi varata resursseja, niin aikaa kuin henkilöstöäkin. Laitosten tulisi varata tutkijoille riittävästi hallinnollista tukea EU:n ja muiden kansainvälisten hakemusten valmisteluun ja ja myös hankkeen toteutusvaiheeseen. Kasvitieteellisten puutarhojen ja museoiden verkoston merkitys on keskeinen ekologiselle ja evolutiiviselle tutkimukselle, joten niiden toimintaedellytykset pitää turvata. Tutkijakoulutus on vankalla pohjalla, mutta muutokset koulutuksen organisoinnissa tulee ottaa huomioon. Yliopistokeskeinen tutkijakoulutus näyttäisi olevan hyvä toimintatapa, mutta samalla verkostoituneen kansallisen tutkijakoulutuksen ainutlaatuiset edut saatetaan menettää. Tutkijakoulutuksessa on turvattava koulutettavien pitkäkestoinen rahoitus. Tutkijatohtorit ovat merkittävä osa tutkimusyksikköjen toimintaa, heidän tietojensa ja taitojensa kehittämistä ja hyödyntämistä on tuettava järjestelmällisesti	
Asiasanat	ekologia, evoluutiobiologia, tutkimuspolitiikka, tutkimusrahoitus, tutkimuksen laatu, tutkimusympäristö, tohtorikoulutus	
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PRESENTATIONSBLAD

Utgivare	Finlands Akademi	Datum Maj 2012
Författare	Utvärderingspanel	
Publikationens namn	International Evaluation of Ecology and Evolutionary Biology in Finland 2006–2010. Evaluation Report	
Sammandrag	Denna rapport presenterar resultaten av en internationell utvärdering av forskningen i ekologi och evolutionsbiologi i Finland åren 2006–2010. Utvärderingen omfattar 14 finländska forskningsenheter på området. Rapporten grundar sig på intervjuar gjorda av panelen samt på bakgrundsmaterial som enheterna lämnat in. Utvärderingspanelen hade som uppgift att analysera forskningens kvalitet, forskningsmiljöerna (inkl. infrastruktur), finansieringen och forskarutbildningen. Panelen konstaterar att det finländska forskarsamhället har utfört banbrytande arbete på många områden inom ekologi och evolutionsbiologi. Ett flertal forskare har lyckats få internationellt beröm för sitt arbete och har t.ex. publicerat artiklar i högt uppskattade internationella tidskrifter. Alla de utvärderade enheterna idkar högklassig forskning. Inom vissa områden kan det konstateras att den finländska forskningen har stor betydelse och att den placerar sig i den internationella toppen. Forskarutbildningen ligger också på en god nivå. Panelen värdesätter överlag de resultat som nåtts inom den finländska forskningen i ekologi och evolutionsbiologi. Utvärderingspanelen tar också fram strategier med vilka Finland kunde upprätthålla och vidareutveckla sina internationellt ansedda delområden inom ekologisk och evolutionsbiologisk forskning. De utvärderade enheterna har inte fullt utnyttjat de samarbetsmöjligheter inom forskning och utbildning som finns på vissa nyckelområden: forskning i myr- och skogsekosystem; teoretisk och populationsgenetik; teoretisk och kvantitativ ekologi; samt insjö- och havsekologi. Många andra länder kan avundas Finlands långa tidsserier, som kan anses vara en nationalförmögenhet och som bör utvecklas och upprätthållas med besked. Forskare bör ha tillräckligt med administrativt stöd för att bereda projekt på EU- och internationell nivå, men också då projektet genomförs. Nätverket av museer och botaniska trädgårdar spelar en avgörande roll för den ekologiska och evolutionsbiologiska forskningen och deras verksamhets-förutsättningar måste därför tryggas. Forskarutbildningen på områden vilar på en god grund, men man måste även beakta förändringar i hur utbildningen organiseras. Den universitetscentrerade utbildningen ligger bra till, men den riskerar att gå miste om de unika fördelar som en nätverksbaserad nationell forskarutbildning erbjuder. Man borde därför säkra en långsiktig finansiering inom forskarutbildningen. Forskardoktorerna utgör en betydande del av forsknings-enheternas verksamhet och man ska se till att systematiskt stödja utvecklingen och utnyttjandet av deras kunskaper och färdigheter.	
Nyckelord	ekologi, evolutionsbiologi, forskningspolitik, forskningsfinansiering, forskningens kvalitet, forskningsmiljö, doktorsutbildning	
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PREFACE

Given both the fundamental and practical importance of the disciplines of ecology and evolutionary biology, their vital and increasingly interlinked relevance to human wellbeing, and their increasing intellectual interdependencies, the Research Council for Biosciences and Environment of the Academy of Finland decided on 6 June 2008 that Finnish ecology and evolutionary biology should be jointly evaluated with respect to the quality and coherence of both disciplines within Finland, in comparison with international standards of achievement in these fields. The evaluation was intended to combine an external assessment by an international panel with an internal self-assessment made by each relevant institutional unit, which were also to be considered by the international panel. The panel members were chosen by the Academy to represent the diversity of the disciplines of ecology and evolution, and included scientists from Europe and North America. The panel met for a week (13–18 November 2011) with representatives of both the academic staff and the graduate students of each unit under evaluation, who gave presentations and engaged in a discussion with the panel about the strengths and potential weaknesses of their unit. In crafting our comments, the panel has relied on insights gained during these meetings, while also carefully considering the written internal assessment provided by each unit. This document reflects the fruits of the panel's deliberations, consisting of evaluations of specific units together with a synoptic assessment of the health, prospects and challenges of ecology and evolutionary biology in Finland as a whole.

Even casual visitors such as the members of the panel can recognise that the culture in Finland shows many marks of an abiding appreciation of nature, and the excellence of Finnish science in the areas of ecology and evolutionary biology is surely built on this dimension of national popular life and culture. We ourselves saw on our visit, while crossing the busy Aleksanterinkatu, an indication of this cultural dimension of ecology – two metal strips, a hundred or so metres apart. These strips, engraved with the musically resonant names of aquatic species, pay homage to a past but not forgotten environment, as they mark the banks of a creek that once flowed where traffic now surges. In like manner, Finnish scientists are today making their own durable and resonant mark in the world of ecology and evolutionary biology. By contributing actively to societal outreach and the crafting of wise and effective policies for environmental and natural resource use, Finnish scientists also help maintain a culture of appreciation for the natural world both within their own country and more broadly across the globe.

On behalf of the panel, I would like to thank the Academy of Finland for its hospitality, and on my own behalf, I thank all the members of the panel for their good cheer, their hard work during and after our meeting, and their thoughtful contributions to this report.

Robert D. Holt
Professor
Chair of the Evaluation panel

SUMMARY

Ecology and evolutionary biology are arenas of exciting fundamental research. They also provide understanding that is essential for maintaining the wellbeing of both natural and human-modified environments in our rapidly changing world. In 2011, the Academy of Finland appointed a panel of ten scientists selected from outside Finland to provide a broad review of ecology and evolutionary biology, including both the state of research accomplishments in these disciplines and graduate education, across the country as a whole and within individual universities and governmental agencies. The review encompassed terrestrial, freshwater and aquatic ecosystems, and many subdisciplines such as systematics, biogeography, population biology, forest ecology, theoretical ecology and population genetics, among others. Although strictly applied research was not contained within the review, much of the research and education reviewed involves significant applied dimensions. The review encompassed 14 units, including ten university departments and four governmental sectoral units. To conduct its evaluation, the panel scrutinised detailed reports prepared according to a common scheme by each of the units, and also met with a selection of scientists, administrators, postdoctoral fellows and graduate students. The goal of the evaluation was both to highlight achievements and to identify potential weaknesses that should be addressed. Overall, the panel was highly impressed by the scope and high quality of research conducted by the Finnish scientific community in ecology and evolutionary biology, and by the strength of its doctoral programmes. The Finnish scientific community makes fundamental contributions to many areas of research in ecology and evolution. Many researchers across the country are internationally recognised for their achievements and this is reflected in a strong record of excellent publications in high-quality journals. Every unity contains examples of high-quality research, and in some subdisciplines, Finnish scientists are truly outstanding, indeed at the top of their fields worldwide. There is also a strong record of graduate training. Overall, the panel applauds Finland for its outstanding achievements in ecology and evolutionary biology.

The panel also identified strategies that should be considered for Finland to maintain and build on its internationally recognised strengths in ecology and evolution. There seem to be lost opportunities for synergistic research and educational endeavours across institutions in a number of key areas. Finland has an enviable record of developing long-term datasets, which the panel applauds and urges to be maintained. The network of field stations, museums and botanical gardens is immensely important, and should be sustained. Graduate education in general appears to be good, but there are some challenges that should be faced. The current move towards university-based graduate schools has many merits, but there is a danger that some unique advantages currently present in the

national schools will be diminished or lost. Greater reliability in funding of doctoral candidates would be desirable. Postdoctoral fellows are an increasingly evident dimension of research institutions, and formal mechanisms for fostering this aspect of developing and sustaining this tool of human talent should be developed. All of these recommendations are meant not to harp on weaknesses, but instead to help the Academy, the units evaluated and indeed the nation as a whole to sustain and capitalise on their evident strengths in this domain of science.

INTRODUCTION

Scope of ecology and evolutionary biology research

Ecology is the study of life in its environment, at all scales of biological organisation from genes to the physiology and behaviour of organisms, to indeed the entire biosphere. Evolutionary biology is the study of the history of life and the processes that generate that history. A key concern of both disciplines is elucidating the mechanisms by which organisms cope (or do not cope) with inevitable changes in their environment, which these days are increasingly caused by human activities. Both disciplines are inherently interdisciplinary, drawing on a wide range of other natural, mathematical and increasingly even social sciences. Though historically separated, these disciplines are increasingly mutually interdependent, and it is hard to assess the accomplishments and limitations of one without considering the other. For instance, the traits of organisms and the structure of communities reflect historical, evolutionary processes such as mutation, selection, colonisation and extinction. Genetic and phylogenetic tools increasingly permit inferences about population and community history, and the use of molecular tools is increasingly pervasive in both disciplines. In like manner, key drivers of evolution include ecological processes such as competition and nutrient limitation, and ecological perspectives in turn are essential to interpreting the flood of data emerging from genomics. The enormous banks of ecological, evolutionary and genetic data require the application of increasingly sophisticated statistical and computational tools, informed by mathematical theory, in both fields. Moreover, there is increasing recognition that the time scales of ecological and evolutionary change overlap in many areas of great concern for human welfare, such as the emergence of novel infectious diseases, the sustainable harvesting of natural resources and the resilience of ecosystems to the looming threats of global climate change. Environmental management will increasingly need to include a dimension of applied evolutionary biology.

A key task is to predict and mitigate losses of biodiversity and the degradation of ecosystem function that are occurring because of burgeoning human impacts, not just in Finland but worldwide. Dealing with these urgent applied issues must be based on high-quality fundamental ecological and evolutionary science. Moreover, this scientific mission mandates that ecological research become increasingly intertwined with the perspectives and approaches of the social sciences. The growing recognition that ecological and evolutionary processes play out over large temporal and spatial scales and that biological processes have significant impacts on physical processes of the Earth has led to an appreciation that ecology and evolution, in the end, are also essential dimensions of the Earth sciences. Finnish scientists are at the forefront of all these issues.

Background of the evaluation

Evaluations of disciplines and individual fields of research are important research and science-policy development tools in providing feedback to the scientific community and to funding agencies. The

aim of evaluation is to inspire discussion and debate and help researchers and funding organisations to identify potential problems and areas of development. The Research Council for Biosciences and Environment of the Academy of Finland thus decided to commission an international evaluation of ecology and evolutionary biology in Finland. The steering group for the evaluation defined the scope of evaluation to cover all research in the areas of ecology and evolution within Finland, including many specific subdisciplines such as behavioural ecology, aquatic ecology, forest ecology, population ecology, population genetics, systematics, community ecology, ecosystems ecology and a broad slice of environmental science. Research overlapping with physiology and genetics was also included, whenever such research involved a significant ecological or evolutionary dimension. Applied research was also included if it involved a component of basic research. The evaluation did not specifically include research that is purely applied, but, in any case, it is often difficult to draw a sharp line between basic and applied research.

The Academy of Finland established a review panel on ecology and evolutionary biology in Finland consisting of eleven scientists from outside Finland. The review panel convened between 13 and 18 November 2011 and had the opportunity to interview staff from units active in fields of ecology and evolutionary biology. This assessment is based on the interviews and on background material provided by each unit. Ecology and evolutionary biology was evaluated from six universities (Åbo Akademi University, University of Eastern Finland, University of Helsinki, University of Jyväskylä, University of Oulu and University of Turku), including nine academic departments and one museum, and from four government research institutes (MTT Agrifood Research Finland, Finnish Forest Research Institute Metla, Finnish Environment Institute (SYKE) and Finnish Game and Fisheries Research Institute). For some units, only a fraction of the work is devoted to basic research in ecology and evolutionary biology. In the evaluation process, the panel considered research quality, research environments including infrastructure and funding, and training of young researchers.

The outcome of the evaluation was to provide assessments and recommendations at unit level and for the research system of Finnish ecology and evolutionary biology. The term 'unit' refers to the department of a university or an independent research institute or the relevant part of it assessed in the evaluation. The term 'system level', on the other hand, describes the organisation of individual units in relation to and as embedded in the Finnish research and innovation system.

Finnish Research and Innovation system

Finland has a national consensus that a prospering society has its roots in a well-functioning research enterprise, distributed throughout the nation and comprising the producers and end-users of new knowledge and technologies. The cornerstones of the national research and innovation system are top-quality education from the first level to higher education, research and product development, and knowledge-intensive business and industry. A carefully conceived policy process that supports and improves research and education is an integral part of the system. In general, there is across the nation a move from a narrow science and technology policy towards a broad-based research and innovation policy, also incorporating issues

of education, research policy, technology policy, entrepreneurship and elements from various other policies into a more coherent entity.

At the highest level, science governance takes place in Parliament and the national Government. The key ministries are the Ministry of Education and Culture and the Ministry of Employment and the Economy. Other ministries have a minor but still important role via sectoral research and governmental research institutes. The Ministry of Education and Culture handles matters relating to education, science policy, universities and polytechnics, as well as the Academy of Finland. The Ministry of Employment and the Economy deals with matters relating to innovation and technology policy and entrepreneurship, as well as Tekes, the Finnish Funding Agency for Technology and Innovation.

The major research funding (via competitive funding) agencies are the Academy of Finland and Tekes. Almost half of government research funding is channelled through these two agencies. Academy funding goes primarily to scientific research at universities and research institutes. The total volume of funding amounts to €384 million (2010). The Academy also has responsibility for the decision-making, development and monitoring of Finnish doctoral programmes in science. Tekes annually funds some 1,500 business research and development projects, and almost 600 public research projects at universities, research institutes and polytechnics. In 2010, from the total of €2117 million of government R&D expenditure, direct research funding to universities, research institutes and polytechnics comprised €517 million.

The operational level where these funds are applied consists of education and research, conducted at educational and development organisations such as polytechnics and universities, research institutes and R&D-oriented enterprises. The Finnish higher education and research system has considerable diversity with 27 polytechnics, 16 universities, 18 governmental and 11 other research institutes.

Finland is one of the most research-intensive countries in the world. In total, Finnish R&D employs some 79,979 people. R&D funding amounts to €6.9 billion, which accounts for 3.9 per cent of GDP. The private-sector proportion of R&D funding is some 70 per cent, while higher education and other public funding account for some 20 and 10 per cent, respectively. Governmental research expenditure was €2.12 billion in 2010, and the estimated funding for basic research was €1.1 billion.

Embedding of ecology and evolutionary biology inside the Finnish research system

This evaluation of ecology and evolutionary biology covered a total of 14 research units (Table 1). The units are from six universities and four governmental research institutes.

Universities promote basic research and scientific education and provide higher education based on research by faculty and other staff. In carrying out their mission, universities must strive to interact with the surrounding society and strengthen the impact of research findings on society. Under the new Universities Act that came into force on 1 January 2010, all universities that have units included in this evaluation are independent corporations under public law. Their operations are

Table 1. Units in the international evaluation of Finnish ecology and evolutionary biology

Organisation	Faculty	Department	Abbreviation
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	UEF_Biol
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	UEF_Forest
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	UH_Biosci
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	UH_Env
	Faculty of Agriculture and Forestry	Department of Forest Sciences	UH_Forest
	Finnish Museum of Natural History	Botany and Zoology Units	UH_Museum
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and Marine Biology)	ÅA
University of Oulu	Faculty of Science	Department of Biology	UO
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	UJ
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	UT
Finnish Environment Institute (SYKE)			SYKE
MTT Agrifood Research Finland			MTT
The Finnish Forest Research Institute			METLA
Finnish Game and Fisheries Research Institute			FGFRI

built on the basic principles of freedom of education and research and university autonomy.

Research performed at sectoral research institutes, by contrast, aims to provide, produce and transfer knowledge to support strategic policy-making in addressing societal needs. The collective activities of these sectoral units provide a highly valuable societal resource, and in carrying out their societal missions, they can also make substantial intellectual contributions to the scientific endeavour. Besides research orientated to applied issues and development, all public research institutes have specific sectoral mandates and organisational structures specified by the Government. Their designated functions are partly based on law. Several organisations have designated tasks in public authority, supervision and service. Three of the governmental research institutes included in this evaluation – the Finnish Forest Research Institute (Metla), MTT Agrifood Research Finland, and the Finnish Game and Fisheries Research Institute (FGFRI) – operate within the administrative branch of the Ministry of Agriculture and Forestry. The Finnish Environment Institute (SYKE) operates under the Ministry of the Environment,

though the Institute's work related to water resources is supervised by the Ministry of Agriculture and Forestry.

During the evaluation period, the Finnish university system started to undergo a phase of restructuring and reformation. Together with university-level changes in organisations, this was reflected in shifts in the structure and titles of several units in the evaluation. So to some extent, a few units are moving targets, which makes appropriate evaluation more challenging. In this evaluation report, units are named according to their current organisational name and status (see Table 1).

Doctoral training

The Finnish education system consists of nine years of basic education, followed by upper secondary education and finally higher education; the latter is provided by universities and polytechnics. The mission of universities is to conduct scientific research and provide undergraduate, graduate and postgraduate education. Universities award Bachelor's, Master's, licentiate and doctoral degrees, and provide venues for continuing education at advanced levels in postdoctoral training as well.

In order to pursue the highest university degree (a doctoral degree) a student has to be accepted as a doctoral candidate by a faculty member of a university, who agrees to be the candidate's advisor. Sometimes, this faculty member is employed at a sectoral unit but has a nominal post (e.g. adjunct professorship) at a university, permitting the researcher to serve as the candidate's advisor. All professors and senior researchers (ranks 1 and 2) can potentially serve in this role. During the application process, a student must present a study plan and a research plan for the doctoral dissertation. Doctoral studies include, in addition to conducting research to be reported in the thesis, high-level studies worth 60 study points equalling one year's work.

In order to increase the number of doctoral degrees, and to support and shorten completion times, a graduate school system was established in Finland 1995, and has ever since gradually expanded. On 1 January 2008, the Ministry of Education delegated the decision-making on and responsibility for the development and monitoring of doctoral programmes (formerly graduate schools) to the Academy of Finland.

Doctoral programmes provide systematic, high-level and supervised researcher training, which is obtained over a given period of time (which may vary among institutions and fields of study.). They ensure the supply of a sufficient number of high-level researchers and experts to meet the needs of universities, business and industry, and society at large. The target length for a doctorate (in an ideal world) is about four years. The four-year doctoral programme positions are intended for full-time work on a doctoral dissertation, and doctoral candidates are generally hired to positions for the entire four-year term. In addition, some doctoral programmes receive funding (operational grants) to arrange systematic and high-level education and to establish systematic cooperation on national, international and sectoral levels.

Ministry of Education and Culture allocates the doctoral programme positions to universities in accordance with the Academy's decisions, and the operating grants are awarded to universities by the Academy. In addition to student positions funded by the Ministry, doctoral

programmes usually accept students who are funded from sources other than the Ministry to take part in doctoral training programmes (matching-funds students), and provide them with equal access to training opportunities. In the end, most (but not all) doctoral candidates carry out their training within one of these programmes.

Doctoral programmes are typically organised as national networks, among different universities and research organisations, with coordination offices allocated to host universities. There are currently 112 doctoral programmes in Finland, of which 85 per cent are national networks and 15 per cent local programmes (the latter are restricted to a single institution). Of the former, there are just seven devoted to the areas of ecology and evolution, but these do typically involve several universities and sectoral research units. Currently, a total of 1,600 doctoral programme positions are funded by the Ministry of Education, Science and Culture. In addition, doctoral programmes have some 4,800 matching-funds students, who receive their funding from private foundations (often this is rather limited in time or amount, and typically covers subsistence, rather than research expenses). The percentage of international students is about 16 per cent. In this evaluation, units reported that nine doctoral programmes or graduate schools at a local or Nordic level provide training for their students (Table 2). Annually, some 1,500 doctoral degrees are awarded in Finland.

The next step in the evolution of Finnish doctoral training is the establishment of graduate schools at the university level. At the moment, being a student in a doctoral programme or in a graduate school is not a prerequisite to be accepted as a doctoral candidate at a university. In the future, it is expected that all doctoral candidates will be members of a graduate school at the university level, whether or not they are participating in a doctoral programme at a national level. At present, some (but rather few) doctoral candidates are not members of a university graduate school. It is anticipated that this will not be the case at some point in the future.

Table 2. List of Finnish doctoral programmes or graduate schools providing training for doctoral students in the units.*

Name of graduate school	Coordinating university	Number of participating universities and institutions
The Finnish School in Wildlife Biology, Conservation and Management – Luova	Helsinki	1
Biological Interactions Graduate School – BIOINT	Jyväskylä	9
Graduate school in population genetics – PopGenSchool	Oulu	4
Doctoral Program in Integrated Catchment and Water Resources Management – Value	Oulu	3
Graduate School in Forest Sciences – GSForest	UEF	4
Finnish Graduate School of Environmental Science and Technology – ENSTE	UEF	3
Finnish Doctoral Program in Plant Science	Helsinki	1

NB. Three evaluated units participate in ENSTE, in addition 12 other units from seven universities are members of the graduate schools. Finnish Food Safety Authority Evira (not evaluated) is also a member of BIOINT. Only one unit is participating in the doctoral programme in plant science.

PROFILE OF ECOLOGY AND EVOLUTIONARY BIOLOGY IN FINLAND

Evaluation materials

For the evaluation of ecology and evolutionary biology in Finland, units collected data on their resources, research profiles, organisation of research and researcher training as well as the outcomes of unit performance in response to the Academy's specifications. Datasets compiled by the units were used as assessment material. The complete set of evaluation forms is provided in Appendix 3. Summary tables of research inputs and outputs and additional information on bibliographic analysis of publications in the fields of ecology and evolutionary biology are provided in Appendix 1-10.

In addition to the pre-collected assessment material, the evaluation panel received additional information during meetings with representatives from each unit, which involved formal presentations by research staff from the units, subsequent discussions and meetings with a selection of graduate students and postdocs.

Research fields

Units were asked to provide information of their research profile by nominating subfields of their research focus. The human resources of ecology and evolutionary biology are allocated in forest ecology (estimated 20%), followed by population biology (17%), evolutionary ecology and biology (17%) and aquatic ecology (13%). Some amount of research (8%) was in the field "other", which was not pre-categorised in the data collection forms. Ecology and evolutionary biology haves a significant role in the larger research portfolio of organisations. The mean percentage of ecology and evolutionary biology research across the departments' research was 41 per cent, with the maximum being 82 per cent for the Department of Biosciences at the University of Helsinki and the minimum of being 3 per cent for MTT Agrifood Research Finland (as a share proportion of annual funding).

It should be recognised that these categories in defining research profiles are not mutually exclusive, and may not give a fully nuanced perspective on the research activities underway in the units (e.g. the population biology of trees could be viewed as forest ecology as well as of population biology, and salmonid population dynamics is surely part of aquatic ecology), but they do as a matter of history provide the organisational scheme for this particular evaluation. In future comparable efforts, the Academy should consider using alternative schemes. For instance, research activities could be parsed by where they fit in the traditional hierarchy of levels of organisation (individuals, to populations, to communities, to ecosystems, to the biosphere). This might be complemented by division among major habitat types (forest, non-forest terrestrial, freshwater, marine, other, e.g. theoretical studies), or

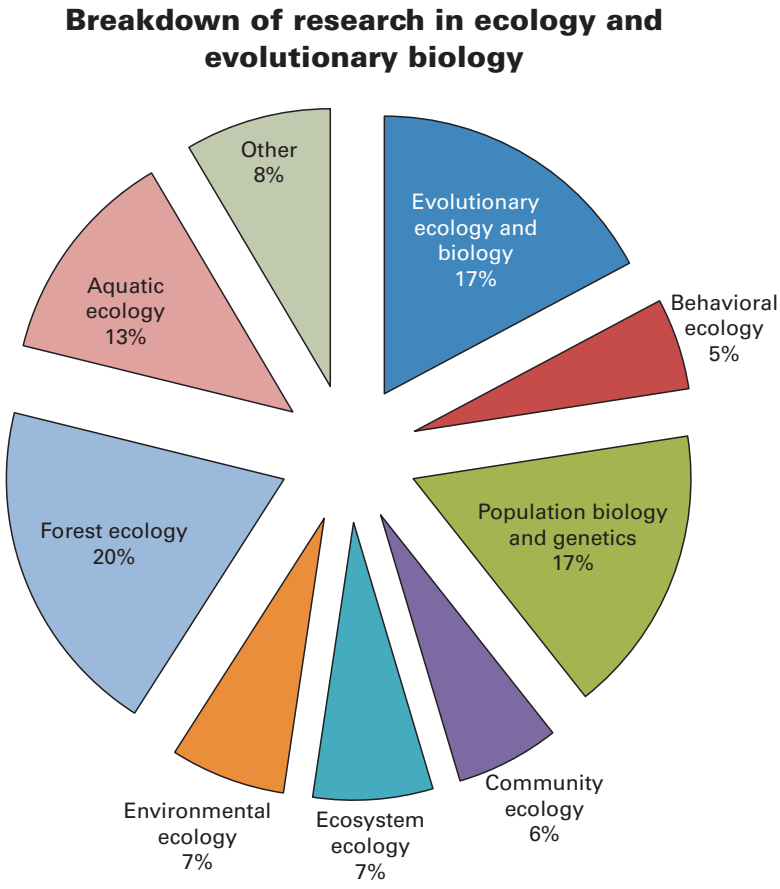

Figure 1. Ecology and evolutionary biology subfields in Finland in relation to staff (%).

by geographical focus (Fennoscandian, other arctic-boreal-northern temperate locations, other, e.g. tropical). All such schemata have their limitations and ambiguities, particularly given the wide scope and inherent complexity of the intellectual arena being evaluated.

A more detailed breakdown into research subfields on a unit level is presented in Figure 2 with additional data given in Appendix Table 10. More information on the units' research profiles is presented in individual unit assessment reports.

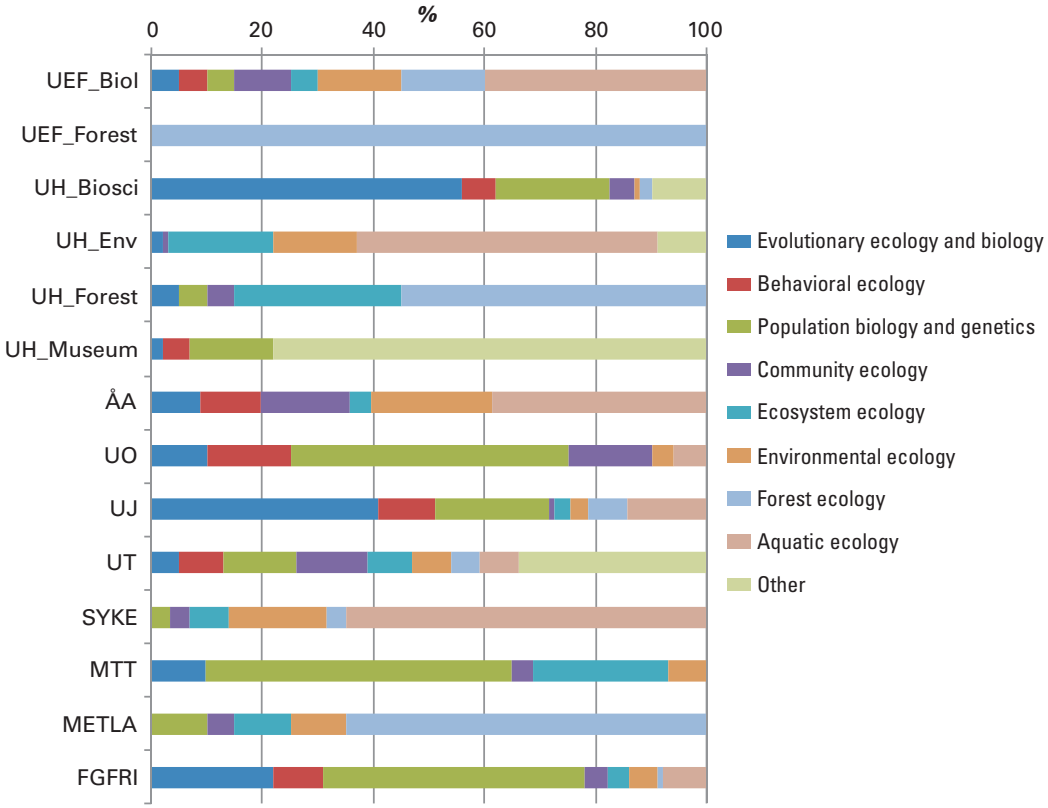

Figure 2. Unit's research profile in relation to staff %.

Research inputs and outputs

Research on ecology and evolutionary biology received a total of €258,698,000 in funding during the evaluation years 2006–2010. Of this, core funding represented 50 per cent and external funding 50 per cent. The most important external funding agency was the Academy of Finland with a share of €61,194,300 for the period 2006–2010, equalling 25 per cent of the funds available to ecology and evolutionary biology research in Finland (Figure 3). A more detailed breakdown of the funding is presented in Appendix Table 5a–d.

The structure of the Finnish ecology and evolutionary biology community as presented in percentage of staff categories shows that doctoral candidates formed the majority of the active research staff with a share of 47 per cent. Other senior researchers were the next largest category with a 21 per cent share of the research force. Professors and postdoctoral researchers represented 6 and 19 per cent, respectively, of the total active research staff in 2006–2010 (Figure 4).

The average number of doctoral candidates per senior researcher was 0.7. A total of 408 doctoral graduates completed their studies at the average age of 34.8 years during the period 2006–2010 (Appendix Table 7). The average number of postdoctoral fellows per senior staff was 0.70, and a total of 586 postdoctoral fellows (as FTEs) were supported during the same period (Table 3).

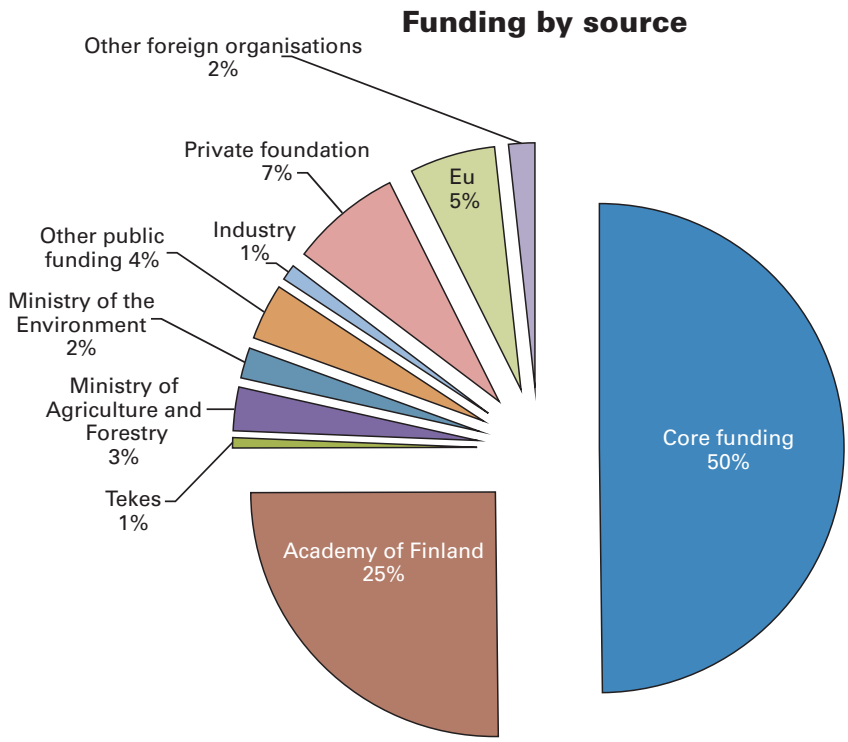

Figure 3. Share funding by source.

Table 3. The relationship between Post Docs and senior researchers in the evaluated units 2006–2010.

Unit	Senior staff FTE	PostDocs FTE	PostDoc/Senior
UEF_Biol	33,6	27,9	0,83
UEF_Forest	19,2	20,3	1,05
UH_Biosci	70,6	145,7	2,07
UH_Env	37,7	10,1	0,27
UH_Forest	51,3	29,3	0,57
UH_Museum	42,5	19,7	0,46
ÅA	28,6	12,7	0,44
UO	42,4	40,9	0,97
UJ	91,2	121,1	1,33
UT	90,3	48,9	0,54
SYKE	96,3	65,8	0,68
MTT	42,0	6,6	0,16
METLA	313,7	31,2	0,10
FGFRI	21,6	6,0	0,28
Total	978,40	586,15	0,696

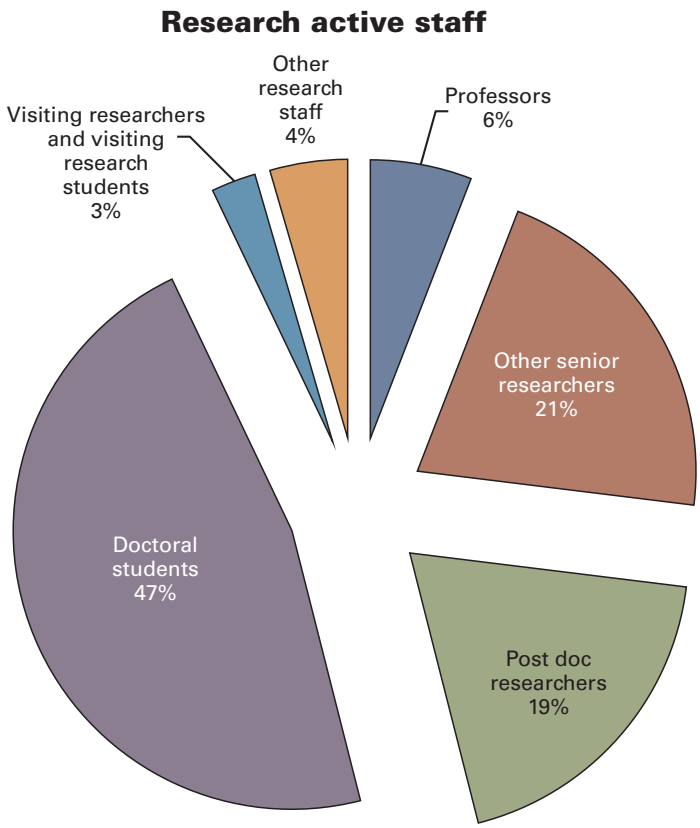

Figure 4. Research active staff in Finnish ecology and evolutionary biology community 2006–2010.

Table 4. UNIT H Scores and sum of citations of senior staff.

Unit	Range	Median	Sum of citations	Senior staff (FTE)
UEF_Biol	6-32	16	434	31,1
UEF_Forest	8-31	20	413	19,2
UH_Biosci	5-63	14	6243	70,6
UH_Env	7-29	12	675	37,7
UH_Forest	4-26	13	600	51,3
UH_Museum	3-24	10	1225	42,5
ÅA	5-25	13	490	28,6
UO	6-36	16	971	42,4
UJ	1-46	19,5	2505	91,2
UT	3-47	17	2414	90,3
SYKE	6-24	13	4161	96,3
MTT	1-16	6,5	611	41,9
METLA	2-45	10	2506	313,8
FGFRI	8-20	13,5	634	21,6

Finnish ecology and evolutionary biology publishing activity, i.e. publications per research FTE, in refereed scientific journals and refereed edited volumes and conference proceeding was 1.8 and 2.2, respectively. A total of 4876 refereed scientific papers was published during years 2006 – 2010. A majority, or 95 %, was published in international forums (Appendix Table 6).

More data on research inputs and outputs are presented in the Appendices.

One way to gauge the relevance and impact of a scientist's work is to assess how often that individual's publications are cited in other publications. One index of such impacts that has been increasingly used in recent years is the h-index (named after J.E. Hirsch, the physicist who invented it). The h-index lists in rank order all papers by a given researcher found on a standard bibliographic database (e.g. the ISI Web of Science), giving the paper receiving the most citations rank 1, the paper receiving the next most citations rank 2, and so forth. As the rank increases, the number of citations for that paper decreases. The h-index is the number h of a researcher's papers that have at least h citations (or more). The measure has an approximate square root relationship to the number of citations an author receives. Individuals with very high h-values are both highly productive (as measured by number of publications) and receive a lot of attention from their peers (as assessed by citation frequency). Scientists who get Nobel Prizes, or the Crafoord Prize, or Ecology Institute Prizes, tend also to have high h-indices. So there is real information in this number about the influence that scientists (or group, e.g., in a department) are having on their intellectual world.

This report, therefore, includes statistics on these indices and reflects on them. However, it should be stressed that one needs to be careful to not over-interpret such numbers. For instance, there are many dimensions of scientific quality and importance that are not so readily quantified. Citation frequencies are generically higher in some disciplines (e.g. genetics) than in others (systematics). A well-done monograph on mosquito systematics might get cited rather rarely, but be absolutely essential to have at hand when studying patterns in malarial infections. Review papers tend to get cited more than primary research papers. There is an overall inflation in the volume of publications produced per year, which magnifies citation rates and age dependencies, too. Here, non-native English speakers could be at a disadvantage.

Caution should be taken in making strong inferences about the relative merits of units, or individual investigators, based on this number. To some extent, however, it is used below. Standing back from these details, it is noteworthy that a recent study of citations associated with the publications of more than 4,000 researchers in the areas of ecology and evolution drawn from around the world, using the ISI Web of Science (www.isiwebofknowledge.com), found that the median investigator (using total number of publications), had an h-index of 7. Table 4 shows that there is no unit we evaluated that has a median H-index notably lower than this, and that most units had median values quite considerably higher. This is a broad and quantitative testament to the excellence of Finnish research at an international scale in the areas of ecology and evolutionary biology.

State of Research in Ecology and Evolutionary Biology in Finland

Research in ecology and evolutionary biology encompasses a breathtaking sweep of activities, as it considers the biosphere, its component ecosystems, communities, populations, individuals and their genes, using a wide diversity of techniques and perspectives. The panel was able to sample the work carried out in Finland over the past five years at all these successive levels of organisation.

Before presenting the evaluation, it is worth summarising some achievements in the last five years in this research area, which is a scientific domain where Finland is prominent at the international scale. Ecology and evolutionary biology are of great practical significance to Finland, which in its economy depends to a significant extent on its natural resources, be they timber, drinking water, fish to catch, or game to shoot. The future health of these resources as an economic base for the nation depends on the intactness of the systems that support them in reciprocal ways across levels of biological organisation. Finnish research in the last five years has contributed significantly to world understanding of ecology and evolution at all these levels, often in international collaborations that mutually enrich the work in different countries. Here, the panel notes just a few illustrative examples.

The panel found excellent research in every unit evaluated, although some stood out above others. Below are some notable discoveries from the period of review that the panel hopes illustrate to the general academic community, and the Finnish public at large, the intellectual value and societal relevance of the work that has been carried out by Finnish scientists. At the biosphere level, where key concerns include climate change and loss of biodiversity, Finnish science has helped reveal how forests have stored more carbon as the levels of carbon dioxide in the atmosphere have risen, and how this storage could be reversed with an increasing use of biofuels. Finnish science has shown how carbon is emitted from land surfaces via freshwaters that drain the land, and how peatland drainage, both in Finland and in the Asian tropics, threatens to increase the release of greenhouse gas carbon dioxide, with shifts as well in methane and nitrous oxide. Methods have been refined for monitoring forest loss from satellite images, and the likely patterns of agriculture in a warmer Finland have been projected into the future.

Work at the ecosystem and community level has been particularly rich, both in elucidating how undisturbed systems function, how ecosystem services are degraded by human disturbance, and what is required to remediate disturbed ecosystems. For example, there is increased understanding of how grazing influences tundra vegetation, how reindeer induce changes in the defensive substances plants produce on the tundra, and how increased ultraviolet radiation is worrisomely altering this response. In agroecosystems, grazing has been shown to generate strong differences in soil nutrients across landscapes. There is increased appreciation of the complexity of bacterial communities in habitats ranging from decaying vegetation and composts to the surface of sea ice. Finns have demonstrated that one must control nitrogen as well as phosphorus inputs to mitigate problems caused by toxic algal blooms in the Baltic Sea. In contrast to the traditional emphasis of ecology on competition, in Finland as in other countries there has been an increasing emphasis on how the activities of different

organisms reinforce one another via mutualisms, facilitation, and ecological engineering, and thereby contribute to broader measures of ecological well-being, such as elucidating how fungi facilitate the survival of forest tree seedlings, and beaver boost teal numbers.

The dividing lines between all levels of study from the biosphere to the gene are indistinct and for human convenience only. Studies on habitats and biological communities in particular merge seamlessly with those at the ecosystem level. This is illustrated by research on declines in predatory fish, owing to fisheries in the Baltic, which have been shown (through successive changes in the food chains) to lead to increased bloom formation. Work on reduced oxygen levels in marine sediments in the Baltic Sea has elucidated disturbing consequences not only for the animals living there, but also for the chemistry and productivity of the overlying water. Experiments on community diversity in seagrass meadows, and in the plankton, demonstrate positive effects on production and other ecosystem services that these communities provide. Introduced species can lead to severe problems, often of great economic importance. Even introduction of non-native strains of Finnish forest trees can be problematic; moose cause more damage to them than to native strains.

Indeed, moose (whose numbers can have negative economic impacts in forestry) nicely illustrate issues that Finnish research has addressed for many taxa at the population level. Excellent long-term records allow population changes to be seen in a lengthier context than possible in the usual research grant and reveal both surges in numbers and declines. The effective population size of wolf in Finland is only about 40, only 8 per cent of their population in the last century. Wolves, as top predators, were likely very important in influencing the structure of forest and wetland systems, to the benefit of many other organisms – for instance, by most likely limiting moose numbers in the past. The population sizes and geographical ranges of many boreal bird species are also declining, and Finnish scientists are at the forefront in documenting changes driven by a warming climate in range limits of birds, butterflies, freshwater invertebrates and other taxa. Land-use modification is another major dimension of global change, with many impacts at the population level, and Finnish scientists are articulating how to modify land use to preserve biodiversity while maintaining economic values. As just one of many examples that could be cited in Finnish science, it has been demonstrated that forest management must shift from the clear-cutting of large areas to a more, textured gradual disturbance, so as to conserve key species of concern such as capercaillie, as well as a huge variety of forest plants.

Finnish science is replete with excellent studies on how particular populations are regulated, spatially distributed and genetically differentiated. Highlights include studies revealing that some ant species form huge colonies have been shown to differentiate into genetically distinct local populations, and that such social organisation, over phylogenetic time scales, may be evolutionarily unstable; that hantaviruses are closely involved in the vole winter deaths; that fish mating is affected by water turbidity due to nutrient pollution and soil erosion; and that there is much complexity in the dispersal patterns of small predators carrying rabies, like raccoon dogs, foxes, badgers and feral cats.

The Finnish research community has long been renowned for its work on the consequences of the internal spatial and

group structure of species for their population and evolutionary dynamics, using both empirical and theoretical approaches. Metapopulation studies have shown how colonisation at one site can compensate for extinction in another, and this perspective has informed many strategies in biodiversity conservation. Finnish scientists have also made distinguished contributions in theoretical ecology and evolution, including analysing the strategies by which individuals select mates, refining models of movement and ascertaining how the correlation pattern of environmental noise influences population dynamics. On the empirical side, the last five years have shown how phenomena such as mimicry, colouration in birds, the sounds produced by the wing beats in flies, and even the individual personalities of animals (via susceptibility to parasitisation), can all determine breeding success and survival. Finnish studies have shown how reduced genetic diversity in fish farms can lead to increased virulence of bacterial diseases, how landscape structure and habitat isolation can select for activity and movement levels in butterflies, and how breeding success in buzzards has been reduced despite earlier mating, as temperatures have increased. Notable have been careful studies on lichen formation, demonstrating a high selectivity for particular strains of cyanobacteria by fungi and a remarkable three-way association between particular fungi, cyanobacteria, and a species of *Sphagnum* moss, hinting at intimate and subtle associations among interacting species in boreal forests.

Finnish scientists have avidly adopted and developed new techniques and technologies to monitor wildlife populations, to investigate the ecological physiology of species and to glean greater understanding from complex datasets.

Finnish scientists were among the first to adopt next-generation sequencing in non-model organisms, and also to apply that knowledge to natural populations so as to understand the interplay between ecology and evolution in determining the dynamics of metapopulations. Such techniques have been applied creatively to understand genetic diversity in devastating pathogens of potatoes. In the last five years, it has been shown that the salmon populations of nearby very small streams are genetically distinct from one another, so that salmon management must consider a much smaller habitat grain than was previously the norm. Trees also show small-scale differentiation, such that local fitness is greatest in populations that evolved in particular sites; such local adaptation has important implications for reforestation strategies and ecosystem functioning, since genetic differences can alter the decay rate of leaves and hence local nutrient cycles. Molecular studies have been used to reduce impacts of rot fungi, to understand toxin production in algae in Finnish lakes, to show how heavy-metal pollution reduces the genetic diversity of earthworms and thence their ability to maintain soil fertility, and to demonstrate how key plant traits are genetically controlled and linked with susceptibility to insect pest damage.

An increasing emphasis on genetic studies is revolutionising our knowledge of how species evolve and are related. Finnish scientists have produced particularly beautiful studies, using genetic tools, of taxa from butterflies and moths, to liverworts, to bananas. They have shown that the stability of mutualisms rests on genetic matches between plant hosts and endophytic microbial mutualists. New light has been shed on the origin of Baltic mussels – surprisingly, Pacific sources are as important historically as are much closer Atlantic sources. Many heritage breeds of

livestock are at risk of extinction, and Finnish scientists have uncovered patterns in the genetic diversity among such breeds which could provide important raw material for future livestock breeding.

Finnish scientists are making key contributions outside Finland, and indeed are helping inform understanding of ecological and evolutionary patterns and processes in ecosystems across the entire globe. For example, biodiversity studies are a salient dimension in Finnish ecology and evolutionary biology. Finnish scientists have brought rigorous analyses to biodiversity frontiers, revealing, for instance, just how little is known of the diversity of life in Amazonia, and how the dung beetle fauna of Madagascar has radiated. In collaboration with an international team of researchers, Finnish scientists have participated in studies that predict that most of the world's lizard species face extinction due to climate change. Analyses of African tropical forest proceeding through succession after deforestation have shown that even forty years does not suffice for full recovery of the herbivorous insect community. Finnish ecologists have been at the forefront in analyses of predator-prey interactions, including elucidating the role of predators more broadly in community dynamics and ecosystem processes.

This is an impressive breadth of significant research contributions for a country such as Finland with a relatively modest population size. The intent in the remainder of this report, both in assessments of individual units and in overall evaluations, is to provide advice and insights that can help Finland maintain its strength and even build in this area.

University of Eastern Finland – Department of Biology

Ecology and evolution is a significant dimension in the profile of the Department of Biology at the University of Eastern Finland, a recent fusion of the former University of Joensuu and the former University of Kuopio. The unit reports that 35 per cent of the biology in the department is focused on ecology and evolution biology. Of the eight professors in the department, there are three professorships of ecology, organised into overlapping research groups working actively on several focal areas, in particular the tropical ecology of biodiversity conservation, phytochemical and other responses to a changing environment, the evolutionary ecology of plants and insects, and ecology and evolution in aquatic systems. An integrating theme in the department is biotic response to environmental stresses in both ecological and evolutionary dimensions.

Scientific quality of research

The activities of the research groups in the department are often strongly complementary, and it is the opinion of the panel that this contributes to the substantial contribution of this unit to the production of ecological and evolutionary science within Finland and around the world. The quality of the work for many of the focal areas of the department is demonstrated by regular publications in top disciplinary journals, such as Evolution, Biological Reviews and Global Change Biology. The work is well cited, as the professors have h-indices ranging from 16 to 32, which are strong indices. The unit median h-index is 15.7, the fourth highest of all units evaluated. Overall, the research profile of the department is strong.

Research environment and organisation

The current funding situation appears to be good, in part thanks to support from the Academy of Finland and private foundations, and University of Eastern Finland scientists have applied this funding in an effective way to their research. This is demonstrated by the strategic application of university funds into major focal areas of research. The panel noted that both core and external funding have notably increased over the reporting period, from about €1.28 million to €2.6 million. However, faculty and the panel expressed concern over the ability to maintain enough external funding, in particular funding specifically targeted at maintaining local institutional infrastructure. The experimental facilities for examining climate change and UV impacts on plants are particularly valuable, for instance, and it is important that this infrastructure be maintained. EU funding remains somewhat low, in part because of bureaucratic constraints.

Repeated restructurings of the university have led to the current – and quite recently established – state of this unit as an ordinary department with research and teaching functions. The staff seem to have substantial administrative and teaching loads, and there appear to be issues with the level of administrative support needed to support major EU proposals. The fusion of two universities into one provides opportunities for creative new directions of collaborative research, but it has also

come with some losses, particularly in the area of aquatic ecology. Aquatic ecology has been and potentially will continue to be a significant and important theme in the department, but there is now no ready availability of a large-scale research vessel suitable for large lakes. Moreover, other aquatic facilities have recently closed, hampering this important dimension of ecological research.

The department is clearly striving towards establishing a stronger sense of intellectual identity, and hiring in crucial areas will be essential for developing this identity, and indeed growth by the unit is needed for it to meet teaching needs while sustaining and building strong research programmes. Interdisciplinarity appears to be a natural by-product of the historical and current organisation of the unit, and it is reflected in the deliberate incorporation in the unit of complementary methodologies, bioinformatic approaches and work at the boundaries of subfields. The department has developed strong international and national networks on issues such as tropical diversity, herbivory in the Arctic and forest pests. The faculty is thinking towards the future by integrating molecular and biotechnology into much of the research. This forward-thinking and coherence is demonstrated by the plan to hire one or more ecological geneticists in the future, strategic positions that would benefit several research groups. The panel strongly supports this initiative. The department should also strive to foster more collaborative ventures with its sister unit, the School of Forest Sciences at the University of Eastern Finland. A past centre of excellence provided a way to synergise activities between individuals in this unit and the other unit, and the panel suggests that the unit continue to strive towards acquiring such a centre.

Research education

The students of the unit spoke very well of their educational environment. The department provides a wide range of courses and many students are in national graduate schools, broadening their educational experience. The teaching load for professors and senior scientists appears to be heavier than for some of the other Finnish institutions evaluated, and this could make the unit less effective in graduate education. The panel noted that the number of graduate students per senior staff had dropped over the reporting period from 5.1 to 2.3, which seems like a healthy shift in numbers. During the evaluation period, the unit had harboured 29.7 postdoctoral fellows, amounting to 0.83 per senior staff member. This number is quite good, and having a substantial number of postdoctoral fellows in the department likely contributes to the positive environment experienced by the doctoral candidates. The department seems to have a good record of placing their doctoral candidates and postdoctoral fellows into good positions.

Interaction between research and society

A number of key research results from the unit have societal implications, in particular those that relate to climate change. As one of many other examples that could be cited, studies of forest pest studies have made an important contribution to society by exposing flaws in legislation to protect forests. Nocturnal moth communities have been shown to vary widely in phenology, which suggests that responses to climate change are poorly predicted by current general models. A second example includes the contribution of genetic studies to the preservation of the critically endangered ringed seal. As a final example, studies on variation in fish "personalities" has been shown to correlate with the probability of being harvested,

suggesting a driver of selection on these populations; this is a theme that has received considerable attention in the media. Research is also underway that provides services to local commercial farms.

Recommendations

- The panel thought that since intense harvesting is now widely realised as a problem that will affect the future yield of exploited fish stocks, work at the University of Eastern Finland to understand the evolutionary responses to harvesting poises the unit for excellent research and funding opportunities. The panel feels that internal support to this unit may be a good investment towards acquiring much greater external funding.
- Teaching loads and high levels of PhD supervision appear to be in part due to the unit being just short of reaching critical mass. The panel strongly recommends that the unit consider 1–2 key strategic hires, such as in the area of ecological genetics, because this is likely to have synergistic effects that would increase the productivity of the entire unit. One aspect of this recommendation is that it would ease the teaching burden of the current faculty.
- The panel thought that the unit would benefit from administrative support from the university for acquiring and managing large-scale EU proposals and grants, given that faculty seem to have heavy teaching and administrative loads. The panel therefore recommends that the university find mechanisms to provide such support.
- Attention needs to be paid to maintaining key infrastructure for conducting ecological research. In particular, the aquatic laboratories and water analysis laboratory that have closed threaten to impair the research environment in this area, and attention needs to be paid to ensuring access to research vessels for freshwater studies.

University of Eastern Finland – School of Forest Sciences

The School of Forest Sciences at the University of Eastern Finland is contained within the Faculty of Science and Forestry. Research in the unit has a focus on the sustainable management of forest ecosystems for multiple uses, and draws on both the natural and social sciences. Basic research in ecology and evolution comprises a significant part of the overall research profile of the unit. This research is largely concerned with production aspects of forestry, for both wood and biofuels; the issues of conserving ecosystem function and biodiversity in managed forest landscapes; and assessing and mitigating a wide range of risks, in particular the impacts of carbon dioxide enrichment and climate change.

Scientific quality of the research

The unit has an excellent international reputation in its field. The ecological and evolutionary research conducted in the unit is aimed at sustainable management of forest ecosystems, including benefits such as the maintenance of biodiversity as well as the traditional production goals of forestry. The department can boast of major scientific achievements. These include innovative large-scale field experiments and broad comparative analyses across Finland on how forestry practices impact biodiversity; modelling that addresses risk to forests of different climate change scenarios; detailed analyses of individual tree growth and other traits pertinent to forestry; and developing technologies for rapid assessments of forest structural and biodiversity patterns. The

research in the unit is strong and well respected. The professors are well recognised internationally, with h-indices ranging from 12 to 31; the median h-index for senior staff (levels 1 and 2) of 20 was the highest of all 14 units considered in this evaluation. Productivity in terms of refereed articles per staff FTE or per senior FTE was also significantly above average. Publications included a number of pieces in good international journals such as *New Phytologist* and *Biological Invasions*, and numerous publications in more specialised forestry journals. The unit has shown major increases in refereed journal publications and in citations since the first PhD student graduated from the programme in 1991, increasing to 50–60 published papers a year and more than 400 citations in 2006–2010. However, there are relatively few publications in more general ecological and evolutionary journals, and the panel thinks that this is an area where the unit could make an even larger impact, given the likely interest to a broader audience of much of the research ongoing in the unit. Overall, the unit has maintained a high quality in its research programme.

Research environment and organisation

From 2006 to 2010, the unit's external funding totalled over €6 million and its annual funding grew substantially, with an infusion of EU funding being particularly noteworthy. The unit has a strong record of international collaboration, as well as excellent domestic collaboration with other universities and Metla. There is always scope to expand this collaboration, and the unit should always look for new opportunities. EU projects are real opportunities that are well exploited now, and this should continue. Much of the research in the above three thematic areas was fostered by the Centre of Excellence for Forest Ecology and Management, in operation from 2000 to 2006. The centre provided a research network that linked the studies of many staff scientists, postdoctoral fellows and doctoral candidates in Finland and abroad. The centre aimed at enhancing the scientific research on functional and structural dynamics of the boreal forest ecosystem with management implications. Given the importance of forest ecology within Finland, there would seem to be a strong rationale for the continued support of a comparable centre of excellence in this area, one that takes a multidisciplinary approach integrating basic and applied sciences towards the end of wise management of boreal forest ecosystems. The report of the unit noted that understanding genotype-environment interactions is essential for management and restoration of forest ecosystems, as is linking ecology with the social and economic sciences. These are both important basic research areas and could be the focus of strategic hires, or contained within the themes of centre of excellence proposals, developed for instance with faculty in their sister unit the Department of Biology, which also has intentions of making hires in the area of ecological genetics. In general, the panel feels that there may be missed opportunities for fruitful cross-cutting activities between these units.

Research education

The unit provided a thoughtful synopsis of how it organises its doctoral programme. It coordinates the Graduate Programme in Forest Sciences (GSForest), which is part of the national network for doctoral training. It also organises a number of annual scientific and professional courses and an annual autumn seminar. At the national and international scale, the training is very efficient, as indicated by the large number of doctoral degrees

awarded annually in relation to the annual number of MSc degrees (the ratio between doctoral degrees vs MSc degrees is 0.25–0.30). From 2006 to 2010, the unit graduated 30 PhD degrees, or 1.4 per senior FTE. Attracting and training international PhD students, with about half of students coming from outside Finland, is a real strength in the department. According to the information provided, PhD completion times may be slightly long, in comparison with other units. The department should evaluate the time required to complete a PhD, relative to how the training of students affects their long-term careers, and also work towards crafting longer time horizons for the funding of students. The department had 28 postdoctoral fellows in 2006–2010, or approximately one per senior staff. Postdoctoral fellows can assist in student mentoring and increased productivity, so this high number of postdoctoral fellows likely bolster a healthy educational environment for students. The unit does well in placing its students and postdoctoral fellows into jobs.

Interactions between research and society

The societal impact of the unit's research programmes is strong. Examples include projections of effects on climate policy, for instance, participation in the formulation of the Finnish climate change strategy and participation in crafting the influential IPCC report on impacts and adaptation; forest policy via participation in national and local boards formulating and monitoring implementation of national forest programmes; national biodiversity assessments, in particular the list of threatened species compiled by the Finnish Ministry of Environment; and collaboration on Lidar-based forest inventory in collaboration with forest industry (UPM-Kymmene, Tornator, Metsäliitto, Metsähallitus). Key strategies towards achieving strong social impact are: 1) active participation in national and international groups that build links between science and policy, and 2) close collaboration with forest owners and managers in joint projects. The unit should strive to increase its public visibility, via articles in the popular press, presentations on radio and TV, and other outreach activities.

Recommendations

- The unit should try to emphasise a strong holistic ecosystem approach and inclusion of other biodiversity and ecosystem factors (e.g. terrestrial-aquatic linkages) in its experimental forest manipulative studies. Omitting these results is missed research opportunities. They should increase collaboration with the Department of Biology, for instance in linking ecophysiology and phytochemistry to climate change.
- Long-term experiments such as those developed by the unit represent important infrastructure for ecological and evolution research in Finland in general, and should be funded by the Academy of Finland as such.
- The panel recommends that the unit consider submitting its research results to more general top journals. In some cases, it was felt that published work of a high quality warranted publication in higher-profile, higher-impact journals than where it actually appeared.
- Some of the research studies could naturally link with other units in Finland (e.g. University of Helsinki Department of Biosciences, University of Oulu and Metla) for strong synergy, and also with other international collaborators. For example, experimental manipulative field studies provide bases for examining

questions related to biodiversity, biomass, risk of wind and fire, and changes caused by clearcutting. The excellent detailed modelling and genetic studies of stem and wood growth of Norway spruce and Scots pine in plantations could be valuably extended to models of natural boreal forest dynamics, with clear linkages to issues such as carbon pool storage in this vast biome. Both issues of forest genetics and coupled natural-human systems were raised as important desiderata, and collaboration across Finland might help realise these goals in the unit.

University of Helsinki – Department of Biosciences

Ecology and evolution comprises about half of the research in this unit. The research clusters in particular around the areas of ecological and evolutionary genetics, spatial ecology, conservation biology and theoretical and mathematical ecology, but does include other areas as well (e.g. phylogenetics). In addition to facilities on the Viikki Campus, the unit operates several active field stations, including within Finland the Tvärminne Zoological Station, the Kilpisjärvi station in the Arctic, the Lammi Biological Station on the Åland Islands, and outside Finland the relatively new stations in Madagascar and Kenya.

Scientific quality of research

This world-class group exemplifies Finland's status as an international leader in ecology and evolution. There is tangible evidence of the international stature of the group, such as Professor Hanski's recent award of the Crafoord Prize, which is equal to winning a Nobel Prize for ecological research. Members of the unit serve on international committees, hold office in international societies and participate in EU-wide research activities at a higher level than any other unit in Finland, and indeed are comparable with academic staff at the best universities in the world. This dimension of the Department of Biosciences is clearly maintaining its reputation for excellence by making continued, substantial contributions to key themes in the field.

The unit's research is unquestionably on a par with the best units of comparable size anywhere in the world, and the unit is certainly the very best ecology and evolution in this evaluation. It conducts cutting-edge research in many areas, including the genetic bases of animal adaptation, the emerging area of eco-evolutionary dynamics, (with a strong infusion of genomics and molecular biology techniques); decision analysis in conservation; social evolution in ants; and mathematical ecology and evolution. The latter area in particular is one intellectual arena where this unit stands out from most other Finnish institutions. The standing of the researchers is reflected in a string of impressive citation rates of scientific articles produced by senior staff. These are complemented by less senior staff, so that the range of h-indices is 5–63, with a median of 14. There is an appropriate emphasis on quality over quantity, with significant papers appearing in the top international journals such as *American Naturalist, Ecology Letters, Science,* and *PNAS*. One of the characteristics of the group is an appreciation of the importance of long-term studies, and the role these play in research and training. The group has been very successful in securing prestigious research awards such as ERC grants, and has numerous international collaborators and linkages.

Research environment and organisation

The external funding of the unit has grown substantially over the reporting period, from €3.2 million to €4.7 million, reflecting increases both in Academy of Finland and EU funding. By contrast, core funding has increased rather modestly. It strikes the panel that, overall, core funding is low in this unit, as scaled by the size of its active research staff, compared to some other units evaluated.

The unit is characterised by largely independent PIs leading strong research groups including Metapopulations, Ecological Genetics, Avian Ecology, and Integrative Ecology. The unit has been one of the leading participants in the Academy of Finland Centre of Excellence (CoE) Programme. These CoEs have clearly been instrumental in facilitating the careers of more junior researchers and enhancing the profile of senior researchers. From 2006 to 2008, the Integrative Ecology group was part of a Nordic Centre of Excellence in collaboration with the Universities of Oslo and Lund. In addition to 8–10 professors, there have been, at any given time, 12–18 senior researchers and 24–39 postdoctoral researchers in 2006–2010. Overall, there is a good balance between male and female researchers, though women are better represented at the postdoctoral level than among the senior staff.

There are excellent international links, both in recruiting new members, in maintaining an impressive roster of collaborators across Europe and globally, and in nurturing the careers of researchers who go on to lead research groups in overseas institutions. While most senior staff are Finnish, the large standing crop of junior researchers from other parts of the world helps ensure the international character of the group.

The panel's view is that the University of Helsinki needs to ensure that there is sufficient investment in the group, in both personnel and infrastructure, to enable the researchers to maintain their world-class reputation. This group is, and should be, a source of pride in Finnish science.

There is scope for increased cooperation between the museum and the department, as well as with other institutions in Finland. Within the department, there would appear to be natural linkages between the Metapopulation Research Group and the Ecological Genetics Group, in the area of linking evolutionary and ecological dynamics. The panel found it somewhat surprising that there was scant evidence of this, and suggests that the department consider how to capitalise on potential synergies between these two outstanding research groups, and with other units, for instance in developing new Centres of Excellence. The many field stations are an invaluable asset, and provide an essential source of long-term and unique datasets, as well as venues for key dimensions of undergraduate and graduate teaching. To ensure the best possible use of long-term studies, there need to be mechanisms (both within Helsinki and across Finland) to facilitate data storage and accessibility and the preservation of samples for future analyses.

Research education

The principal organisational structure harbouring graduate students is LUOVA (Finnish School in Wildlife Biology, Conservation and Management), funded both by the Ministry of Education, Science and Culture and by the Academy of Finland. The unit exhibits clear evidence of

success in training graduate students and postdoctoral fellows (e.g. in 2006–2010, in all 65 students completed their PhDs), and in general provides excellent opportunities for early-career researchers. The unit has an excellent record of placing its students and postdoctoral fellows into good positions after they leave. The number of postdoctoral fellows increased during the review period. At least half of the PhDs and postdoctoral fellows are from other countries. Postdoctoral fellows have the opportunity to teach, which both helps them develop this dimension of their academic careers and enriches the educational opportunities provided for students. There is a variety of funding mechanisms to sustain students; some have four-year fellowships, others are self-funded or supported by their advisors. The panel did find it surprising that, given the real strengths of the unit in the crucial area of mathematical ecology and evolution, it was unclear how much training and exposure there was in this area of graduate education, particularly for graduate students whose own research interests are not specifically in the area.

Interaction between research and society

Some members of the unit have demonstrated outstanding outreach in terms of contributing to the public understanding of science, and there have been numerous presentations on radio and TV and popular science articles generated by unit staff. Ecological software developed in the unit is becoming widely used in environmental decision-making, both within Finland and abroad. Such efforts are more apparent in the Metapopulation Group than in other parts of the department. The graduate schools (e.g. LUOVA) based in the department have organised international courses on topics such as communication of research findings to the public and to policy-makers, which helps generate communities of scholars with experience in interacting with the public.

Recommendations

- To maintain its reputation as a world-leader in research in ecology and evolution, the unit needs appropriate investment to support infrastructure, to be able to fill vacant positions and to retain outstanding staff, and may need an increase in its core funding to fulfil these needs.
- The unit has been very effective at generating Centres of Excellence (CoE), which enable successful young investigators to become established and are an important asset to the system as a whole, and should continue to be supported. The panel found the linking of a recently funded CoE with other institutions to be a very positive institutional model, and would encourage the unit to consider how to engage in other CoEs involving other institutions, as well.
- The unit could develop additional links with other institutions in Finland in graduate education. In particular, it has notable strengths in the area of mathematical ecology and evolutionary biology, pre-eminent in the country, and could foster the development of country-wide training programmes to spread this specialised yet crucial perspective via training beyond Helsinki.
- The Department of Biosciences needs to interact more effectively with and complement the Finnish Museum of Natural History. This is a two-way street, and both sides need to craft creative ways to foster synergies among ecology, evolution and systematics at the University of Helsinki, and indeed across the entire country.

University of Helsinki – Department of Environmental Sciences

The department was formed within the last two years, following a series of reorganisations within the University of Helsinki. It comprises scientists who were formerly part of the Department of Biological Sciences, the Department of Ecological and Environmental Sciences in Lahti and a small number of social scientists recently appointed or brought into the unit. It has grouped itself around three themes: environmental ecology (urban ecology), aquatic sciences (the Baltic Sea system, including the catchments of river and lakes that drain into the Baltic Sea) and environmental change and policy.

Scientific quality of research

One strength of the new department is that it includes several well-known professors with substantial reputations, and strong senior researchers as well (h-indices in the range of 7–29, with a median of 12). The unit has carried out quite significant research in a number of important arenas of applied ecology, but often including a substantial dimension of contributions to basic science as well. Urban ecology is a particularly noteworthy emerging area where the unit has unusual strength and prominence internationally, and it has also addressed important aspects of ecosystem services in Arctic ecosystems as well as in urbanised landscapes. The aquatic ecology group has made significant contributions to understanding basic aspects of aquatic ecosystems, for instance in analyses of community structure in diatoms and ecosystem processes in lakes and coastal areas. The suite of publications includes many in very good ecological, freshwater and marine journals, including a number of papers in first-rate general journals such as Ecological Monographs, as well as good specialty journals such as Ecography, Microbial Ecology, and Limnology and Oceanography. There seem to have been very few international research visitors. This suggests a somewhat surprising degree of isolation, but may also reflect the applied and often specifically Finnish nature of much of the research in the unit.

Research environment and organisation

The department consists of two geographically separated pieces, one in Viikki and the other in Lahti. The piece housed on the Viikki Campus has access to instruments and facilities in other departments that give it a very wide potential range of techniques and measurements. The new department provides, in principle, the opportunity of a well-integrated environmental sciences school, with a range of expertise that spans both terrestrial and aquatic ecology in a catchment-based approach. It has further potential linkages to the management of the urban environment and its waterways, and also with a time dimension provided by excellent palaeoecological expertise that is key to understanding the implications of climate change. This opportunity and potential, however, is not yet fully realised. The unit's core funding seems to be stable, accounting for 22 per cent of the total funding. Its external funding grew considerably over the evaluation period, from about €0.88 million to €1.26 million.

It is noteworthy that one professor is a Dean, and two others are Vice Deans, and administrative burdens doubtless greatly cut into the time available for research and writing; this is indicated by the fact that in 2010, for instance, there were eight professors associated with the unit, but only 1.12 FTEs. The relatively small

number of permanent research staff, combined with substantial teaching responsibilities, creates difficulties for long-term planning and the strategic development of research and educational programmes. The scope of the unit is quite large, relative to the size of its permanent research staff.

The recent formation of this unit means that it is still probably experiencing uncertainty, and it seems to still be in the challenging phase of defining itself. Indeed, the department appears still somewhat disorientated, and is finding its feet following the reorganisations. It does not help that the allocation model for core funds to departments in the University of Helsinki seems poorly defined at present; this must make planning difficult. The department gave to the panel the impression of diversity without unity, with only a rather vague idea of what its future plans should be, and how it can capitalise on its strengths to become the strong adviser on environmental policy to Finland that it aspires to be – and which it certainly has the potential to achieve. Undoubtedly, this reflects to a large degree how very new the unit is. The separation of its subunits in Lahti and Kotka pose inevitable problems for integration simply because of their geographical separation and very different funding bases. Although it goes beyond the focus of this evaluation, the panel noted that a strong environmental department might also be expected to encompass dimensions of geography and Earth sciences, as well as forestry, and indeed include aspects of law and economics that are presently in separate faculties.

Research education

Systems for doctoral training are in line with other departments at the University of Helsinki, and the students the panel met felt well supported. The statement provided about researcher training is thoughtful, and it is noteworthy that each student's advisory committee comprises experts from outside the university. The panel notes that there has been an increase in the number of graduate students per faculty member (professors plus senior researchers) over the period of the evaluation, though it is still low relative to other units. It is important that this trend be continued, so as to develop strong cohorts and effective training programmes. The graduate schools appear to be largely those centred at other universities. There would appear to be an open niche here for this unit to provide national leadership via a graduate school tailored to its strength in environmental science. One seemingly unique dimension of graduate training is the collaborative venture with the Arctic Centre at the University of Lapland.

The unit has considerably fewer postdoctoral fellowships per senior researcher (0.27) than the other university units evaluated. It is not certain whether this has any particular significance; it may be a function of the nature of the income the department receives. However, the department could contemplate whether there is any significance to it. In general, increasing the number of postdoctoral fellows could facilitate (and indicate) a robust research and training environment. The single postdoctoral fellow the panel met from the department was complimentary as to her research environment and the atmosphere in her unit.

Interaction between research and society

The department operates closely with government institutes, particularly SYKE, in conveying its results to the general public through the well-organised system that the institutes have for communication with the public, but it does not appear to

have a strategy of its own, with the exception of its units in Lahti and Kotka. These are strongly dependent for funding on the respective cities, and in Lahti in particular there has been a close working relationship with local administration and the general public. This has shown tangible benefits in the improvements that have been made in the catchment and to the lake of Vesijärvi. In terms of outreach to the community, it has clear potential strengths in the nature of its research because it is tackling problems (urban ecology, water pollution and habitat restoration) that are clearly relevant and of interest, but there is no clear strategy for outreach. At present, there is a modest level of outreach via TV, radio and popular journal articles, but this clearly could be stronger.

Recommendations

- The department should strive to identify how it 'niche-differentiates' itself not just internally in the university, but across the country as a whole, and begin to develop a stronger international profile. The area of urban ecology is one clear possibility.
- For research in the Baltic Sea and its drainage basins, mechanisms for fostering collaboration across Finland should be pursued.
- The department is encouraged to explore how its existing talents can be integrated under the three thematic areas it has identified, and attempt to correct whatever reasons account for the relatively low average productivity of its most senior staff.
- The panel has a positive impression about the progress to date made by the department since the recent reorganisation. There is considerable talent in the current unit, and it should be given the opportunity to define itself.

University of Helsinki – Department of Forest Sciences

The Department of Forest Sciences is part of the Faculty of Agriculture and Forestry and has only been in existence since the restructuring across the University of Helsinki as a whole in 2009. It comprises three units: Forest Ecology, Forest Resource Management, and Forest Economics, together with two field stations. Eight groups contribute to research in ecology and evolution in the department. The research is focused on the ecology of forest growth, the role of forests in a changing environment, biodiversity and sustainable use, and the role of forests in the tropics and developing countries.

Scientific quality of research

There is excellent research coming out of this unit. It has real strength in forestry-related modelling, such as models for tree growth and stand dynamics including allometric scaling and evolutionary optimisation, and models of radiation in tree canopies including a remote sensing dimension. The work in disturbance ecology in unmanaged boreal forests seems exciting, with expeditions to remote areas of Finland and Russia, and the work on peatlands and forest pests and wildlife seems strong. The department seems to have found a nice balance between pressures of applied research – meeting expectations of society – and intellectual basic biological research related to forests. This is evident in the good publication output in highly ranked scientific journals, such as a recent article from the forest mycology group that appeared in Science. The h-indices of the professors are also good (range 4–26, median 13), suggesting the work is having strong impact on the discipline. This area

of science underwent a major restructuring at the University of Helsinki just two years ago, yet it seems to be doing quite well nonetheless.

Research environment and organisation

Despite the reorganisation, the research environment of the unit seems healthy and proactive. Its funding stream has increased over the reporting period, including an increase in funding from the Academy of Finland. The unit is currently moving from a boreal forest focus to a more international outlook – especially the role and importance of forests in the tropics, but also via studies of insect defoliation in China, explorations of undisturbed boreal ecosystems in Russia, and analyses of Southeast Asian peatlands. This commitment is reflected in recent professorial hires in the areas of tropical forest ecology, and forest mycology and pathology. This is a good strategic shift that is particularly appropriate for a university forestry department, seeing that the applied and local focus is already covered very nicely in government agencies. The Viikki Tropical Resources Institute (VITRI) seems to provide a valuable venue for the continued development of this newly defined emphasis. The panel was pleased to see that the unit's research is strongly underpinned by an ecological and evolutionary outlook that provides the conceptual and empirical basis on which sound applied solutions can be developed. The panel strongly supports this approach. Part of the research activity is geared towards implementing the expertise of forest ecology and forestry in a societal context.

The unit's infrastructure is good; researchers have access to excellent research and experimental stations, which provides invaluable opportunities for long-term studies that can be difficult to maintain at other sites, in the absence of the stability permitted by institutional support. The unit should take this long perspective in developing its research profile. There is an effective use of different research methodologies including modern molecular techniques in combination with strong theoretical skills, long-term monitoring programmes, and remote sensing, in addition to experiments and modelling. Overall, the infrastructure seems strong. In particular, there are two field stations that provide important facilities for addressing key issues in forest-atmosphere relationships, and that are strongly used by members of the department. There is good evidence of extensive research interactions within Finland (University of Helsinki Department of Biology, Metla) and abroad. The approach of the unit appears to be to facilitate cross-disciplinary studies within various forest sciences and with other sciences, a general approach that looks very promising. Although not emphasised in the present report, the unit notes that a priority area is economic-ecological models. This cross-fertilisation of social and natural sciences is very important and to be encouraged. However, the unit does appear to suffer from a lack of permanent administrative and technical support staff, which could hamper its research in the future.

Research education

There is strength in the research education offerings in this unit, including involvement in a number of educational networks, and VITRI seems to provide an innovative educational venue for students interested in tropical forest research careers. The statement provided by the unit is thoughtfully crafted. The length required to complete the PhD programme

is of some concern; it is possibly the longest of all units evaluated. The unit states that it is currently discussing with the graduate school about the fact that the starting age is high, but then it takes students about 5–6 years at least to complete. The target is four years, but this is not readily achievable due to a lack of continuous funding for students. The issue of how to ensure steady progress towards a timely graduation by students needs to be addressed, as well as what the optimal time in the degree programme is, in terms of graduates being effective professionals within and outside academia. The unit indicated that there were problems in finding motivated students, and indicated that insecure funding might be partially responsible for this. Despite this worry, there is a reasonable number of PhD students (the standing crop of course may be boosted because turnover rates are low), but the unit is somewhat low in terms of postdoctoral fellows (0.57 per senior staff). A potential reallocation of resources away from PhD towards postdoctoral fellows might be considered (although there is a feeling that the unit needs to produce even more PhD students as they all do seem to get jobs).

Interaction between research and society

The department provided an excellent statement about its interaction with society. It has a tradition of collaboration with different forest-related stakeholders both nationally and internationally. For instance, it has provided consultation on policy issues involving peatlands in Finland, as well as in the tropics. The staff also interact with society through general publications, acting as consultants in forestry and environmental issues, being active in various outreach activities, and participating in public discussions on forest-related issues. The department has published several popular science books in Finnish about recent research findings in the field of forest ecology, and staff members regularly contribute to articles in professional hand- or guidebooks, as well as regularly appearing on TV, radio, and writing for the popular press.

Recommendations

- The department should carefully evaluate the time that is currently required to achieve a doctorate. Were this time to be reduced, the thesis criteria should be amended accordingly (maybe move some of the requirements/ expectations to postdoctoral levels, which has happened in other fields in biology). The funding issue needs to be looked into to become more equitable among students, and if, say, four years is the expected number of years required for a PhD, then four years of funding should be assured.
- The panel encourages increased international links (Canada, for example) beyond the tropics and Europe, and in particular urges the unit to search for opportunities for collaboration or the sharing of insights and data within Finland and across the world. It is important for depth to strengthen the international dimension of research, through visitors and postdoctoral fellows, and the department seems well poised to do so.
- It is not clear how funds are allocated to units within the University of Helsinki, based on achievements. The panel recommends that the university provide a clear reward system based on achievements in ecology and evolution. University of Helsinki funding needs to be transparent, so that it is possible to plan ahead and execute coherent strategies for long-term viability of particular intellectual programmes and disciplines. The unit is strong and vibrant and deserves robust support.

- The Academy of Finland should help with funding for the long-term data and monitoring efforts and large-scale field experiments, which could be considered to be ecological infrastructure key to addressing many issues such as climate change impacts. More formal structures should be developed to help foster involvement of researchers in long-term monitoring programmes.

Finnish Museum of Natural History

The Finnish Museum of Natural History is an independent institution within the University of Helsinki. It is a research institute with the responsibility to care for and display the national natural history collections. The museum also performs inventories of flora and fauna and monitors changes in their numbers and distributions. The great majority of its research agenda (around 80%, according to its self-assessment) is in the area of ecology and evolution. Most of this is naturally in systematics and taxonomy, but the museum also conducts significant work in the area of population ecology and genetics.

Scientific quality of research

The museum collections, with 13 million specimens, constitute an outstanding and invaluable source of information on species over time and space, of national and international importance. Especially important collections are lichens, bryophytes, Lepidoptera and Coleoptera. Research at the museum is of a high international quality and focuses on systematics and biogeography, but also on animal ecology and aquatic fauna. Several researchers are involved in flora projects in many parts of the world and the Atlas Flora Europaea is edited from the museum. The research staff are collectively very productive with 456 publications in international journals and edited volumes (6–8 per capita) reported for the period 2006–2010, with the bulk of these in specialised journals, such as *Mycologia*, *Lichenologist* and *Zoological Journal of the Linnean Society*. Examples of more general journals with a higher impact factor include *Proceedings of the Royal Society B. Biological Sciences*, *Cladistics* and *Journal of Biogeography*. The h-indices of the staff are moderate (for senior researchers, the range is 3–24, median 10), but this is typical in systematics, and particular taxonomy – a key mission of natural history museums. Many results from taxonomic studies, such as names of species or higher taxa, identification keys or floras, provide essential information and tools for scientists in many fields. Mostly, this kind of information is used by other researchers (e.g. in identifying specimens from field samples) without citing the original publications.

Data associated with specimens provide scientifically valuable information and making this information easily available over the internet for the research community should be given high priority. So far only a small fraction of the museum's specimen collections are electronically catalogued, but the digitising centre in Joensuu (associated with the University of Eastern Finland and run on EU funding) should in the future speed up the process. Researchers at the museum and their students have access to infrastructure and equipment at the University of Helsinki Department of Biosciences and there is also a shared DNA laboratory. Noteworthy monitoring activities involve bird populations, where bird-ringing and observations, by a large number of volunteers, contribute to a rapidly growing database of international importance, which is also used for research on animal ecology. Long-term collection

and curation of data from monitoring and inventory projects are extremely important facilities for research and the panel strongly urges that these activities be maintained and adequately supported.

Research environment and organisation

There has been a downward trend in the unit's external funding (total 36% of all research funding) due to the availability of governmental funding (i.e. Ministry of Environment), but funds from the Academy of Finland have increased, as has core funding, thanks to restructuring, favouring ecology and evolution research. As a consequence of the recent university reform, the museum has gone through a major reorganisation. Five units have been reduced to three, led by permanent unit directors. There has also been an adaption to the University of Helsinki's four-level career system. A steering group for research has also been formed. The idea is to promote high-quality research, attract top-level scientists and increase external funding. It is too early to say if the changes will have the desired effect, but already several very positive effects are evident. The staff members interviewed describe a creative and open atmosphere that fosters collaboration instead of competition. The new organisation has also helped identify common needs, such as a collection management information system and a training programme for new systematists. A hindrance to synergy is that the different units are not in one building but scattered over Helsinki. The panel thought it essential to maintain collaboration, interaction and synergy with the Department of Biology at the University of Helsinki. This goes both ways: biology would significantly weaken without the expertise and outreach of the museum. Both the museum and the faculty should work towards removing strong barriers, for instance, seeing sharp distinctions among ecology, evolution and systematics. Shared positions between the museum and the Department of Biology could contribute to a stronger sense of unity. The museum has a long-standing, healthy and active collaboration with researchers and institutions in Finland, Europe and globally. Every year a large number of researchers visit the collections to study the material and many specimens are also sent out on loan.

Research education

The museum does not grant PhD degrees but does supervise students. Most doctoral candidates are affiliated with the Faculty of Biological and Environmental Sciences at the University of Helsinki and belong to the LUOVA graduate school. The museum lists as a weakness that it may have difficulty in the future in attracting new students to taxonomy, since museum staff are not visible at the undergraduate level. A solution to this could be that researchers from the museum participate in undergraduate teaching. The representation of systematics within the graduate school and in general at the University of Helsinki is too small, with scant support for graduate students in systematics, for instance. A clearly defined dimension of systematics and taxonomy training by experts within the existing LUOVA organisation would be an attractive solution. Apart from supervising graduate students at the University of Helsinki, often primarily at the museum's premises, the staff are involved in (co-)supervising students in other universities in Finland and abroad. The "taxonomic impediment", a phrase coined by Diversitas, has been identified as one of the major obstacles for achieving the goal of the Convention of Biological Diversity.

The PhD students also see the recently changed institutional structure as very beneficial; they now have regular meetings and discussions, whereas before they were more isolated. A very promising indication is that the new system with externally funded PIs is bringing in more PhDs and postdoctoral fellows. The reported ratio of postdoctoral fellows to senior staff is 0.46, which is below average relative to the units in this evaluation. But the panel noted that, already during the evaluation period, the number of postdoctoral fellows has increased from one to five, and in any case systematics and taxonomy have traditionally had somewhat fewer postdoctoral positions than other biological disciplines.

Interaction between research and society

The unit's interactions between research and society are excellent. As the museum itself states, it is in a unique position to deliver state-of-the-art scientific knowledge to society. Recipients include the general public, state, regional and municipal authorities, the media and NGOs. The numbers of popular presentations and publications and appearances in the media are very impressive. The high quality of these interactions can only be guaranteed by keeping an active research staff at the museum. In general, the museum plays a critical role in disseminating the pace and extent of changes occurring in the natural world to the public. The museum could also act as an arena for dissemination of research results from the Faculty of Biological and Environmental Sciences as a whole.

Recommendations

- The museum should continue efforts to support high-level research through the new organisation and strengthen the collaboration with the Department of Biosciences at the University of Helsinki, for instance, by shared positions.
- In Finland, as in many other countries, taxonomic competence is threatened, which is a very serious problem. It is therefore of the utmost importance that this competence be maintained and that knowledge be disseminated to a new generation. The panel suggests that a nation-wide graduate school specialising in systematics be considered.
- Establishment and development of a modern curation management system involving digitisation of the specimens in the collections to make the data readily accessible is essential. This will ensure that long-term observations from monitoring can be continued and be made openly available.
- Creative ways to foster synergies among ecology, evolution and systematics at the University of Helsinki, and indeed across the entire country, need to be developed. This would seem to be an excellent theme for a centre of excellence, and could provide a creative focus for a graduate school.

Åbo Akademi University – Department of Biosciences: Environmental and Marine Biology

Environmental and Marine Biology is part of the Department of Biosciences. It is a small unit with a primary focus on environmental biology and behavioural and evolutionary ecology (especially aquatic biology, in particular marine biology). The unit has been growing over the period of the evaluation, and includes supervision of several field facilities. It is responsible for teaching in biology at levels from BSc to PhD, with considerable effort at the MSc level. Undergraduate teaching has to be conducted in Swedish, which makes the unit unique among those in this evaluation.

Scientific quality of research

The department produces high-quality research. Its particular strengths include work on fish mating system evolution, prey colouration, zoobenthic ecology (incl. spatial and temporal dynamics), aquatic vegetation dynamics, coastal food webs, hypoxia in the Baltic Sea, and other dimensions of applied marine biology. Species and habitat distribution modelling is another important area; this makes good use of historical and long-term data. This work is being published in good journals, such as *Evolution, Animal Behaviour,* and *Marine Ecology Progress Series*, and the research conducted in the department includes substantial national and international collaborations. Research from the unit is well cited (with h-indices ranging from 5 to 25, with a median of 13), showing that its researchers are of international standing. The numbers of papers per senior staff member seem relatively low, but it should be noted that the rate of production of peer-reviewed papers has been rising in recent years. Moreover, heavy administration and teaching loads in this unit appear to limit the time available for research by its staff. It should also be noted that recent investment in postdoctoral fellows is likely to translate into more research outputs in the near future.

Research environment and organisation

The research at the unit focuses on the areas of marine, behavioural and environmental ecology. Much of the focus is on the Baltic Sea with aquatic ecology (at 39%) providing the main thrust of the research. The researchers are attempting to build stronger links between the different research themes and are also keen to find ways to attract more foreign visitors to the unit, building on their existing international collaborations. Distinctive features of the unit are that the researchers view their doctoral programme as the only cohesive marine academic programme in Finland. The panel concurs with this self-assessment. An unusually strong aspect of the programme is the integration of behavioural studies into aquatic environmental biology. The unit is also expected to provide regional advice, and does so regularly. Although it is a small unit, it has, according to the documentation provided, good research facilities including notable recent improvements in field stations as well as on the main campus.

Funding for the unit has grown somewhat over the reporting period, from €1.56 million to €1.98 million. The group has also been successful in attracting external funding. The unit benefits from the positive attitude of its relatively young and enthusiastic staff, including key new appointments and its unified and well-organised emphasis on marine research combined with a willingness to seek creative interactions between research themes. There is evidence in both the materials provided and in the presentation of a long-term vision in strategy and approach. There may be real opportunities to further develop the unit's marine strengths, especially following the breakup of the Institute of Marine Research, and the existing field stations provide crucial infrastructure that could help such development. Fostering collaborations with the SYKE Marine Research Centre founded in 2009 could provide one avenue for developing the unit. Weaknesses include the small size, high teaching and administrative loads, and constraints on the availability of research vessels at one of the field bases. The unit is not associated with a centre of excellence, and developing such a centre in collaboration with other units could

provide a mechanism for leveraging its current strength at the interface of aquatic ecology and behavioural and evolutionary ecology.

Research education

The graduate students express strong support for the staff but are concerned about the precarious funding situation that necessitates frequent applications for support. The students also indicated that there may be discrepancies in the reliability of support among students. The expectations about what is required in terms of published/publishable papers for a dissertation suggested a lack of clarity in student expectations. Attention should be paid to how to make graduate education benefit more systematically and strategically from the presence of a second strong university (University of Turku) close at hand in the same community, building on the links already present. The unit has a good record of placing its graduates, including into non-academic positions. Recent expansion in the number of postdoctoral fellows, thanks in particular to the Aronia collaboration with Novia University of Applied Sciences on *Integrated Coastal Zone Management* – which began in 2008 and runs for five years – adds to the intellectual vigour of the group. Postdoctoral researchers in this unit clearly contribute to the training of Master's students and doctoral candidates and receive mentoring that help foster independent research careers.

Interaction between research and society

One of the strengths of the unit is the interaction between research and society. For example, there is outreach to school classes on Baltic marine ecology. The unit also provides expert advice on marine and coastal environmental issues at various levels of government.

Recommendations

- There appears to be a relatively high administrative and teaching load, and the unit should explore ways of providing administrative support (e.g. by 'buying in' short-term teaching support) and flexibility in how institutional funds are used, freeing up more time for research by senior staff.
- The panel recommends that this unit build on the very strong opportunity provided by its seeming identity as the principal marine PhD-awarding programme in Finland, for instance, by crafting an initiative to secure a centre of excellence in this area.
- The panel also recommends that collaboration be increased both within and outside the department (e.g. with cell biology and biochemistry, and even the social sciences for the applied issues in marine biology addressed by the unit).

University of Oulu – Department of Biology

Ecology and evolution comprise a substantial fraction of the Department of Biology at the University of Oulu, including eight of the twelve professors, and 80 per cent of the self-defined research effort of the unit. There are two main research focuses: evolutionary ecology and population genetics, and community and population ecology. These are populated by five research "teams", which comprise several research leaders (1–2 professors and further senior researchers). The teams span a number of significant research areas, including in particular the population genetics, adaptations and ecology of plants, and community ecology and biodiversity, and the behavioural ecology and conservation biology of vertebrates and insects. The

department is also responsible for the Botanical Garden and Museum and the Zoological Museum, and is associated with (but does not run) the Oulanka field station.

Scientific quality of research

The emphasis at Oulu is on basic research, with some application occurring when linked to state research institutes. There is a clear research focus on the two main areas of emphasis. The recent loss of a prominent ecological geneticist was a substantial disadvantage to the programme, but unavoidable and due to personal reasons unrelated to the department. The unit has a strategy to redress this, including a recent joint professorship hire in the area of genetics and biometry. There is a strong tradition of interdisciplinarity, which leads to a strong research unit. The quality of publication is excellent to very good, with papers in *Proceedings of the National Academy of Sciences USA, American Naturalist,* and other top-rate international journals. The h-index of the senior staff ranges from 6 to 36, with a median value of 16, which is good. There are no noticeable weaknesses, and there is a truly internationally recognised research programme in evolutionary population genetics, particularly of trees. Other more ecological aspects of the department are also strong and internationally respected, such as the work in plant population biology, life history evolution and invasion ecology. The bar-coding activity is very good, as is the population and community ecology research.

Research environment and organisation

There is good funding, although the funding sources are not diverse. The unit receives on the order of 20 per cent of funding from the Academy of Finland, which is somewhat lower than might be expected (on a par with the University of Eastern Finland, but well below, for example, University of Helsinki Biology, Agriculture and Forestry, and Environmental Sciences) given the high number of PhD students and postdoctoral researchers. EU funding is not a substantial source of funds. The reason for this is not clear; it may reflect a lack of administrative support in administering a grant if awarded, or it may be because the staff does not quite see how their research matches EU calls. In any case, it is important that the department ascertain how it can mobilise its many considerable assets to compete successfully for these extra-Finland funds. Oulu had a Centre of Excellence in Population Genetic Analyses, and crafting a strategy to secure another centre tailored to its current mission would be highly valuable.

Oulu has recently been reorganised, with a reduction in the number of groups, a recently minted philosophy of research "teams", and a desire that all researchers belong to at least one team (so that there are no "loner" groups). Although very much a work in progress, this re-casting of organisation appears to have been successful to some degree to date, and it certainly provides greater flexibility in hiring (e.g. more senior researchers instead of one or a few professors) and sharing of resources, training and teaching. The overarching theme is integrative population biology, which now provides a focus for the whole department. The risk in this approach is that it can lead to a top-down mentality, and a muffling of individual creativity, which is essential to nurture even if it does not closely match a group vision.

The impression that the unit provided in its presentation is that it is very much top-down in terms of how decisions are made. This is not healthy. It is important that an environment be structured that encourages individual creativity, and even 'risky' science.

Infrastructure has suffered, especially the closing of the experimental unit of the Zoological Museum. In addition, the Hailuoto station was effectively closed, with no staff at present, and the Oulanka station is now detached from the department. Moreover, the evaluation documentation for the unit states that the remainder of the Museum, and the Garden, might well be threatened with closure. Such closures are very worrisome and, in many ways, potentially disastrous. When a field station is closed, it threatens the integrity and continuation of long-term datasets associated with that site, as there is no easy opportunity to fund continued collection of these data.

On a more positive note, there are strong links to government research institutes, particularly the Finnish Forest Research Institute (Metla). There are shared professorships with this institute, which is encouraging and a step to be applauded, on both sides of the appointment.

Research education

The PhD programme at Oulu is undergoing changes, as seems to be the case everywhere in Finland. There is a movement within the unit towards four-year degrees (i.e. ensuring or strongly encouraging students to complete their PhD within four years), a trend towards employing postdoctoral scholars rather than PhD students, and a reorganisation of the administration of the PhD programme. Both students and academic staff noted that annual, renewable funding from foundations was less than ideal, because of the almost annual uncertainty of support, and the amount of time required by students to craft proposals. Reduction in the total number of PhD students and an increase in postdoctoral researchers were seen as positive changes by both students and academic staff, and the panel agrees with this perspective.

Oulu is reorganising its administration of graduate training so that all PhD students fall under a single graduate school within the university. It may well work towards a more uniform experience for PhD students, particularly as gauged by the length of time required to achieve the PhD and security of funding, in which case it would be a success.

Students were, on the whole, positive about their experiences at Oulu and, although somewhat uncertain about the future, generally positive about life after the PhD. The number of doctoral candidates per senior researcher is 1.8. There is a growing number of postdoctoral researchers within ecology and evolution at the University of Oulu, which is a healthy sign of a strong research programme. In fact, Oulu has the fourth highest ratio of postdoctorals to senior staff, per FTE, of all the units evaluated. This increase in the postdoctoral body can in a variety of ways enhance the intellectual environment for graduate students.

Interaction between research and society

The unit presented considerably less evidence of societal impact than other units in this evaluation. However, there is some evidence of policy having been influenced by research produced in this department.

Conservation of the lesser white-fronted goose has been modified as a result of the research from this unit. Legislation protecting northern rivers and preventing transmission of fish from their home waters has been implemented as a result of research on salmon parasites. There is outreach to research institutes and collaboration on applied research, for instance on trees based on population genetic studies. These are all positive, but it would seem that there could be considerably more outreach and communication of key research findings to the general public than at present.

Recommendations

- The unit has to be careful that its recent reorganisation does not hamper individual creativity.
- The unit might consider more flexible requirements on the number of published articles to graduate, to facilitate passage through the doctoral programme. There may be variation among subfields.
- There should be a strategy for maintaining long-term datasets, even after retirement of the main users or collectors of these data. Long-term data are a national infrastructure and valuable to all researchers in ecology and evolution in Finland. Likewise, it is important to retain strength in museums and botanical gardens and not let them languish and die.
- The unit should more assiduously address the issue of societal impact.
- The movement towards internationalisation, particularly among students and postdoctorals, should be encouraged to grow.
- Seeking EU funding, especially ERC Starting Grants and Advanced Grants, should be encouraged.

University of Jyväskylä – Department of Biological and Environmental Science

The Department of Biological and Environmental Science has a particular focus on evolutionary biology and genetics, with substantial strengths in conservation biology and aquatic science as well. It is organised into four main divisions: Cell and Molecular Biology, Ecology and Evolutionary Biology, Aquatic Sciences, and Environmental Science and Technology. The department also includes the Konnevesi Research Station, 70 km north of Jyväskylä. The majority of ecology and evolutionary biology research is carried out within the Division of Ecology and Evolutionary Biology (evolutionary ecology, evolutionary genetics, applied ecology and conservation biology) and within the Division of Aquatic Sciences (freshwater ecosystem research, aquatic parasitology, fish ecology and fisheries biology). Other ecology and evolutionary biology research takes place in the Division of Cell and Molecular Biology (evolution of virus structures and virulence) and the Division of Environmental Science and Technology (environmental impact assessment).

Scientific quality of research

This is a very happy, collaborative and successful department with highly motivated and enthusiastic members of uniform high quality. All senior staff are of international stature. The unit operates under a clear culture of collaboration and congeniality. It has an impressive international publication record with many well-cited papers in top-tier journals. The h-indices of the research staff range from 1 to 46, with a median of 19.5 – the highest of all units in this evaluation. Experimental evolutionary ecology is particularly excellent, and this

strength must be maintained. Researchers in the unit have been principal players in two Academy of Finland Centres of Excellence: the CoE in Evolution and Ecology and the CoE in Virus Research, recently unified into the CoE in Biological Interaction, in collaboration with the University of Helsinki Department of Biosciences. There are excellent interactions among group members, with evidence of collective decision-making being a real strength to continued success. The unit actively considers the future rather than simply being satisfied with its current success. It has a good plan for fostering future research (e.g. as witnessed in the strategic hire of a young foreign theoretician) and is now actively pursuing biodiversity and aquatic ecology research. The moderate size of the department encourages flexibility and research across traditional disciplinary boundaries; for example, molecular and cell biology is well integrated with the ecology and evolution groups, and an example of the kind of cross-linkage of disciplines that is rare in many biology departments. There is a clear strategy for future hires in important research areas that should complement existing strengths. The unit has fostered an outstanding programme of internationalisation, which is reflected in hires of foreign staff, extensive international networks of collaborators, numerous visits by foreign scientists and international dimensions in the training of students. There is also excellent integration of impact (contributions to policy) with basic research, and these applied efforts themselves bear on significant intellectual research questions, such as how to gauge the effectiveness of landowner voluntary conservation efforts in more complex regional conservation strategies.

Research environment and organisation

The environment for research seems very healthy and dynamic. The highly positive atmosphere in the unit came through very clearly in the really excellent written report, as well as in the oral presentation and subsequent discussions. The department makes effective use of the Konnevesi Research Station, for teaching and research. There are considerable linkages across these division boundaries, further highlighting the intellectual vigour of the unit. At a practical level, it is noteworthy that the department has a large number of technical and administrative personnel. This is a wise strategy, since it frees up the research staff and students to do what they are presumably best at, which is conduct research.

Core funding seems strong, having increased over the reporting period from €3.1 million to €3.9 million. This indicates laudable support by the central administration of the university for this high-quality department. The panel noted that the main external funding comes from the Academy of Finland and that this highly competitive funding has increased as well, which is a clear testament to the intellectual strengths of the unit. It would be advantageous for the department to generate more international funding, such as from the EU, which is rather modest at present. The unit has developed specific plans to pursue EU funding, which could supplement current funding, and in so doing it may require additional support from its central administration, for instance to procure and then manage far-flung collaborative grants.

Jyväskylä is becoming the main centre for freshwater research in Finland. Although freshwater research is represented in other

universities, it appears to be on the decline or is represented by just a few individuals in many units. This provides a real opportunity for the department to play a crucial role in this dimension of environmental science in Finland and beyond. Jyväskylä has several freshwater scientists and good linkages with fish ecology and parasitology within the department. There is strength in the use of stable isotope analysis in freshwater research, and some evidence of attempts to widen this approach. It will be valuable for Jyväskylä to continue to develop this strength, and the panel applauds the attempt to gain a centre of excellence in this area in collaboration with biodiversity researchers.

Research education

The students appear to be well supported, in terms of both material, financial and intellectual support. The unit produced 40 PhD dissertations in 2006–2010, and there is a healthy ratio (2–3 to 1) between doctoral candidates and senior staff. The philosophy of the unit is to aim to ensure four years of funding for students at the time they are accepted, to ensure completion within this time frame, as well as to reduce the time graduate students need to spend scrambling for funds rather than educating themselves and conducting their doctoral research. The graduate students are encouraged to have an international outlook and to attend one conference a year, which is a real strength, for instance allowing them to meet potential postdoctoral mentors. The department also fosters and promotes international links that benefit the students in several ways. The majority of PhD opponents are from an institute outside Finland, which means the students are linked into international networks throughout their graduate experience. These external evaluators then provide recommendations, or help provide postdoctoral opportunities. There is a very good graduate school (Biological Interaction) involving several universities across Finland that provides PhD funding, organises events and training for the students and also promotes networking that benefits everyone involved. The unit also has a vigorous seminar series. There is a reasonable corps of postdoctoral fellows –1.33 per senior staff, the second highest of all units evaluated. It is noteworthy that many of these are foreign. This undoubtedly reflects the steady increase in funding reported by the unit, but it is also a testament to the attractiveness and quality of the research environment in this unit. Staff members perceive a need to increase the number of postdoctoral researchers, and the panel encourages them to seek additional sources of postdoctoral funding such as from the Marie Curie scheme and other EU networks.

Interaction between research and society

There is strong evidence of research with societal impact. Examples include evaluating the use of restored peatland to function as carbon dioxide sinks within the context of carbon credit markets; work on invasive species, sustainable forestry and fisheries management; and emerging diseases. All these evince a desire and willingness to look for ways to tie basic research to applied problems. This research often involves end-users at the early research development stage, which is good. The Peerage of Science has been recently created by several staff so as to overcome perceived limitations with the often cumbersome traditional reviewing system in science. This initiative is still very much an experiment, but it shows at least a willingness by the staff to consider novel ideas to create new outreach opportunities. The unit could consider strengthening other ways of broadening its societal

impact in outreach to the public, for instance by increasing the number of articles appearing in the popular press.

Recommendations

- The unit is in the process of adopting a tenure-track system and can use the resources within the unit as it sees fit, and to ensure that resource use is flexible. The panel recommends that this system be used to maximise internal growth and retain talented staff.
- Additional administrative support is needed to help run centres of excellence and the graduate school, which are highly valuable and visible elements at the university, and also to help secure and run large, multi-institutional EU-funded projects. At present, this work is carried out by the researchers themselves. There is a real need for a full-time academic administrative coordinator in the unit.
- The panel supports the movement made by the unit towards fewer PhD students and more postdoctoral researchers, and recommends that this continue.
- The panel applauds the unit for aiming to increase its expertise in mathematical biology. Thought should be given to developing a centre of excellence linking several schools and to involving graduate students across the whole country, specifically focusing on this area and cognate areas such as statistical methodologies for linking models with data.

University of Turku – Department of Biology

The Department of Biology at the University of Turku has a substantial and successful focus on ecology and evolution, comprising about 60 per cent of its total research effort. It engages in research from molecular levels up through individual ecology to population and ecosystem processes. It has focal emphases on ecological interactions, evolutionary genetics, systematics and ecophysiology, particularly in the context of ecotoxicology.

Scientific quality of research

The quality of the unit's research in ecology and evolution is very high. The scientific output of the researchers is substantial and of excellent scientific quality, with many publications appearing in the most highly ranked journals, such as Ecology and the Proceedings of the National Academy of Sciences. Several papers are also among the most cited in ecology and evolution at any Finnish research institution during the period 2006–2010. The scientific impact of the researchers is generally high (h-scores for senior staff ranges from 3 to 47, with a median value of 17 and several professors are ISI Highly Cited Researchers). Indeed, in the eyes of the panel, several papers produced by researchers in the unit have contributed to the advancement of whole fields of research, so these citations metrics, if anything, underplay the influence of individuals in the unit.

The scientific focus among the different researchers is diversified, for instance, ranging from dynamical interactions in different ecosystems to genetic determinants of behaviour. Similarly, the geographical location differs vastly, from tropical regions in Amazonia to Arctic regions in northern Norway. The committee finds that this diversified strategy produces important cross-fertilisation of ideas among the researchers, resulting in several innovative approaches. The panel particularly appreciates the inclusion of systematics into ecological research, as well as the unusual approach of using evolutionary perspectives to

analyse human demography. Including the latter dimension demonstrates an intellectual flexibility which is laudable, and the former is, the panel believes, a key dimension of the emerging fusion of ecology and evolutionary biology.

An important foundation for important research areas in the department has been the development of long-term time series of population and demographic data from several ecological systems, such as on species' distributions and interspecific interactions in the Arctic. This has enabled its researchers to address questions that can hardly be addressed in any other system in the whole world. As a consequence, results produced by researchers in the unit have rapidly entered into textbooks, especially in ecology. To conclude, the panel finds the research in ecology and evolution at the University of Turku to be of excellent quality.

Research environment and organisation

Core funding has risen modestly over the reporting period, and Academy of Finland and other external funding has stayed roughly constant, albeit with fluctuations. There has been a quite recent increase in funding from EU sources, and the unit should marshal its forces to capitalise on such funds more effectively.

The well-crafted report of the unit lays out a very clear and coherent description of the structure of research activities in the unit and lays out a detailed plan of action, acknowledging problems as well as strengths. The department clearly is a healthy and dynamic place to carry out creative science. The unit has obtained a status as one of the six strategic research areas identified within the University of Turku. This funding has been used very wisely to improve laboratory facilities and to secure the continuity of long-term study systems. This has in turn facilitated the further integration of the different subdisciplines in the department, resulting in a unique research environment, not just in Finland but internationally as well. The department has been able to garner both national and international centres of excellence, for instance with one focused on climate change in the tundra. The scientific background of the researchers is diverse and has resulted in important cross-fertilisation of ideas and techniques among different subdisciplines within the fields of ecology and evolution. The panel finds that the unit has been able to establish some common scientific goals that help tie the diverse elements of the department together in a common framework. Such an overarching research focus is generally rare in university departments. It has made excellent plans for filling open faculty positions. The department has established a molecular biological laboratory within the unit used in common by graduate students and researchers from different research groups.

The panel also notes that there are some serious issues that need to be addressed, such as an overly cumbersome burden of administration, compounded by relatively heavy teaching loads. A serious issue is that the field stations, Kevo in the far north, and on the island of Seili, quite badly need modernisation; without upgrading, their value for research will be reduced. A long-term institutional goal might be collection of the different sections into a common building, which would also further strengthen integration among research groups.

Research education

Most doctoral candidates are in the new Biological Interactions Graduate School. The unit has a large number of doctoral

candidates and few permanent positions, relative to the breadth of the research programmes. Several of the staff have also been heavily involved in research, leading to periods of leave. This means that teaching at times heavily relies on the use of temporary staff, which introduces an extra administrative burden of organising teaching programmes. The panel would emphasise that this underscores the importance of rapidly replacing staff as they retire, avoiding periods of vacancy in key positions. The supervision of the graduate students seems to be excellent and carried out by highly motivated supervisors. However, there are some concerns that the unit has allowed too many PhD students, and it is notable that a relatively low fraction of students are supported by reliable long-term funding, including via the graduate school. But the panel noted that there has been a recent decrease in doctoral candidates (from 2.7 per senior staff to 1.7), trading off with an increase in postdoctorals, and the current ratio of doctoral candidates to senior research staff is less than 2:1. These are healthy trends, and should be continued.

Interaction between research and society

The panel finds that the unit addresses questions and produces results that will have wide implications for our understanding of the implications of the expected global changes that will occur in the future. For example, the panel notes the recent research on how changes in grazing pressure in alpine areas will affect biogeochemical cycles and ultimately the rate of global warming. Researchers in the department help provide expert advice for decision-making in conservation and other applied arenas, both locally, across Finland and also internationally (e.g. in Amazonian Peru). The unit does an excellent job in conveying scientific findings to broader audiences, for instance via radio, TV, public presentations, popular journal articles and translating books into Finnish. The Botanical Garden and Zoological Museum have been quite active in linking to the public, and members of the unit have contributed to early education in science.

Recommendations

- The university, in collaboration with relevant potential funding agencies, should develop a strategy ensuring continuity in the unique long-term data series that have been generated by researchers in the unit.
- It is important that the university continue to recognise ecological interactions and ecological genetics as strategic research areas.
- The research groups are of a small size and therefore vulnerable to delays in the replacement of retired researchers. Long periods with vacancy in positions should be avoided.
- The field stations need to be modernised, and the panel observes that a lack of access to nearby field experimental facilities might constrain the unit's potential for scientific progress. Such facilities should be established reasonably close to the university, if feasible.
- The panel recommends that actions be taken to improve both formal and informal collaboration between the University of Turku and Åbo Akademi University, so as to broaden and enrich the research and educational environment in ecology and evolution in both institutions.
- The panel applauds the fact that systematics and biogeography are an organic part of the research mix in the unit, since this seems absent in many other Finnish institutions. The panel therefore recommends that this area of research and education be sustained with permanent positions.

Finnish Environment Institute (SYKE)

The Finnish Environment Institute (SYKE) is the largest environmental research institute in Finland. It has three research focuses (Marine, Biodiversity and Ecosystem, and Freshwater) spread across four main sites (Oulu, Joensuu, Jyväskylä and Helsinki). Research activities in the areas of ecology and (to a degree) evolution account for approximately 30 per cent of research within SYKE, with basic research being just part of this total effort. There is a strong focus across SYKE on addressing issues with Finnish societal relevance, and many linkages with policy-makers exist, from local communities, to ministries and the EU, to the broader international landscape.

Scientific quality of research

The quality of the research is overall excellent, as clearly demonstrated by the number of first-class publications in international high-quality journals (e.g. *Nature, Nature Geosciences, TREE, Proceedings of the National Academy of Sciences USA, Global Ecology & Biogeography*), and by the fact that the h-index among the staff is quite respectable (overall in the range of ~6–24, with professors 10–24), comparable to that of most university departments in this evaluation. There is substantial diversity in the particular research questions that fall into the domain of SYKE. Research themes currently being addressed span biodiversity and ecosystem processes, marine ecological research and freshwater ecological research. In addition, four strategic research programmes have been established (for the period 2010–2014) in the areas of climate change, Baltic Sea ecology, inland water and aquatic resources, ecosystem services and sustainable communities. The panel noted a range of valuable research accomplishments produced by SYKE scientists, ranging from, for instance, elucidating aspects of the global and regional carbon cycle, to climate change scenarios, to the relationship of diversity to stability in phytoplankton assemblages, to effects of hypoxia and eutrophication in the Baltic Sea. An impressive range of environmental and technical approaches is employed to study the different research themes, and there is strong research on identifying the mechanisms involved in driving observed induced changes in marine and terrestrial ecosystems. Keeping to the applied mission of SYKE, a notable theme in the terrestrial programme is excellent research into impacts of climate and land-use change on biodiversity in many ecosystems, including conceptual analyses and reviews, and analyses in the Baltic Sea and inland waters have highlighted key issues in understanding and managing these systems. Moreover, although it goes beyond the purview of this evaluation, the panel noted that there is considerable focus in SYKE on incorporating socio-economic perspectives into scientific research on environmental issues.

Research environment and organisation

SYKE combines being a research institute with being a centre for environmental expertise and information in Finland. It provides a central clearing house for environmental data from around Finland. Its focus is Finland, but it has many regional and international linkages, for instance serving as the secretary general for the Partnership for European Environmental Research (PEER). Its funding has increased modestly

during the reporting period, from €4.9 million to €5.2 million, in part due to an enhancement in Academy funding, more than offsetting declines in other sources. The institute should consider how it could diversify its funding sources.

The unit is clearly successful at much of what it does. There is real strength in a unit being as large and diverse as SYKE is, but it also can create difficulties. The panel had some concerns that the current organisational structure of SYKE, both physically (spread out among multiple sites) and in terms of its numerous research subunits or programmes, is resulting in a research and service portfolio that leads to a danger of a lack of cohesion, at least as perceived by the panel. It goes beyond the parameters of the assessment to state in any detail how the unit might better foster such cohesion, but the panel feels it important to note that that was the overall sense of the unit.

Each of the main physical locations of SYKE across Finland is located in a town with a university. It is noteworthy and laudable that many publications produced by SYKE are co-authored with university staff. The panel would encourage SYKE to continue to strengthen these linkages. Towards this end, the panel notes that SYKE laudably has several joint university professorships, and suggests that it could consider striving to develop more of these joint appointments, as they provide a durable mechanism for pushing strategic areas forward.

One important and indeed crucial dimension of SYKE is its responsibility for long-term monitoring, leading to time series that are invaluable for addressing many key basic questions in ecology and environmental science, as well as for responding to urgent applied issues. It is essential that this dimension of SYKE be maintained, via maintenance of infrastructure and key hires. SYKE is also responsible for coordinating the Finnish Long-Term Socio-Ecological Research network (FinLTSER), which the panel views to be potentially a highly valuable player in assessing long-term trends in ecological conditions. There needs to be a conscious integration of this activity with the national monitoring schemes that are SYKE's charge. SYKE also has responsibility for physical dimensions of infrastructure, such as the ice-reinforced vessel Aranda, and other laboratory facilities needed in marine research. It is important that these facilities be maintained.

Research education

Research education within SYKE is only at the graduate level. There are currently 94 doctoral candidates registered with on average about 23 new students each year, averaging to about 0.7 students per senior staff. These students are widely dispersed across the Finnish universities (which are the degree-awarding bodies) and there is no dedicated graduate school specifically for SYKE students. Although the strong links with the universities can be seen as advantageous, in that the students will receive research strengths from their particular campuses or supervisors, the panel felt that lack of a deliberately structured SYKE graduate programme was possibly to the detriment of the research education of doctoral candidates. In particular, it was felt that the added value of belonging to SYKE cannot be fully realised by the students in the current structure. The panel suggests that this be viewed as a serious issue by the SYKE administration. As a possible institutional model for what SYKE might do, a recent

Western Hemisphere example might be instructive. After an external evaluation, the Smithsonian Tropical Research Institute (STRI) in Panama (likewise not a degree-awarding institution, comparable in this respect to SYKE) decided that training the next generation of tropical biologists would be a key priority for scientific excellence in their strategic plan. STRI established a Dean of Academic Programs, who now oversees all doctoral candidates working at the various physical locations occupied by STRI. The Smithsonian has a range of institute-wide graduate and postdoctoral fellowships, which can attract the finest young scientists to work with particular staff members. There are also regular workshops and training programmes, including professional development courses, targeted to these students, and activities aimed at providing social cohesion among the corps of STRI students. Each student is of course also enrolled in an institution of higher learning, and so will shuttle between two different research and educational milieus while receiving his or her doctorate. Something along these lines might well provide a strategic tool for SYKE to facilitate its engagement with universities. Furthermore, a deliberate focus on improving graduate education and linkages with university would surely enhance the valuable role of SYKE in developing the human capital represented by graduate students and postdoctoral researchers within Finland.

SYKE has had a reasonable number of postdoctoral researchers per senior staff (0.68). It would be helpful for it to develop deliberate institutional strategies for fostering the careers of postdoctoral fellows, and to utilise them in the training of graduate students.

Interaction between research and society

One of SYKE's substantial and truly laudable strengths is in this aspect of the assessment; there is clear evidence of good to excellent interactions with NGOs, government agencies and industry. There is also evidence that work undertaken at SYKE has influenced policy, including EU directives, government assessments and international threatened species classification lists. The panel applauds SYKE for all of these. Also apparent are interactions with individual citizens and local communities, and the panel noted that there are good structures for disseminating research findings and interaction with these stakeholders. An excellent example is the Baltic Sea Portal (www.balticseaportal.fi); pages of the portal were uploaded 3.5 million times in 2010. The outputs reported for popularising science (popular publications and representations on TV and radio) from SYKE were, however, relatively low compared to some other units, which may be a function of a lack of emphasis, or even a simple lack of recording. Many of the research findings would be very appealing to broad, popular audiences. The panel noted that SYKE is making an effort in this direction by publishing a regular, quarterly e-newsletter, dubbed Envelope, which provides a useful capsule summary of current issues in conservation and environmental protection, and guides to best practices. The institution needs to develop mechanisms for assessing the efficacy of such outreach efforts.

Recommendations

- Individual-driven research agendas should be allowed to develop, in addition to the current project-driven agenda approach.
- Consideration needs to be given to finding structures that enable agenda-setting science projects to be prioritised.

- Development of SYKE-wide synthesis, cross-cutting meetings and seminars should be implemented.
- More consideration needs to be given to fostering a dynamic research environment for doctoral candidates and postdoctoral fellows, possibly through the development of a national graduate school in under-served areas such as aquatic ecology, or in creative interdisciplinary areas such as social-ecological analyses. The panel's recommendation is not for any specific such school, but rather that SYKE address what appears to be a systematic issue.

MTT Agrifood Research Institute

MTT Agrifood Research Finland has a primary mission that focuses on the appropriate use of renewable natural resources with an overarching goal of providing a sustainable and responsible bioeconomy for Finland. The task of this unit involves maintaining the integrity of entire food chains in agroecosystems, food sector production, rural development, agriculture and the sustainable use of natural resources, yet it must also deal with food and biodiversity security in response to a changing climate. The contribution of MTT to the study of ecology and evolution in Finland is derived from the pursuit of this primary mission and is manifest in research on adaptation to and mitigation of climate change, biodiversity in agroecosystems, caretaking of the genetic resources of agricultural plants and animals, and reduction of anthropogenically derived increases in nutrient loads to natural systems. Overall, ecology and evolution represent a quite small proportion of the overall research conducted in the unit (its self-assessment reports about 3%).

Scientific quality of research

MTT is tackling key questions and producing results in a wide range of topics thematically related to ecology and evolution, including domestic animal and plant genetic research, conservation and sustainable use of these genetic resources, the preservation of genetic diversity and refinement of population structure markers for cattle, sheep, goat and horses, analysing ancient DNA through different genomic techniques, developing potential scenarios and responses for future production in a climate of increased uncertainty and variability, study of the evolution of pest species and in particular plant pathogens, elucidating key aspects of soil ecology such as earthworm dynamics, exploring plant-endophyte-consumer interactions, and exploring the factors that maintain diversity in agroecosystems. This spans much excellent research. Although the primary aim of the unit is to provide research addressing applied issues, such research is best when underpinned by basic studies. Consistent with best practice, an evolutionary ecology outlook informed all of the research presented to the panel. The unit reported 134 refereed articles relevant to ecology and evolution that had been published during the reporting period. There was evidence of an increasing output of research results and publications over time, with 50 in 2010 alone, suggesting that the research focus and productivity of the unit in this area is growing. Some publications are in good general journals in ecology and evolution (e.g. *Conservation Biology, Molecular Ecology, Heredity, Ecological Monographs, PLoS One*), but most publications appear in specialist journals that have less of a general profile, but are nevertheless internationally respected. The professors and senior researchers have low h-indices, with a range from 1 to 16, with a median of

6.5. This would be worrisome, but the panel noted that there has been a very recent increase in the number of individuals in these positions, and there are inevitable time lags in scientific citations. It was the opinion of the panel that investigators at MTT often produce a remarkably high level of research related to ecology and evolution, considering how minor these disciplines might be viewed to be in the context of its national mission. The recent surge in productivity is to be applauded. But the panel wishes to highlight the continuing need by MTT scientists to ensure that their applied research is always based on fundamental science, some of which should be conducted within the unit itself.

Research environment and organisation

There are two MTT research units relevant to ecology and evolution – Biotechnology and Food Research, and Plant Production Research – divided into six thematic research groups. These units appear to have little or no overlap in mission or research. MTT has a main centre for research in Jokioinen, and experimental fields and greenhouse facilities elsewhere in Finland as well, and can rely on excellent facilities housed in other units. MTT appears to be well networked with university research groups and international research institutes and organisations, although there are no clear linkages with university centres of excellence. The Biotechnology and Food Research Unit belongs to a Nordic research consortium focused on animal genetic resources. It seems to be a rather small unit (in 2010, it reports 13.15 FTEs of rank 1 and 2), but quite an active one, for instance in characterising genetic variation in domestic livestock. There is a clear emphasis on interdisciplinarity in the approach. There is also an international dimension in some of the unit's research, for example, the subunit should also get substantial credit for reaching out to Russian and Chinese scientists in research on improving and preserving genetic diversity for domesticated livestock. The Plant Production Research Unit by contrast has a large staff (the document reports a total of around 240, of whom maybe 40–60 are involved in the research under the purview of this evaluation), and it deals with a wide range of topics focused on sustainable agriculture. It was not clear from the documentation provided how these separate topics were related or integrated within the overall unit. There appears to be a rather modest level of international exchange and collaboration in this part of the agency. The panel suggests that the current emphasis in the unit on mitigation of and adaptation to climate change in agricultural environments provides an opportunity – and indeed presents a critical need – for more systematic whole-system approaches that could cut across many of these separate subunit themes. This theme also should involve increased international collaboration. Research funding has shown a substantial increase over the funding period, from about €0.78 million to €1.23 million, thanks to increases in both core funding and Academy support. EU funding and other international sources of support are quite minor in magnitude, but maybe that should be expected in a governmental agency such as this.

Research education

Education of PhD students is not a primary aim of MTT, but students are trained in collaboration with universities. This provides opportunities for students to directly participate in the translation of research into applied solutions and gain valuable experience and contacts outside

the university setting. It also provides a mechanism for other university students and researchers to experience a more diverse research spectrum. The collaboration between research institute and university sectors is therefore potentially and generally positive. However, because education is not the primary remit of this unit, it is important that students not fall between the cracks of two institutions and become isolated. Special attention needs to be paid by supervisors both in the agency and at the university to how best to maintain the engagement of students with a broader intellectual community. This should be made explicit and not be left to chance. Moreover, the panel noted that there have been rather few doctoral candidates trained in the unit, with a total of five doctorates completed in the reporting period. Graduate students provide an obvious mechanism for enhancing the intellectual engagement of the supervisors themselves, and more broadly the institutional units in which they are housed. The unit notes in its report that it has been difficult to recruit students in those areas of applied research that constitute MTT's mission. A systematic study of what the bottlenecks are that impede student recruitment is needed. Training students in this and other research institutes could provide a potential conduit for acquiring a cadre of future, well-trained employees who are grounded in fundamental science but focused on the key applied questions that are the remit of MTT. The panel likewise noted that there are very few postdoctoral fellows per senior staff (0.16). It is not clear if this low number reflects the kind of research that is done, or other factors, but the institute should consider ways to enhance postdoctoral opportunities within its ongoing research programmes.

Interaction between research and society

It is obvious that the research mission of an entity such as MTT is by its very nature focused on issues of societal importance, for example issues of agroecosystem viability and sustainability. It occurred to the panel that just as universities need to find links between their basic research activities and societal issues, it is essential that free-standing research institutes articulate how to ground their applied research with more fundamental questions in science. For instance, applied systems can provide ideal testing grounds for assessing hypotheses in ecology and evolutionary biology, and these tests can in turn inform sophisticated applied practice. There should be a continual ongoing loop from basic research to applied issues, and back again. There could also be creative opportunities for collaborations with foreign and university scientists, using applied agroecosystems as venues for addressing fundamental questions. The panel noted that the documents provided included little or no indication of how the unit connects with the broader public.

Recommendations

- Maintain or increase allocation of funding to collaboration with foreign researchers, for instance via opportunities for EU funding.
- As a source of novel ideas, develop a different model for PhD mentoring in which students are free to pursue a broader range of scholarship, encourage further links with PhD students in other Finnish universities working on similar research through the graduate school programme, and identify mechanisms to incorporate postdoctoral researchers.
- Training of graduate students should be based on explicit plans for how the students will be integrated into both host institutions – the institute and the

university. Such plans should be in place when the students start their programme, and not be left to chance.
- Community genetics, landscape-scale questions and quantitative theory are inherent dimensions of some of MTT's work in ecology and evolution and should be fostered. An increasing use of mathematical models, for instance linking mathematical infectious disease models with plant pathogen genetic studies, could be a highly profitable direction to develop. Analyses of field-level ecological processes might benefit from being placed in broader landscape and regional contexts. MTT should consider seeking collaborative connections or future hires in the context of these areas of ecology and evolution.
- The panel thought that the genomic aspects of research reported are superb but could be characterised more broadly to more accurately represent their potential contribution to ecology and evolution.
- There is potential opportunity for MTT to cast some of its ongoing work in the context of defining ecosystem services provided by agroecosystems.

Finnish Forest Research Institute (METLA)

The Finnish Forest Research Institute (Metla) is a governmental research institute that has its focus on all aspects of forest ecology, production and related issues, ranging from basic research on the structure and functioning of forest ecosystems, to crafting viral biocontrol agents of forest pathogens, to helping develop policies related to forest-centred economic issues. Its mission is largely applied, but it does contain a significant component of basic research. However, basic research in ecology and evolution in the unit has shrunk in recent years, and research is increasingly tied closely to the fostering of enterprise and business activities. The goal still appears to be strong publications, but typically with direct relevance to economic impacts. Basic research in the unit addresses the biological basis for sustainable forestry and fundamental processes of forest ecosystem functioning – ranging from microbes to mice – in order to provide conclusions about issues of current general interest in forestry and the forest environment.

Scientific quality of the research

Most research in Metla is tied to applied problems. It ranges from genetics of forest trees, to soil processes such as element fluxes, to key animal drivers in forest dynamics such as tree pathogens and voles (and the pathogens of these voles), with first-class research in all these areas, often with the development of novel methods. Interdisciplinarity is a key basis for the research, which includes economic and other social-science dimensions of forestry. In 2006–2010, Metla produced more than 300 articles in international refereed journals. Outputs include many fine publications in high-quality international journals such as *Ecology Letters, PNAS, Molecular Ecology, Functional Ecology*, etc. The professors and senior researchers in the unit have h-indices ranging from 2 to 45. Although the maximal h-index reported is among the higher values found in this review, the panel noted that Metla's median h-index, 10, is the third lowest of the 14 units evaluated. The panel has some concern that the most successful programme by this metric was not emphasised in the documentation, and hopes that this does not indicate a phasing out of this research dimension by the unit. A new book, *Biodiversity in Dead Wood*, will be published in June 2012, which

promises to provide a critical and timely synthesis of this poorly understood area of biodiversity. The unit has been active in IPCC and researcher training, and has participated in more than ten EU projects. Research networks such as in forest genetics collectively demonstrate the high recognition and quality of Metla's research and researchers. In short, Metla conducts high-impact, long-term basic ecological research. Yet its ability to continue to do so may be threatened by current trends in staffing and funding.

Research environment and organisation

There has been a recent shift in the strategic direction and funding of Metla, which will likely impact its ability to contribute as strongly to the understanding of forest ecosystems in the future as has occurred in the past. The total budget of Metla, cumulatively from 2006 to 2010, is just under €48 million, of which only €6 million is in the area of ecology and evolution. Core funding of ecology and evolution research in Metla has shrunk over five years from approximately €13.6 million to €4.5 million. Over the same period, external funding has also declined (though Academy funding has remained roughly level). Thus, there has been a substantial shrinkage over this period – over two-fold – in the budget to the unit, including core and external funding. The panel feels that this corrosive trend should be stopped, and indeed reversed, given the intellectual and societal importance of the research mission of the unit. The research emphasis has also shifted to forest-based enterprise and business of forestry, to emphasise societal impacts and economic benefits of forests. It is understandable that this governmental unit necessarily needs to have a strong focus on applied issues, but it would be a long-term strategic error not to ground such applications on high-quality basic science, some of which should be carried out by the unit itself.

Metla has many technical personnel, which is a real strength in carrying out empirical research. It also has extensive involvement in scientific networks with universities in Finland and internationally (INRA, Spain, Sweden, etc.). A great strength of Metla is that it has experimental setups and monitoring plots that represent the whole of Finland and that are components of a Europe-wide experiment network. These include long-term experimental studies on the impacts of forestry operations on forests and forest ecology, with factorial experiments since the 1970s and some even going back to the 1950s. This is an important research mission of the sort which only governmental institutes can hope to carry out, and could be of great importance in understanding the interplay of forest management and climate change in the decades to come.

The number of active staff has declined by one-third during the period of evaluation. Projecting over the next five years, 30–40 per cent of senior researchers in Metla are expected to retire, and it is unclear how they will be replaced, given budget cuts. This precipitous drop in research staff is a serious issue. Research on biodiversity and conservation, among other dimensions of forest ecology studies, may be at risk, and defining the core scientific work of Metla is a challenge. Another challenge is that Metla works on very many small (albeit interesting and worthy) problems, which is why the panel encourages the unit to identify some large-scale problems and challenges. Examples could include a holistic approach to water quality issues and the effects of forest practice on carbon budgets and fluxes. Metla needs to maintain a capacity for emerging

pathogen identification in forests. An important strength of Metla is that it shares infrastructure and positions such as professorships with universities. Creating more such shared positions could be an important way to lever Metla funding with other avenues of support to sustain a critical basic research element in the institute.

Research education

There are no formal obligations for researchers in the unit to provide graduate or doctoral training and teaching, even though there are professors at the institute; graduate training and teaching is voluntary. The unit does not award degrees, so PhD supervision is necessarily carried out in collaboration with universities. Doctoral candidates number around ten per year, and are supported by external funding (Academy of Finland €2.8m over the last five years, EU €2.6m, industry €1.2m, etc.). Students and postdoctoral fellows are crucial because they do much of the actual research. It is important that graduate students who are based in Metla labs are not isolated, and communication among such students within and outside the institute (i.e. with university programmes) regarding common problems and approaches could be improved. The students expressed a sense of isolation, which hampers their intellectual development and engagement with their disciplines. There are at least four joint Metla or university positions that facilitate doctoral research, but all professors and most senior scientists are adjunct professors (docents) and supervise students. Connections with universities are important and efficient, via both shared professorships and doctoral candidates, and because Metla is involved with most academic units, it could play a particularly crucial role in facilitating the synthesis of Finnish research in forest ecology, which occurs scattered across many institutional units at present.

Metla makes effective use of postdoctoral fellows. From 2006 to 2010, it had 17 postdoctoral periods in comparison with 15 PhD students graduated; this was the highest postdoctoral fellow to PhD student ratio of any unit evaluated. It is important for the unit to ensure that postdoctoral fellows participate in PhD student mentoring within Metla, both within and across disciplines

Interactions between research and society

Metla has demonstrated an excellent record of societal outreach and impact. One indicator documented more than 850 radio or TV presentations or articles popularising science by Metla staff over the last five years. This is impressive indeed. Examples of impact have included development of national guidelines for sustainable bioenergy harvesting, water protection and good forest management; establishment of the Forest Biodiversity Programme for southern Finland; providing scientific data for nationwide activities; and assistance with the preparation of legislation on biodiversity and conservation planning and legislation, forest health legislation, climate change and environmental monitoring. Metla-developed treatments for conifer stumps against *Heterobasidion* spp. are now used in more than 100,000 ha of forest in Fennoscandia, which would translate into a substantial economic impact. Most of the novel alien forest pathogens found in Finland have been first observed by Metla, and new virus-based means to control tree diseases are being developed. The societal impact of Metla is based on conducting top-level scientific research

and drawing conclusions based on this understanding. Public interest in forests and forest-related issues is bigger than ever, due to bioenergy, bioeconomy, carbon, greenhouse gases and water issues.

Recommendations

- It is important to maintain strength in long-term ecological research and to emphasise sustaining the shared professorships and senior research cadre in Metla.
- Metla has extensive, valuable long-term ecological data on forests that are a critical national asset and that warrant a national strategy for long-term maintenance. Efforts should be made into computerising these data, documenting metadata and making them accessible for multiple uses.
- Solid basic research is the basis for applied research, and Metla should continue to support this strongly, while also being creative in exploiting applied research for the study of basic ecological questions.
- Metla should aim at identifying synergistic mechanisms and strategies for facilitating the synthesis of Finnish research in forest ecology, which occurs in many institutional units at present. The large-scale network of experimental forestry sites, spanning Finland, is a particularly valuable resource, and should be sustained and enhanced.
- Metla needs to identify mechanisms so that graduate students who are based in Metla labs are not working as isolated individuals in single labs, but instead engaged in a broader research community within Metla and the wider graduate student community, via workshops, symposia, graduate schools and other activities.

Finnish Game and Fisheries Research Institute (FGFRI)

The Finnish Game and Fisheries Research Institute is a governmental agency that oversees game and fisheries issues in Finland. It has many responsibilities and duties that are not research in a strict sense, but nonetheless provide the information by which research questions might be answered. Staff members at the institute monitor populations of a number of game and fish species that are recreationally or commercially exploited, or might be, were they more abundant, contributing to sustainable management and exploitation of fish and wildlife. Its aegis includes aspects of the ecology of Finnish habitats and taxa that go well beyond the simple population monitoring of exploited species, and its staff have addressed important questions in behavioural ecology that have real implications for management.

Scientific quality of the research

The panel was impressed by the attitudes of the staff and noted that some of the unit's senior researchers are very distinguished. It was felt that the unit was wisely managed by individuals familiar with its science as well as with the needs of administration. The interactions between the institute and society can be readily perceived in work involving species that are valued as food or recreational species (for instance the Atlantic salmon), as endangered but charismatic and sometimes unnecessarily feared species such as wolves, and as species that are relatively abundant and perceived as damaging owing to human desires to exploit aspects of their habitat, like timber, such as moose.

The panel perceived the institute's staff had a very strong commitment to their work. The research staff have published a steady stream of excellent papers, in journals of basic science as well as in more applied venues. Despite the decrease in the level of staffing, the researchers have maintained a steady level of scientific publication, which is impressive. Among the research institutes, the Finnish Game and Fisheries Research Institute obtains proportionately more than the average level of funding from external sources, e.g. Ministry of Agriculture and Forestry, though less from the Academy of Finland. By its very nature, its research is strongly of an applied nature and in this arena is exemplary and complementary to population studies of unexploited species. There is no real distinction in this area between applied and fundamental research; the two blend and are mutually reinforcing. As a key dimension of its mission, the institute maintains long-term datasets that become more valuable by the year, and clearly cherishes them. The panel thinks that more formal provision needs to be made for safeguarding and maintaining the availability of such data, not only from the unit but from all institutions in Finland, and for sustaining these long-term studies.

The productivity of the unit, in terms of refereed publications, is higher than the average among both research institutes and all institutions combined, and its costs per refereed publication are relatively low. Unit's senior staff are particularly productive, and the research is of high quality and appreciated by the scientific community, with an h-index among its staff ranging from 8 to 20. Institute staff publish in high-quality international journals (e.g. *Proceedings of the National Academy of Sciences, Molecular Ecology and Proceedings of the Royal Society*) and there is extensive collaboration with universities as evidenced by joint authorship on many publications. Overall, the panel is highly impressed with the quality of the research carried out by the unit.

Research environment and organisation

The unit's core support has been decreasing in recent years, with the result that the age distribution is skewed towards the latter end of careers, albeit of people with immense experience and knowledge. There has been some reduction in overall funding, from €1.8 million to €1.5 million, with minor support from the Academy of Finland. The unit has facilities such as fish tanks and tracking equipment that it readily makes available to university researchers and is a crucial organisation for large areas of Finnish, indeed Scandinavian, wildlife and fisheries research. Much of what it does is closely specified by ministries, and new directives require that the results of monitoring and recording should show increased applicability. This is not a major change, because the sorts of data that have been collected in any case are directed towards and indeed required for the setting of standards for management and exploitation.

The institute has kept pace with modern technology and widely uses molecular techniques for identification of definable populations as evolutionary units, and, for example, has demonstrated a very high specificity of genotypes of salmon to particular streams and tributaries, which are findings of considerable evolutionary as well as management interest. The statistical approaches used by the unit are advanced, and it also uses up-to-date technology for tagging and marking individual animals and tracking their movements. The institute works closely with all universities in carrying out ecological research.

The institute perceives its strengths and threats largely in terms of the inevitable restrictions placed on its activities by mandates from the Government, but these are not truly weaknesses, as it is doing the job it was set up to do and does it admirably well. Older staff may to some extent regret the current trend towards satisfying the desires of the human population to a greater extent than in the past, but it is clear that their commitment to the accurate assessment of the state of the animal populations, and their needs, remains very high. The panel notes that there has been a substantial decline in research staff in this area, as well as in support personnel, over the last five years, with the number of research-active staff diminishing by almost half. There also are very few postdoctoral researchers associated with the institute. If continued, this trend will greatly degrade the ability of the institute to continue to provide basic research essential to effective management of game and fish resources. These personnel issues are serious and need attention.

Research education

Research institutes do not have specific responsibilities towards doctoral education; that is the role of the universities. But they do have facilities and datasets that can be exploited by partnerships with universities through the placement of doctoral candidates and that potentially serve a vital role in developing and maintaining the human scientific capital of the nation. This role has greatly declined in the unit over the period concerned and there is only one student presently associated with the institute. The reasons are probably outside the institute's control, for it has shown great willingness to provide facilities to the universities; they lie perhaps in trends and fashions in the preferences of potential students, but the lack of doctoral interest is a threat in terms of future staffing of the institute with suitable researchers. The institute should do some soul-searching, and devise strategies to foster more involvement by graduate students in its research activities.

Institutes tend to have lower ratios of postdoctoral researchers to senior staff than universities, simply because the career structure is different and the work of postdoctoral researchers, insofar as there is an equivalent, is done by permanent junior staff. However, this institute has lost many staff as a result of government manipulations of its budget in the last five or more years, but it has been skilled in attracting university collaboration to use its data. The one postdoctoral fellow the panel met was very satisfied with her lot, and this policy of data sharing appears to be working well.

Interactions between research and society

The importance of game and fisheries in Finland is substantial with some two million recreational anglers, 300,000 registered hunters and some 4,000 people employed in commercial fishing. Much of the basic work of the institute is focused on research closely related to issues of game and fisheries management, and so the societal implications of the research are rather clear. In addition, the institute deals with charismatic species of great public interest. It astutely provides a great deal of information through popular publications and is manifestly in the public eye. The panel's impression is that the institute is well thought of and appreciated by the public.

Recommendations

- The panel recommends that any further reduction in core resources be avoided on account of the quality of the long-term data gathering and research on fish and game populations and, more broadly, the valuable service the institute provides to ecologists both within Finland and elsewhere.
- The panel also recommends that the Academy of Finland recognise the value for basic science of the long-term data gathered by this unit, and that it recognise this in funding applications for research utilising these data by those institute staff who have the closest understanding of the datasets.

The likely future shortage of suitably qualified researchers in the domain that is the mission of the unit is a real concern. The problem may be one of image, with fisheries and game seen as a preserve of rugged he-men, whereas actually the skills needed for frontline research, data analysis and sophisticated management are the same as those for any other area of ecology. Traditionally, the area has been male-dominated, whereas many, indeed perhaps the majority of, PhD students in ecology at present are women. The institute might like to invest in ways of changing its image to surmount this likely sociological challenge in perception.

OVERALL ASSESSMENT OF ECOLOGY AND EVOLUTIONARY BIOLOGY IN FINLAND

Status of research: quality and systemic issues

The quality of research in Finland in the areas of ecology and evolution is high. There are many excellent papers published in high-quality journals and, overall, the panel was impressed with the wealth of strong research programmes scattered among a range of universities and governmental institutions. Every unit evaluated is making real and internationally significant contributions to basic understanding in ecology and evolution. The panel notes that Finnish ecology and evolution has stars in many subdisciplines, including scientists who have made fundamental contributions to behavioural ecology, population biology, community ecology, forest ecology, population genetics and metapopulation and spatial ecology. There is considerable excellence as well in ecological genetics, experimental evolutionary biology and phylogenetic systematics, all of which seem to be in an active phase of growth at present. These are fields of research that are very strong and where Finland has an international presence. Indeed, Finland can boast of a proud record of cutting-edge research agendas in many areas of ecology and evolution that have been influential worldwide. The quality and productivity of ecology and evolutionary biology in Finland is on a par with the best research today, at an international scale. For instance, Professor Ilkka Hanski recently won the Crafoord Prize, which is analogous to a Nobel Prize in this discipline. The current strong status of the disciplines of ecology and evolution in Finland should be viewed as national intellectual assets, by the Academy of Finland and indeed by the nation as a whole.

In a time of worldwide economic woes, with substantial cuts currently evident in many units' budgets, the panel perceived a strong positive attitude towards maintaining and building research strength in ecology and evolution, and generating human intellectual capital via education, across almost all units that were evaluated. It is important to stress that the panel feels that budget cuts should be minimised for this area of science, which is very strong. Fields can degrade rapidly, if appropriate infrastructure is not sustained, and key researchers are either discouraged or leave the country due to inadequate or erratic research support. It is important that this message be clearly received by academic and institutional administrators, as well as by governmental ministries and funding agencies, including in particular the Academy of Finland. The Academy research council that is responsible for this area should develop strategies to ensure the maintenance of this critical area.

The panel is particularly impressed with the evident ability of Finnish scientists to work across traditional disciplinary boundaries in an intellectually integrative fashion. The panel applauds the fact that the approach to evolution in Finland is permeated by ecological perspectives, and that many ecologists have a strong evolutionary or genetic flavour in their thinking, including many working in applied areas. Also, there is a pervasive concern with linking analyses of behaviour and physiology with processes at higher levels of biological organisation, an emphasis that the panel believes is essential

for developing sophisticated, predictive understanding of ecological responses to environmental change.

Finnish scientists have a strong and laudable tradition of basing applied issues on a sound foundation of basic research. They have been very creative in finding ways to apply basic research in novel ways to important economic and societal issues, including in particular conservation and renewable resource management. Finland has a low population density and both economically and culturally it is highly dependent on its natural resources, particularly on timber. Given its geographical location, it may be experiencing profound ecosystem changes driven by climate change. More than most countries, Finland needs a deep understanding of ecology to manage its natural environment sustainably and to conserve its biodiversity. Thus, the strength in research in ecology and evolution discerned in this evaluation is both appropriate and valuable, and it represents a dimension of scientific research where national investment clearly addresses national needs.

Beyond this, Finnish ecology and evolutionary biology is strongly rooted in significant conceptual issues. This is important both for maintaining excellence in research and for training graduate students and postdoctoral fellows. Complementing this conceptual emphasis, it appears to the panel that universities and agencies are taking advantage of frontline technological advances. Both the conceptual focus and the utilisation of state-of-the-art technology are key to maintaining and further boosting the high international status of Finland in these areas.

An outstanding strength of Finland in ecology and evolutionary biology is that the country, viewed as whole, has a substantial number of long-term datasets and field studies by many scientists scattered across many units. Such datasets are essential for assessing global change impacts, which are already particularly severe in northern ecosystems. There is a risk of these long-term studies becoming orphaned, starved and even terminated, due to the pressures of budget constraints. This would harm the quality of future research in these areas.

The panel notes with some concern that key aspects of systematics, particularly taxonomy, are not well represented in many universities and research institutes in the country. It is critical that the Academy of Finland, as well as the separate entities, devise mechanisms to maintain and build strength to train the next generation of taxonomists across a wide range of taxa.

The panel has identified some areas where there should be more cooperation and collaboration across Finnish institutions. There are overlapping domains of interest among units in a number of applied ecological areas, but during the evaluation, synergies among units have often been difficult to discern. One unit states in its report, about the nation as a whole and its stance in this area: “Linking the scattered strongholds into a high-quality environmental science is a national challenge.” This is a candid and we believe quite accurate statement.

Five areas in particular stand out:

- First, a number of ecological research groups are currently working on issues of peatland restoration and degradation, without much evidence of interaction, particularly among research institutes. This is a critical issue in boreal ecosystems at present, due to matters of

climate change among others, and enhanced synergy is essential.

- Second, forest ecology is strong in Finland, with a decided emphasis on timber production. Forestry as a business does not seem to invest in research, so wise and farseeing policy depends on government-sponsored research. The panel did discern what appear to be weaknesses in this area. For instance, holistic ecosystem ecology (e.g. integrating nutrient cycles and fluxes in the context of ecosystem function) seems to be somewhat weak. Forest ecology is another area where there seem to be lost opportunities for synergy across institutions. Coupling between aquatic and terrestrial systems in the context of forest ecology is increasingly recognised as a critical aspect of community and ecosystem ecology, but it is not prominent in the research profile of the country.
- Third, Finland has strength in theoretical and empirical population genetics, with some of the best scientists in the world in this area. Incorporating a genetic and evolutionary dimension into the applied mission of government agencies is a recent trend, and one that is very impressive. For instance, the work on genetic heterogeneity in domestic breeds is groundbreaking, and highlights an implicit conservation dimension in agriculture. But the overall number of researchers in this area seems rather small. This area of excellence provides an essential foundation for evolutionary biology in the country as a whole, and should be built up.
- Fourth, Finland has some outstanding theoretical ecologists and evolutionary biologists, in terms of both mathematical theory and statistical and data analytic methodologies, but the panel noted that this area of expertise is not widespread among Finnish institutions. The panel would encourage additional appointments in this area, and identification of mechanisms to facilitate cross-institutional facilitation of this critical modelling and quantitative dimension of ecology and evolution.
- Fifth, and finally, freshwater and marine research has been required extensively in management of the problems created by use of catchments for forestry and agriculture, in management of important fisheries, and in the international safeguarding of the water quality of the Baltic Sea. The research carried out has been prominent and reputable and, in some areas, has contributed greatly to new ideas in international thinking, for example in the use of stable isotopes in the dissection of freshwater food webs, in the increasing understanding of how organic matter from terrestrial systems provides substantial food and energy sources to rivers and lakes, in catchment management and water pollution control, and in palaeolimnology. There is evidence of a decline in capacity for this research in the country viewed as a whole, given the retirement of some older limnologists, the reduction of facilities at one university, the effects of continued reorganisation at another, the at-least-temporary disruption of marine research with the closure of the Finnish Marine Institute, and the separation of work in biological and chemical oceanography and physical oceanography into different institutes, and emphasis on applied marine research in its new location. On the other hand, there is also some evidence of increasing strength, for instance, at what is emerging as the new centre for freshwater research in Finland in Jyväskylä. And, of course, much work in ecological genetics of fish and other aquatic organisms represents a strong national asset. But the panel does

suggest that fundamental aquatic research at the system level be rebuilt and reorganised.

Beyond these five particular areas, there are others that should be mentioned as possibly being targeted in Finland for the future crystallisation of identifiable research (e.g. using mechanisms such as Academy-funded CoEs), in particular microbial ecology (a key and inadequately understood dimension of all ecosystem), infectious disease ecology, and historical and paleontological dimensions of ecology.

Recommendations

- The Academy of Finland should consider how to capitalise on the current evident strengths of Finland in ecology and evolution to enhance the profile of Finland in international science, for instance via sponsoring major symposia, or facilitating in some fashion the outreach of researchers to the broader society.
- There appear to be lost opportunities for synergistic interactions, research programmes and education among institutions in some key areas, including:
  - peatland ecology
  - forest ecosystem ecology
  - theoretical and empirical population genetics
  - theoretical and quantitative ecology
  - freshwater and marine ecology.
- The panel notes that such lost opportunities include research at the interface of applied environmental science and basic research, but also even within the latter.
- Long-term datasets in ecology and evolutionary biology should be viewed as national assets, and steps should be taken to retain, synthesise and sustain them.

Research environment and infrastructure

It is the panel's impression that there has been steady support for some years within Finland for acquiring the essential infrastructure needed to carry out cutting-edge research across the country, but there are also concerns.

For instance, there is an enviable wealth of field stations scattered around the country, which seem to be well used, but some have recently closed and others need modernisation. This is worrisome. This network of sites is, the panel believes, essential for maintaining strong field programmes in ecology. An important challenge is to integrate the diverse studies that have been carried out at these sites, and to ascertain how these sites can be used to maximal advantage for advancing ecology and evolutionary biology in Finland. The Academy of Finland provides avenues for the acquisition of large pieces of equipment, but does not appear to have programmes directly targeted at the development and optimal use of these field stations. A programme comparable to the US LTER (which has dedicated funding for infrastructure and research, and seems more comprehensive than the existing Finnish analogue, LTSER), including the array of existing field stations, would help facilitate the optimal use of field stations as instruments for ecological research.

Such field stations are often the sites of long-term studies. Long-term data from these sites will be particularly valuable in addressing impacts of global and regional environmental change. For this reason, among others, it is crucial that a strategy be devised to maintain and strengthen this network of field sites. Long-term datasets, often complemented by specimens, are a

particularly valuable intellectual resource in our rapidly changing world, and, as noted above, Finland has an unusually strong tradition in generating such datasets. However, maintaining continuity in the generation of such data is a serious institutional challenge, and this issue is one that arose repeatedly during the evaluation. This issue should be considered to be a national problem – and opportunity – and the Academy of Finland should work with faculty and other researchers involved in collecting long-term data to address it. The LTSER network could be expanded, and sustained, with resources specifically allocated towards the capture and synthesis of long-term datasets from a wide range of research programmes, beyond the sites themselves. There needs to be a formal mechanism for ensuring the capture and availability of long-term environmental and biodiversity data. A national scheme for maintaining and making available such long-term datasets, possibly sponsored by the Academy, is an urgent necessity. The availability of such data to researchers is part of what defines their research environments.

Likewise, museums and botanical gardens are essential ancillary institutions in ecology and evolutionary biology – institutions that are often vulnerable in times of budgetary constraints. Understanding biodiversity fundamentally depends on knowing what species are and how they are related, and specimens in museums and gardens are essential for generating this knowledge. Moreover, the physical and chemical composition of an organism provides a kind of bioassay of conditions in its environments, and specimens provide in effect a lens into past environmental conditions. It appears to the panel that museums in Finland need additional resources in order to digitise their specimen data in a curation management system, which would make this information much more available to researchers. More attention needs to be given to maintaining specimen collections generated from ecological studies. Museums have a special role to play in retaining such collections. Moreover, it is important to link shorter-term ecological stories with insights drawn from deeper time, such as provided by palaeoecology.

Recommendations

- The current array of field stations should be maintained and strengthened, and the stations should be linked to broader networks – this should be a significant goal of institutions, and the country as a whole.
- Museums and botanical gardens should likewise be sustained, including training of appropriate research staff and digitisation of collection information.
- Mechanisms for the retention and continuation of long-term datasets from monitoring and other activities should be devised and implemented at a national scale.
- Creative opportunities for cross-institutional appointments, particularly linking universities and governmental research institutes, should be pursued.

Recruitment and funding

On the positive side, Finland obviously has done an excellent job in recruiting outstanding scientists into professorships and senior research positions, as reflected in the current strengths in its international research profile. On the negative side, a recurrent theme in the evaluation is the pervasiveness of constraints on appointments, and the uncertainties that are inevitably present, given the prevalence of short-to-moderate terms, versus permanent,

appointments. Many research groups may be constantly at risk, because of the danger of 'poaching' of key researchers. Dealing with this danger, however, in the end involves many societal, economic and institutional issues that are well beyond the purview of the panel. The panel is encouraged to learn that some Finnish universities are now moving towards a tenure-track system, which could help alleviate some of these issues.

There is a wealth of interactions at present between universities and research institutes, but there is room for improvement here. In particular, an important mechanism for fostering interaction between universities and research institutes can be the formal sharing of positions. Such positions, if carefully defined and judiciously recruited, can provide natural conduits between basic research and applied issues.

There is scope for some institutions (which they recognise themselves) to increase external funding from a diversity of sources. In some cases, there appear to be local, institutional impediments that make this more difficult for some researchers.

The panel applauds the Academy of Finland for supporting projects that appear meritorious to international review panels. This level of targeted support is, we believe, reflected in the quality of research that is produced in Finland, viewed as a whole, and as recognised by the world of science.

Recommendations

- There seems to be a perception among some research groups of a shortage in the administrative staff required to craft and then manage complex research awards, for instance from the EU. It is beyond the panel's purview to pursue this issue in any detail, but it is clear that in order to increase the amount of EU funding garnered by Finnish investigators, and in particular for them to lead large EU programmes, institutions must ensure that there is adequate administrative support available to researchers, both during proposal generation and after the award is granted.
- Networks of cooperation between universities and the research institutes are developing well, but more could be done in this area. The Academy of Finland might consider developing grant programmes analogous to the "Research Cooperation Networks" programme of the US National Science Foundation, for instance, but in thematic areas where there should be stronger synergies between universities and the institutes. There appears to be a substantial emphasis in several institutions on developing international cooperation. This should be deliberately pursued across all institutions.

Doctoral training

In many respects, PhD students are the lifeblood of the research enterprise, and like the rest of ecology and evolution research in Finland, doctoral candidates in Finland are internationally competitive and respected. Finnish doctoral training, and indeed higher education as a whole, has undergone and is undergoing considerable change. The situation and structuring of doctoral programmes appears to be in flux, and indeed, it is fair to say, is in a somewhat confusing state. There are graduate schools financed by the Ministry of Education and Culture (through the Academy of Finland), either contained with a single university or as a network of departments or units across several universities. In addition, there are graduate schools financed directly by the

universities, without direct funding from the Ministry or the Academy. It is unclear if there is, or will be, a country-wide system for regular external evaluations of doctoral programmes. It is also unclear whether the current plan is to maintain schools that combine units across several universities. This makes it somewhat difficult to evaluate the system completely, as it is something of a moving target.

University education is now more clearly divided into undergraduate (three years), MSc (postundergraduate) and PhD (post-MSc) training. Although the panel's charge was to evaluate doctoral training, it should be recognised that a more synoptic appraisal of education in any given scientific discipline needs to encompass lower levels as well, and in particular MSc programmes, as well as the continuation of training at higher levels, in postdoctoral positions. That should be the focus of a completely separate evaluation than what was attempted here.

The mission of universities is to conduct research and teach courses that are underpinned by research, and PhD students clearly play a vital role in the research side and to a lesser extent in the teaching side of universities. In government research institutes as well, PhD students can play vital roles in carrying out research that is informed by current thinking and technological advances in ecology and evolution. One of the biggest changes is the move towards completing the PhD within four years, a change that the panel heard about from several universities. It makes sense to aim for commonalities among institutions in the flow of students through their professional training, but room must be made for some heterogeneity in the vicissitudes of research, particularly in field ecology. Moreover, diversity among institutions itself can be a source of health, since there is no guarantee that any particular organisation of education is truly the optimal way of organising things for all disciplinary areas and career trajectories.

The Academy of Finland, in conjunction with the Ministry and possibly other entities (e.g. foundations that currently support graduate students) should consider commissioning an analysis specifically on issues of funding and timing of graduate studies. There remain some remnants of the old system (e.g. year-to-year funding from foundations) that should be addressed. This is outside the remit of this panel, but the funding environment sustaining graduate studies needs to be carefully thought through. As a standard, units should strive towards more dependable, longer-term funding for doctoral candidates, rather than year-to-year support, to provide stability and allow students to focus on research and training without continually seeking support each year.

Overall, the panel's inclination is that it is better to have fewer good students who are well supported than to have many that are not. Students who are constantly writing proposals to garner more funds for their next year of education, are thereby spending less time actually carrying out research and writing it up for publication. There is a move towards training fewer PhD students with more competitive admission to the PhD programme, and instead training more postdoctoral scholars. This is another trend the panel supports, as increasing the supply of postdoctoral positions does provide places for completed PhD students. It is appropriate that the competition for places occurs at the level of the entry to PhD studies as long as there is an increase in funding for postdoctoral positions. This last point is crucial. What is needed is an analysis of training in ecology and

evolution, in effect across the entire life cycle of researchers, taking into account both the needs of individual students and the desire for society to have as vibrant and creative a body of researchers produced as possible. All evolutionary biologists and ecologists know that conditions that are optimal for individuals are not necessarily those which are optimised (by whatever criterion) at higher, aggregate levels, and balancing individual and societal needs is a real challenge in graduate education, as in all human endeavours.

There is a recent development of university-wide graduate schools. This is a shift away from national graduate schools, and is an experiment. The panel sees this as potentially positive, but only if the strengths of the current system are maintained in parallel. One of the real strengths of the training in Finland, echoed in the interviews with all students, are the courses that cut across campuses and the meetings organised by students that any student from any university can attend. These courses, often with international instructors, serve to foster collaborations, build networks, spread best practices, provide moral and intellectual support, and lay the groundwork for positions after the PhD. Because national graduate schools draw on expertise from many institutions, the quality of the courses and possibly even the breadth of supervision offered in them might exceed what could be expected from any single institution. A critical mass of faculty and students is needed to sustain cutting-edge graduate education in any subdiscipline in science, and this critical mass might only be present when one aggregates across multiple institutions. Should Finland move solely to university-based graduate schools, it could lose what seems to the panel to be significant advantages of the current system for graduate education. If this happens, the Academy of Finland should then devise mechanisms to fund specialised courses and workshops for graduate students, and foster activities for students within a coherent discipline such as ecology or evolution to get together for extended periods. Field stations are excellent sites for such interactions and graduate training to occur, and this provides an additional line of argument for the maintenance and support of the existing network of field stations. There could also be negative implications of a decline in national graduate schools in the total funding pool available as grants and support for graduate students, for instance for students to attend national and international meetings and visit far-flung labs and field sites.

In ecology and evolution, many students pursue a PhD through joint supervision between a university and a government research institute (e.g. SYKE, Metla and MTT). These associations are extremely valuable for Finnish science and for the students, but need to be carefully managed. It is highly valuable for graduate students to be directly involved in the research activities of these free-standing governmental institutes, both for themselves, and for maintaining strong links between cutting-edge basic science in universities and applied research aimed at crucial societal issues. The enthusiasm of young investigators is a priceless leavening for raising the quality of ongoing research in any institution. Yet students who reside primarily in a research institute often have trouble integrating and are often poorly supervised. The panel's impression is that it is easier to become orphaned if the PhD is primarily within the research institute. Indeed, the rare concern expressed from a student during the interviews was almost always associated with a feeling of isolation

from being located in an institute. The panel suggests that university supervisors develop more formal mentoring and supervision methods for these students.

The Finnish PhD generally takes 4–5 years, but can be highly variable within, and to some degree across, institutions. The goal of a four-year PhD has been suggested as a target norm, and this goal has its merits, but it should be recognised that there will naturally be variance around this due to the unexpected exigencies of research, the degree of preparedness of students, the contingencies of their lives (e.g. maternity leave), and the intellectual breadth one expects graduates to have as they launch their careers. As noted throughout this report, there is increasing activity across the traditional disciplinary boundaries of ecology, evolution, systematics and genetics, as well as between natural and social sciences. If such cross-disciplinary dimensions are to be seriously contained within the scope of graduate training, this if anything increases the amount of time students need to complete their degree, rather than shrinks it. Moreover, field studies in ecology and behaviour often take considerable time to play out, and artificially constraining the time requirements of a degree will cramp the range of questions students can attempt to answer. The panel notes that the median age for doctoral degrees across units ranges from 30 to 43. This presumably reflects breaks in the continuity of individuals as they move through the educational system, for instance, taking professional positions before returning for their doctorates. But this issue is one which might be worth pondering in more detail, particularly given that many doctoral candidates enter one or more postdoctoral positions before entering a permanent position.

So flexibility needs to be built into the system. The issue of the structure and timing of graduate education is a question that should receive separate and close scrutiny as a separate exercise, given that Finnish universities have been experiencing recent restructuring, and given the existence of the Bologna Process. It will be important for university programmes in ecology and evolution to look towards their requirements for the PhD and ensure they do not inordinately lengthen the time required for completing a PhD. For example, requiring publishable manuscripts as a prerequisite for the PhD is seen as one real strength of the programme, but the number required and whether they are published, accepted for publication, submitted or manuscripts ready for submission may vary among programmes. These expectations should be realistic. Alongside this, students who are accepted into a PhD programme should at least be guaranteed four years of funding (excluding maternity leave). This would reduce the amount of time they spend in securing annual funding and would in any case tend to automatically sculpt their schedules to fit this time frame, without a rigid requirement on the length of time allowed for the degree necessarily being imposed top-down.

Education for an individual, broadly conceived, extends beyond the doctorate to include one or more stints as a postdoctoral fellow. It would be valuable for the Academy of Finland and other relevant agencies to consider education more broadly, to encompass the years of postdoctoral training that typically ensue in individuals' careers between their doctorate and their finding permanent employment, so as to ensure the development and retention of a pool of highly trained human talent in these critical areas of scientific endeavour.

Recommendations

- Moving to a single graduate college within each university is sensible, but it will be important for the Academy of Finland to also find ways to ensure PhD students and postdoctorals from the different universities interact and develop the strong networks that now seem to be characteristic of the Finnish PhD, as is currently the case with the national graduate schools. These should be viewed as complementary dimensions of a Finnish doctoral education.
- The panel strongly supports the continued funding of national PhD courses and graduate schools in ecology and evolution.
- Mechanisms should be developed to improve the educational environment and reduce the sense of isolation of doctoral candidates carrying out their research in government institutes, and those institutes should identify ways to increase their abilities to creating this crucial intellectual capital for Finland.
- As a general rule, funding for PhD students should be guaranteed for at least four years. PhD students should not be made continually (i.e. yearly) to seek funding.
- In addition to expanding the funding of postdoctorals on research projects, the panel supports a national scheme that supports funding international postdoctoral training. This could be modelled on the Marie Curie outgoing scheme, with two years in another country followed by one year in Finland.

Some units presented thoughtful statements about postdoctoral mentoring and training. This is an area that should receive scrutiny by all universities and institutes.

Finally, there should be a scheme to support researchers linking postdoctoral and permanent tenure-track positions. The Academy of Finland should look at the UK Research Councils' scheme whereby fellowships are provided for academics to join a university, provided the university promises a permanent position at the end of the fellowship.

SOCIETAL IMPACTS

Interactions between research communities and civil society

Most units have demonstrated a good to excellent record of societal outreach and impact. One aspect of this is the public dissemination of scientific results in the popular media. Recipients are the general public, state, regional and municipal authorities, the media and NGOs. The review documented as one indicator the number of documented radio and TV presentations or articles popularising science, and this was very high by units such as the Finnish Museum of Natural History (more than 900 in 2006–2010) and Metla (more than 850). Some other units lacked a strategy to convey scientific research results to civil society or did not accurately track such dissemination (media interviews and articles, etc.). Research results were also incorporated into handbooks or national or local guidelines, for example for sustainable bioenergy harvesting, water protection and good forest management, as well into field guides and other materials useful for citizens interested in natural history.

Also apparent throughout the report are interactions with the individual citizen or communities via both traditional and new forms of dissemination and engagement with key stakeholders. SYKE, for example, has established the Baltic Sea Portal (www.balticseaportal.fi), pages of which were uploaded 3.5 million times in 2010. The Finnish Museum of Natural History plays a critical and very effective role in disseminating the pace and extent of changes occurring in the natural world to the public. Examples in other units include an outreach programme for school classes on Baltic marine ecology; publication of several popular science books about recent research findings in the field of forest ecology; contribution to articles in professional hand- or guidebooks; and participation in public discussions on ecological and forest-related issues. All of these activities contribute to increasing the public understanding of science and to the development of policy.

Public interest in ecological and forest-related issues is more pronounced than ever, due to the drumbeat of ominous news about climate change, water and marine issues, endangered species, urban ecology, habitat restoration, overharvested fish stocks, etc. It is important that ecological and evolutionary research continue to actively contribute to public understanding and discourse on these issues, via strategic outreach activities coordinated within and possibly among units. Often, it appears to the panel that such outreach activities are ad hoc and haphazard at present.

Using research as a basis for policy decisions

The impact of ecological and evolutionary research is based on conducting top-level scientific research, drawing conclusions based on this understanding, and translating this science into appropriate policy. This requires links between science and policy organisations, and, in most cases, ecological and evolutionary research organisations in Finland are effectively having impact on industry, local and national policies, and in some cases on international policy. There is clear evidence for examples of good to excellent interactions with NGOs, government agencies and industry.

The national research institutes are most closely linked to policy support, as this is one of their primary mandates. Metla, for example, has contributed to the establishment of the Forest Biodiversity Programme for southern Finland and has provided scientific data for nationwide activities and preparation of legislation on biodiversity and conservation planning and legislation, forest health legislation, climate change and environmental monitoring. Work at SYKE and other units has become incorporated into policy including EU directives, government assessments and international threatened species classification lists.

Research at universities with policy impact has included participation in the formulation of the Finnish climate change strategy and the IPCC report on impacts and adaptation; forest policy input via participation in national and local boards formulating and monitoring implementation of national forest programmes; and national biodiversity assessments, in particular the list of threatened species compiled by the Finnish Ministry of Environment. Key strategies towards achieving strong social impact are 1) active participation in national and international groups that build links between science and policy, and 2) close collaboration with forest owners and managers in joint projects.

A variety of other more specific examples of successful social impact of research is available, and here the panel cites just a few. Studies of forest pests have made an important contribution to society by exposing flaws in legislation to protect forests. Nocturnal moth communities have been shown to vary widely in phenology, which suggests that responses to climate change are poorly predicted by current general models. Genetic studies have contributed to the preservation of the critically endangered ringed seal, and studies of variation in fish "personalities" has been shown to correlate with the probability of being harvested, suggesting a driver of selection on these populations. Legislation protecting northern rivers and preventing transmission of fish from their home waters has been implemented as a result of research on salmon parasites. Research has also addressed how changes in grazing pressure in alpine areas will affect the geochemical cycles and ultimately the rate of global warming.

Another form of research impact lies in fostering changes in practical management. The evaluation revealed a rich variety of examples, and here we will just cite a few. Metla, for instance, has developed treatments for conifer stumps against *Heterobasidion* spp., and these treatments are now applied in more than 100,000 ha in Fennoscandia. Most of the novel alien forest pathogens have been first observed by Metla, and new virus-based means to control tree diseases are being developed. Research in other units provides services to local commercial farms and to industry. Other research has evaluated the use of peatland restoration to function as carbon dioxide sinks analogous to the carbon credit trade, in addition to work on invasive species, sustainable forestry and fisheries management and emerging diseases. Forest sciences research at the University of Eastern Finland has involved direct collaboration with forest industry (UPM-Kymmene, Tornator, Metsäliitto and Metsähallitus) on Lidar-based forest inventory.

Some of the research involves end-users at the early research development stage, which can be an effective means of facilitating adoption and use of results.

Recommendation

- Each unit should develop a strategy for outreach on and input of their research results into policy and practice. Effectiveness in this arena varies among units and researchers at present, and in nearly all cases outreach and policy involvement could be made more effective with a more strategic approach.
- The Academy of Finland should work with institutions to facilitate outreach, for instance, by channelling particularly interesting research findings to journalists and sponsoring publications aimed at popular audiences, and even by employing staff professional journalists who can facilitate this aim.
- If societal outreach and policy impacts are important desiderata, then the Academy should include formal requirements in grant proposals that investigators and research units provide statements describing how they will achieve these goals.

APPENDIX 1. Panel members' short CVs

Ragan Callaway is a professor at the University of Montana conducting research in the general field of community ecology. He has been there since 1993. He is interested in how organisms interact, including direct interactions, such as competition for resources, allelopathy and facilitation, and indirect interactions mediated by herbivores, soil microbes and other competitors. A focus is on facilitative interactions among plants, mostly alpine habitats, with the culmination of this work published in a 2007 book titled *Positive Interactions and Interdependence in Plant Communities*. Much of his effort is spent exploring how exotic invaders dominate habitats despite limited opportunities for local adaption, and suppress native species that have had ample opportunities to adapt locally. Specific interests in invasions include the role of soil biota, novel biochemical interactions with native competitors, microbes, the effects generalist herbivores and using invaders to test general ideas about ecological theory. He has been a Fulbright Fellow, won the Grodzinsky Award in 2005, was The University of Montana Distinguished Scholar in 2006 and won the Slobodkin Award in 2007. He was awarded a William Evans Fellowship at Otago University in New Zealand in 2009, and was made an AAAS Fellow in 2010. Professor Callaway has served or now serves on the editorial boards of *Ecology*, the *Journal of Ecology*, and *Trends in Ecology and Evolution*.

Robert D. Holt (chair) received his doctorate at Harvard University in 1979, and was a faculty member at the University of Kansas from then until 2001, when he moved to the University of Florida to take the positions of Eminent Scholar in Biology and Arthur R. Marshall, Jr, Chair in Ecology. He is largely but not exclusively theoretical in his research, which has dealt with a variety of topics in population and community ecology and evolutionary ecology, including multispecies interactions such as apparent competition and intraguild predation; spatial dynamics such as source-sink processes and metacommunity ecology; habitat fragmentation (e.g. a large-scale landscape experiment on fragmentation in eastern Kansas, set up in 1983 and still running); and niche conservatism and evolution, including the eco-evolutionary dynamics of species ranges. He has published 262 journal articles, essays and book chapters and co-edited two books (*Metacommunities*, 2005, University of Chicago Press, and *The Ecology and Evolution of Trait-mediated Interactions*, in press, Cambridge) and has others in the work. He is an ISI Highly Cited Researcher and has been a visiting professor at the University of Paris in France, Ben-Gurion University in Israel and Imperial College in the UK, where he was an Honorary Research Fellow at the Centre for Population Biology. He has served on a number of editorial boards (*Evolution, Ecology Letters* and *The American Naturalist*), and been on many advisory boards, for example, the Visitors Committee of the Smithsonian Tropical Research Institute. In 2003, he received the International Institute of Ecology Prize for Excellence in Ecology. He was President of the American Society of Naturalists, and in 2011 received its Sewall Wright Award. He loves art, music, literature and natural history, in particular birding, and at last count has seen just over 4,700 bird species, which is not quite half of all of them.

Mari Källersjö received her PhD in Systematic Botany in 1990 at the University of Stockholm. In 1992, following a postdoctoral stint at the Smithsonian Institution, she became Director of the Molecular Systematics Laboratory at the Swedish Museum of Natural History. From 2006 to 2008, she held the position as Director of Science at the same museum. Since 2009, she has been Director of the Gothenburg Botanical Garden and Professor at the Department of Plant and Environmental Sciences at the University of Gothenburg. Her research concerns molecular systematics covering a broad range of organisms such as seed plants, lichens, fresh-water mussels and annelids. She also has an interest in phylogenetic methods and tests, as well as in large-scale analyses. She has served on editorial boards of, for instance, *Systematic Biology* and *Cladistics*, and reviewed manuscripts for journals such as *International Journal of Plant Sciences, Molecular Phylogenetics and Evolution, Journal of Molecular Biology, and American Journal of Botany*. Since 2010, she has been a member of the review panel for Infrastructure for Research on Earth System Sciences at the Swedish Research Council. She is also a member of the Advisory Board of the Swedish Taxonomy Initiative 2009–2012 and a member of the Swedish Royal Society of Sciences and Letters since 2010. Previous assignments include: member of the review panel in Biodiversity and Evolution at the Swedish Research Council 2003–2005 and 2008–2009; reviewer of NSF and National Geographics proposals; and member of Scientific Panel of EU-funded Access project SYNTHESYS 2004–2005. As Director of Science at the Swedish Museum of Natural History, she had an overall responsibility for GBIF-Sweden, and she represented the museum at the Swedish node for the Global Taxonomy Initiative, as well as in a number of international collaborations in research, biodiversity informatics and collections.

David A. MacLean is Professor at the Faculty of Forestry and Environmental Management, University of New Brunswick in Canada. He served as Dean of the same Faculty in 1999–2009. Prior to joining the University of New Brunswick in 1999, he researched effects of natural disturbance (insect outbreaks and fire) on forest ecology and management with the Canadian Forest Service. Through the 1990s, he coordinated two Canada-wide research networks to (1) develop GIS-based decision support systems (DSS) for four of Canada's major insect pests, and (2) determine silvicultural approaches to integrated insect management. He led development of the Spruce Budworm DSS, which has been implemented, in partnership with and with funding from provincial governments and industry, for forests in five Canadian provinces and one US state. His current research projects deal with analysis of TRIAD (zoning) forest management, the role of natural disturbance (fire, insects, wind), causes of natural decline of forest stands, and use of forest management and pest management to sequester carbon by forests. He currently supervises twelve graduate students and postdoctorals. He has published more than 150 papers and 75 technology transfer publications and given numerous presentations. He led a successful eight-university TRANSFOR (*Transatlantic Education for Global Sustainable Forest Sector Development*) international academic mobility project under the Canada-EU Programme for Cooperation in Higher Education. He was presented the Canadian Forestry Scientific Achievement Award in 2008.

Anne Magurran is Professor of Ecology and Evolution at the University of St Andrews in Scotland and a fellow of the Royal Society of Edinburgh. She received her PhD – a study of biological diversity in Irish woodlands – from the University of Ulster in 1981. Thereafter she was a postdoctoral researcher (incl. holding a Royal Society University Research Fellowship) at the Universities of Bangor and Oxford before moving to St Andrews in 1994. She is an evolutionary ecologist investigating the evolution, measurement and conservation of biological diversity and has a particular interest in how ecological communities change through times. Her research uses both experimental and modelling approaches to examine the structure and function of freshwater fish and other ecological assemblages, and involves collaborations with researchers in a number of countries including Brazil, Mexico, the US, Trinidad and Tobago, South Africa, India and Malaysia, as well as within Europe. She has written three monographs, co-edited a book with R.M. May and another with B.J. McGill, and published more than 150 peer-reviewed articles. She has been an editor of *Proceedings of the Royal Society* (*Biological Sciences*) and is currently on the Board of Reviewing Editors for Science.

Allen J. Moore is Professor of Evolutionary Genetics in the Centre for Ecology and Conservation, University of Exeter (UK) as well as Professor and Head of the Department of Genetics at the University of Georgia (USA). He received his PhD in Behaviour Genetics from the University of Colorado in 1988. He spent one year as a postdoctoral researcher at Northwestern Medical School in the laboratory of Jim Cheverud, and then held an NSF Postdoctoral Fellowship in Environmental Biology at Washington University School of Medicine (St Louis, USA) for one year. In 1990, he joined the faculty in the Department of Entomology at the University of Kentucky. He moved to the University of Manchester (UK) in 1999, and then the University of Exeter in 2005. In September 2011, he took up his current position as Chair of Genetics at the University of Georgia, alongside his chair in evolutionary genetics at Exeter. His research focuses on the genetics and evolution of sex differences, particularly in morphology and behaviour. He examines parental care, maternal effects, and epigenetics using both statistical and molecular techniques. He is currently Editor-in-Chief of the new Wiley Open Access journal, *Ecology and Evolution*. In 2007–2011, he was Editor-in-Chief of the *Journal of Evolutionary Biology*. He served as Secretary to the Society for the Study of Evolution (2003–2006) and on the executive committee (as Editor-in-Chief of the society journal) of the European Society for Evolutionary Biology (2007–2011). He currently serves as Chair of the evolution panel for NERC (UK) and previously served as programme director in population biology (1998) at NSF (USA).

Brian Moss was Holbrook Gaskell Professor of Botany at the University of Liverpool from 1989 until 2008, when he retired to work just as hard on half the income. He has held posts in Malawi, the US and the UK and has taught or carried out research or both on six continents over nearly fifty years. He is an experimentalist whose most recent research has involved freshwater management, eutrophication, lake restoration and climate change, with a minority interest in the linkages between tropical forests and their stream systems arising out of teaching courses from the Tropical Biology Association in Africa

and Borneo. In addition to a conventional long list of papers in learned journals, he has published a well-known text book, *Ecology of Freshwaters* (fourth edition, March 2010), a Harper Collins New Naturalist book, *The Broads: the People's Wetland*, and a manual for shallow-lake restoration. His experience in research assessment has embraced the Peer Review College of the Natural Environment Research Council in the UK, the Scientific Advisory Board of the Dutch Institute of Ecology, the chairing of the research assessments of biological sciences for the University of Helsinki, and of the field of water science for the Academy of Finland, and numerous assessments for professorships in several countries. He also sits on the editorial boards of several journals, does much paper reviewing and was editor of the *Journal of Ecology* from 1980 to 1987. He is much concerned with wider global environmental problems and with how the arts might be used to get over messages about the environment to the wider public. He also plays the contrabass inexpertly and is Chairman of the Southport Orchestra. He has been President of the British Phycological Society, Vice President of the British Ecological Society and is currently President of the International Association for Limnology. He was awarded the Association's Naumann-Thienemann Medal in 2007 for his research and leadership in creating new understanding of shallow-lake function, and the 2009 International Institute of Ecology Prize for Excellence in Ecology, the outcome of which will be a book entitled *Liberation Ecology*, to be published in early 2012. In 2010, he was awarded the annual medal of the UK Institute for Ecology and Environmental Management. Despite, or perhaps because of, all this he would want to be remembered as a non-establishment, liberal and liberated iconoclast.

Bernt-Erik Sæther has since 1996 been Professor in Population Ecology and leader of the Centre for Conservation Biology at the Norwegian University of Science and Technology in Trondheim. He received a PhD from the University of Trondheim in 1986. Sæther has a background in applied science and has been employed by the Norwegian Institute for Nature Research (1984–1996), where he currently also keeps a part-time position. He has published more than 190 papers in internationally journals and is co-author of a book on stochastic population models. A majority of these papers are cross-disciplinary at the interface of biology and mathematical sciences, focusing on dynamical processes of biological systems. Key questions in his research have been how stochastic fluctuations in the environment affect important characteristics of populations, such as their expected lifetime and the degree of spatial synchrony in the population dynamics. These models have been applied to analyse the dynamics of many natural populations of birds and mammals. Finally, Sæther has been involved in establishing and running long-term demographic studies of several species, including isolated house sparrows on islands where his group tries to keep track of every single individual and its fate.

Nina Wedell is Professor of Evolutionary Biology at the Centre for Ecology and Conservation at the University of Exeter and a Royal Society Wolfson Award Holder. She received her PhD in Evolutionary Ecology at the University of Stockholm in 1993. She spent three years as a postdoctoral fellow at the University of Liverpool, and then held a Research Fellowship at the University of Stockholm until 1999, gaining a DSc in 1997. In 2000, she received a Royal Society University Research Fellowship, which she took up at

the University of Leeds, and later moved to the University of Exeter in 2004. Her research is focused on the evolutionary ecology of sex and its consequences for intra-genomic and sexual conflict, in particular the role of selfish genetic elements in sexual selection. She works predominantly on insects and applies both behavioural and molecular biology approaches. She is currently on the editorial board for *Behavioral Ecology*, and *Behavioral Ecology and Sociobiology*, and was an associate editor of Evolution (2006–2009). She is a Councillor for the European Society of Evolutionary Biology, a Trustee of The Royal Entomological Society, Treasurer of the Society for the Study of Animal Behaviour, and was the Non-North American President for the Society of the Study of Evolution (2009), in addition to being a panel member of various Royal Society and European committees and granting panels.

Kathy Willis holds the Tasso Leventis Chair of Biodiversity at the Department of Zoology, University of Oxford, is Director of the Biodiversity Institute, Oxford Martin School and Head of the Oxford Long-term Ecology Laboratory (http://oxlel.zoo.ox.ac.uk/). She has been involved with research and teaching in biodiversity, conservation and management for the past 20 years at the Universities of Oxford and Cambridge. She has worked on a number of projects examining biodiversity baselines and the ecological and evolutionary processes responsible for ecosystem thresholds and resilience using both palaeoecological and contemporary ecological data. Recent work has also focused on the development of web-based decision support tools to provide a measure of ecological and biodiversity value of landscapes outside of protected areas that can be used by businesses to minimise ecological impacts and determine ecological risks. In addition to her position at Oxford, Professor Willis is an Adjunct Professor in the Department of Biology, University of Bergen. She is a trustee of WWF-UK and a member of the WWF-UK programme committee. She is also on the panel of advisers for Commonwealth Scholarship Commission, a trustee of the Percy Sladen Memorial Fund, an International Member on the Swedish Research Council's FORMAS evaluation panel, and a College Member of Natural Environmental Research Council. She has recently been elected Director-at-Large of the International Biogeography Society. She was awarded the Lyell Fund in 2008 by the Geological Society of London, elected Fellow of the Royal Geological Society in 2009 and made a Foreign Member of the Norwegian Academy of Sciences and Letters in 2010.

APPENDIX 2. Terms of reference for the evaluation panel

1 Background and purpose

The Research Council for Biosciences and Environment decided on 6 June 2008 that Finnish Ecology and evolution biology will be evaluated with respect to the international level. The evaluation combines an external assessment by an international evaluation panel with an internal self-assessment exercise.

This document sets out the standard Terms of Reference applicable to the panel. The content of this document is relevant to the panel members as well as to the units being assessed. The document should be read in conjunction with the Guidance for Units, which will be used by the units being assessed when preparing their evaluation documents. The term 'unit' here refers to the department or institute involved in the evaluation.

2 Definition of the field to be evaluated

This evaluation covers all scientific ecology and evolution biology research in Finland. It covers ia. evolution ecology and evolution biology, behavioural ecology, aquatic ecology, forest ecology, population ecology and population genetics, systematics, community ecology, ecosystems ecology and environmental ecology. Physiology and genetics are included insofar as their problems are related to the topics above. Applied research is included in the evaluation insofar as it involves clear basic research aims. The evaluation does not cover any research that is purely applied. The research that was evaluated in the plant science evaluation is not included in this evaluation.

3 Organisation

The Research Council for Biosciences and Environment of the Academy of Finland approved the general agenda for the evaluation of the research field in January 2011. The Research Council also appointed a Steering Group to lead and support the execution of the evaluation in March 2011.

The members of the Steering Group are:

Paavo Pelkonen, Professor, Academy of Finland, Research Council for Biosciences and Environment, Chair

Jaana Bamford, Professor, Academy of Finland, Research Council for Biosciences and Environment

Laura Höijer, Research Director, Ministry of the Environment

Jaakko Kangasjärvi, Professor, Academy of Finland, Research Council for Biosciences and Environment

Matti Nummelin, Senior Environmental Adviser, Ministry for Foreign Affairs

Riina Vuorento, Senior Adviser, Ministry of Education, Science and Culture

Rauno Väisänen, Director, Metsähallitus

4 International evaluation panel

An international group of independent high-level experts will carry out the evaluation. All departments, independent research institutes and research stations will be evaluated by the evaluation panel.

The Academy of Finland has invited ten renowned scientists as evaluators:

Professor *Ray Callaway*, University of Montana

Professor *Robert D Holt*, University of Florida

Professor *Mari Källersjö*, University of Gothenburg

Professor *David A MacLean*, University of New Brunswick

Professor *Anne Magurran*, St.Andrews University

Professor *Allen Moore*, University of Exeter

Professor *Brian Moss*, University of Liverpool

Professor *Björn-Erik Saether*, Norwegian University of Science and Technology

Professor *Nina Wedell*, University of Exeter

Professor *Kathy Willis*, University of Oxford

5 Objectives of the evaluation

The purpose of this exercise is to evaluate Finnish ecology and evolution biology research and research education. The evaluation covers the period 2006–2010, on which the recommendations to be provided for the future will be based.

The main objectives of the evaluation:

- To form a general picture of the focus, *scientific quality and strategies* of Finnish ecology and evolution biology research and research education
- To assess the *organisation, strengths and weaknesses* of the research field and research units
- To make *suggestions and recommendations* concerning the needs for development, focus and emphasis of the units and the whole research field.

The basic unit to be assessed by the panel is a department of a university or an independent research institute or relevant part of it.

6 Evaluation criteria and recommendations

The evaluation panel is asked to give

- a written statement on the quality of the research, strategies, achieved results, scientific contribution and doctoral training
- a written statement on the quality and efficiency of the research environment and organisation
- a written statement on the research system as a whole, focus, synergies and cooperation
- written feedback on the interaction between research and society, and its impact.

The main emphasis is on the scientific evaluation. The panel should ensure that the evaluation takes into account all relevant material available.

The panel is also asked to give recommendations for the future of the field (Section 6.5).

6.1 Scientific quality of the research

The panel's main task is to evaluate the quality of Finnish ecology and evolution biology research internationally. The quality statement is based on evaluation *documents* submitted by the units. Panel members will have the opportunity to complete this information during *presentations* and *interviews* in Finland.

The quality statement must reflect the work of all the research staff listed in a unit.

Important issues to be considered:

- How do the *quality* and productivity of Finnish ecology and evolution biology and research education compare with international standards?

- Does ecology and evolution biology in Finland today focus on innovative, challenging and successful research lines, themes and problems (strategy)?
- Which fields of research are strong and which are weak?
- What are the differences between strong and weak fields?
- Strengths and weaknesses, needs for improvement?

6.2 Research environment and organisation in its immediate vicinity

The evaluation deals with the prevailing research practices, research environments and collaborative networks. Does the research environment and organisation promote the quality of research and research education?

Important issues to be considered:

- How innovative and successful are the research *strategies* of the units?
- Balance between research and other duties?
- Relationship between senior and junior researchers?
- Role of national and international *networks* (universities, research centres, enterprises)?
- What is the role of *interdisciplinarity* in the units, and within the whole field? Do the units have relevant research infrastructures?
- Strengths and weaknesses, needs for improvement?

6.3 Research system

On the basis of the assessment of the units, the panel may also evaluate how appropriate the prevailing research system is.

- Does the research system focus on innovative and successful research lines?
- Does the panel see any synergy benefits in the Finnish ecology and evolution biology system?
- What kind of action and cooperation could promote them? (e.g. common strategies, cooperation, new division of labour, researcher mobility, better use of infrastructure, critical mass)
- Strengths, weaknesses, needs for improvement?

6.4 Interaction between research and society

The evaluation panel is asked to give feedback on the interaction between research and society and the impacts of research on society (e.g. environmental, technological, economic). The feedback is to be based on the evaluation documents as well as interviews and discussions. The panel should especially consider other activities such as expert tasks, popularised works, patenting, technology transfer and cooperation with other sectors of society.

The panel should pay special attention to the societal contribution of each unit, and to the relevance of its research on a national and international level. Questions to be asked:

- How actively and efficiently does the unit communicate its points and findings to various stakeholders and to society at large?
- How fruitful is the cooperation between the unit and the communities that ultimately apply the results of the research?
- How can the societal impact of Finnish ecology and evolution biology be improved?

6.5 The panel's recommendations for the future

The panel is asked to provide recommendations for the future development of the research field. Recommendations should focus both on the units and the research field as a whole.

Key issues to be addressed:

- What kinds of means does the panel recommend in order to improve and strengthen research performance at various levels?
- What opportunities do the units and the research field as a whole have and what challenges do they face?
- How can the units and the research field meet these challenges and utilise the opportunities?
- How can the quality and societal impacts of research be improved?
- Better use for infrastructures, needs for new infrastructures?
- What kind of research funding programme could best promote the quality of ecology and evolution biology in Finland?

7 Tasks, responsibilities and working arrangements of the panel

Panel members will set responsibilities within the group together with the Expert Secretary. The Evaluation Office will provide all evaluation documents and background information dealing with the Finnish research system. The evaluation material consists of evaluation documents, the units' presentations, interviews and discussions.

For full description of the evaluation documents, please see the submission form and related instructions, which will be used by the units assessed in preparing their evaluation documents together with these Terms of Reference.

7.1 Desk research

Desk research will be carried out before the panel's visit to Finland. The material includes

- facts on research staff and funding
- list of publications
- lists of key publications of senior staff
- collection of key publications
- list of doctoral theses
- lists of visits and collaborations
- self-assessment exercise of the unit.

The Steering Group suggests that panel members perform a preliminary assessment of each research unit prior to any discussions with research staff. The evaluation panel may supplement their views during the visit to Finland.

7.2 Presentations and discussions

Each research unit is given an opportunity to give a presentation dealing with the focal points of the unit's research.

A sample of researchers will be interviewed during the site visit, e.g. heads of units (research), senior staff, professors, postdoctoral researchers, and visiting foreign scholars. The evaluation panel will also discuss research education with graduate students.

The specific timetable and instructions will be provided by the Evaluation Office.

7.3 Confidentiality

Panel members undertake not to make use of and not to divulge to third parties any non-public facts, information, knowledge, documents or other matters communicated to them or brought to their attention in the performance of the evaluation. The evaluation and the ratings are only for official use and they are confidential until the final summary evaluation report is published.

7.4 Evaluation report and publicity

The evaluation report including the main recommendations is based on the evaluation criteria defined by the Steering Group of the evaluation. The report will be written and edited by the panel members with the assistance of the Expert

Secretary. The evaluation report is confidential and only for official use until publication.

Prior to final editing and publishing, the units of assessment are given an opportunity to review the report to correct any factual errors. The evaluation report will be published in the Academy of Finland Publications Series in both printed and electronic form (www.aka.fi/publications).

7.5 Impartiality

Evaluation is subject to the impartiality rules common to the field of evaluation. A panel member will be disqualified if his/her impartiality is endangered or if he/she feels that he/she has a conflict of interest with a research group included in the evaluation.

If you find that you may be unable to evaluate a research group, please notify the Academy and the other panel members of this as soon as possible. Clarification of potential conflicts of interest must preferably be carried out during the first panel meeting.

8 Schedule

March	2011	Appointment of Steering Group
April	2011	The launch seminar
May-June	2011	Preparation of evaluation documents
September	2011	Delivery of evaluation documents
Nov-Dec	2011	Preparation of report
Feb-March	2012	Publishing and relasing the report
	2012	Dissemination of information on results
	2014	Follow-up of implementation of recommendations made

9 Coordination of evaluation

The evaluation team working mainly at the Academy of Finland coordinates the evaluation process. Director Laura Raaska, Senior Adviser Timo Kolu and Project Secretary Heidi Nora-Klemetti form the evaluation team together with the Expert Secretary Kyösti Lempa. The Expert Secretary will assist the panel on site visits and in preparing and editing the evaluation report. The duties of the evaluation team are to compile the evaluation documents, organise the site visits in practice and provide administrative support.

10 Funds

The evaluation is funded by the Academy of Finland. The Academy of Finland will pay an expert fee to the panel members. All travel expenses related to the panel's visits and accommodation in Finland will be covered or reimbursed by the Academy of Finland.

APPENDIX 3. Submission form

ECOLOGY AND EVOLUTION BIOLOGY[1] IN FINLAND 2006–2010

GENERAL INFORMATION

Organisation	
Faculty or equivalent	
Department or equivalent	
Address	
Phone	
Website	http://
Head of department	
Phone	
Email	
Contact person for evaluation	
Phone	
Email	

Percentage of ecology and evolution biology in your department's research (in proportion to staff or funding):

%

Please give the information requested below only in relation to the ecology and evolution biology part of your research.

The submission form shall be submitted by 15 June 2011 in two (2) paper copies and one copy including appendices in electronic format (PDF). Please send all appendix files (Excel) to the following address:

Email: eco@aka.fi

Timo Kolu
Academy of Finland, POB 99
00501 Helsinki

More information:
Senior Adviser Timo Kolu
Email:Timo.Kolu@aka.fi
Tel. 09 774 88 341 or 040 719 6834

Director Laura Raaska
Email: Laura.Raaska@aka.fi
Tel. 09 774 88 336

[1] This evaluation covers all basic research in the field of ecology and evolution biology. See Terms of Reference for the Evaluation Panel.

PART 1. RESOURCES AND RESEARCH OUTPUT WITH REGARD TO ECOLOGY AND EVOLUTION BIOLOGY

1 Staff

1.1 Staff in 2006–2010 (**Appendix 1.1a-b**)

1.2 Research-active staff in 2006–2010 (**Appendix 1.2**)

1.3 What is the present staff situation at the unit? (Is the staff structure balanced, does staff recruitment or funding involve any specific problems? 1 page)

2 Funding

2.1 Unit's core and external research funding in 2006–2010 (**Appendix 2.1**)

2.2 As regards ecology, how functional is the national and international research funding system? Does the current research funding system involve any specific problems from the perspective of ecology and evolution biology (core funding, Academy, other funding agencies; basic research vs. applied research, 1 page)?

3 Unit's research profile and scientific output

3.1 Unit's research profile in the context of the evaluation
(in relation to staff and funding)

Research field	(%) staff	(%) funding
Evolutionary ecology and biology		
Behavioural ecology		
Population biology and genetics		
Community ecology		
Ecosystem ecology		
Environmental ecology		
Forest ecology		
Aquatic ecology		
Other (please specify):		
Total	100%	100%

Comments:

3.2 Description of the unit's research profile (max. 3-5 pages). Describe the unit's research orientation, strategy and main results during the period under evaluation (see Guidance).

3.3 List of publications and other output in 2006–2010 (**Appendix 3.3**)

3.4 Number of scientific publications and other outputs in 2006–2010 (**Appendix 3.4**)

3.5 Lists of senior researchers' key publications (see 1.2) (**Appendix 3.5**)

3.6 List and copies of the unit's key publications in 2006–2010 (**Appendix 3.6**) (Append copies of publications, maximum *number of publications = number of senior researchers* but a minimum of *five* and maximum of *twenty* publications)

3.7 Describe the unit's practices on i) open access to scientific publications, and ii) promoting the reuse of research data. Does the unit have a data policy on open access to and reuse of research data? (max. 1 page)

4 Researcher training and research careers

4.1 Organisation of doctoral training, the role of graduate schools/doctoral programmes and other researcher training and supervision. Describe the aims, practices and arrangements of doctoral training at the unit (max. 2 pages).

4.2 Doctoral thesis supervision in 2006–2010 (**Appendix 4.2**)

4.3 Completed doctoral degrees in 2006–2010, in order of completion, per year (**Appendix 4.3**)

4.4 What are the unit's key principles in promoting postdoctoral research careers (max. 2 pages)?

4.5 Completed postdoc periods in 2006–2010, minimum one year (**Appendix 4.5**)

4.6a Present employment of PhDs who graduated in 2006–2010 (**Appendix 4.6a**)

4.6b Present employment of post-docs[2] (**Appendix 4.6b**)

5 Unit's collaboration contacts

5.1 Visits abroad in 2006–2010, minimum duration: two weeks (**Appendix 5.1**)

5.2 Visits to the unit in 2006–2010, minimum duration: two weeks (**Appendix 5.2**)

5.3 Short but particularly important visits in 2006–2010 (**Appendix 5.3**)

5.4 Most important collaborators in Finland and abroad in 2006–2010 (**Appendix 5.4**)

5.5 Describe the most important outcomes of the visits and collaboration contacts (max. 1 page)

6 Other scientific and societal activities

6.1 Invited presentations at international scientific conferences in 2006–2010 (**Appendix 6.1**)

6.2 Memberships on editorial boards of international scientific journals in 2006–2010 (**Appendix 6.2**)

6.3 Prizes awarded to researchers, honours and scientific positions of trust in 2006–2010 (**Appendix 6.3**)

6.4 Other significant tasks of no primarily academic nature in 2006–2010 (Appendix 6.4)

[2] Post-doc period between 2006 and 2010

PART 2. UNIT'S SELF-ASSESSMENT

7 Unit's self-assessment

7.1 The unit's research strategy for 2012–2016 (priority areas in research, development measures; max. 2 pages).

7.2 Did the organisational changes (new Universities Act, organisational changes) in 2010 had an impact on your research? Describe the changes and their impact (max. 1 page).

7.3 SWOT: Evaluation of the unit's present scientific strengths and weaknesses, and future external opportunities and threats (in relation to the evaluation criteria: quality, research environment, societal impacts; max. 2 pages).

7.4 Infrastructures (incl. research stations; max. 2 pages). Describe a) any infrastructures that the unit possesses that are unique or of major importance, and b) any other infrastructures important for the unit's research. Give a brief analysis of the access policy to existing infrastructures and a foresight of the need for new infrastructures.

7.5a Role of the societal impact of the unit's activities. Give examples of situations where you have successfully promoted the societal impact of your unit's research. What would be the best way to increase the societal impact of ecological research? (max. 2 pages)

7.5b Contact information and impacts of the most important end-users/collaborators in relation to societal needs.

7.6 Assess the academic and societal need for doctoral training within the unit's research fields. Describe the unit's role in doctoral and postdoctoral training (max. 1 page).

APPENDICES 4–10.
Statistic information on evaluated research organisations

Table 4a. Unit's staff 2006–2010 (FTEs)

Organisation	Faculty	Department	2006	2007	2008	2009	2010	Total
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	39,1	43,8	41,7	50,1	44,7	219,4
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	21,2	18,7	17,7	20,5	21,2	99,4
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	116,4	117,9	123,7	128,7	145,6	632,3
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	15,6	14,4	21,0	21,2	24,9	97,0
	Faculty of Agriculture and Forestry	Department of Forest Sciences	47,6	49,3	58,5	54,5	64,4	274,1
	Finnish Museum of Natural History	Botany and Zoology Units	34,3	35,1	28,5	31,7	35,2	164,8
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	15,4	15,2	26,0	30,6	38,0	125,2
University of Oulu	Faculty of Science	Department of Biology	61,6	58,6	59,8	65,2	67,0	312,2
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	82,2	103,7	121,6	132,9	139,0	579,4
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	75,1	81,8	85,2	107,1	101,3	450,5
Finnish Environment Institute (SYKE)			64,6	61,7	53,3	58,5	64,0	302,1
Agrifood Research Finland (MTT)			16,7	16,7	16,1	25,2	26,8	101,6
The Finnish Forest Research Institute (Metla)			175,3	136,1	124,7	129,7	130,8	696,6
Finnish Game and Fisheries Research Institute (FGFRI)			27,2	26,6	24,0	19,1	17,8	114,7
Total			792,2	779,6	801,7	875,0	920,6	4169,2

FTE = full time work = min. 36.25 hours/week

Table 4b. Unit's research active staff 2006–2010 (FTEs)

Organisation	Faculty	Department	2006	2007	2008	2009	2010	Total
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	34,6	38,3	36,2	44,6	38,4	192,0
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	21,2	18,7	17,7	20,5	21,2	99,4
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	103,4	104,9	110,7	115,7	132,6	567,3
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	11,8	10,6	17,2	17,5	21,1	78,2
	Faculty of Agriculture and Forestry	Department of Forest Sciences	47,6	49,3	58,5	54,2	63,2	272,6
	Finnish Museum of Natural History	Botany and Zoology Units	25,0	26,0	22,1	25,5	29,5	128,1
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	14,2	14,0	24,8	29,4	36,8	119,2
University of Oulu	Faculty of Science	Department of Biology	54,5	52,1	53,3	58,7	61,5	280,1
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	65,2	77,7	94,6	101,9	103,0	442,4
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	66,2	71,4	74,2	75,0	76,8	363,6
Finnish Environment Institute (SYKE)			61,1	58,2	49,8	55,0	60,5	284,6
Agrifood Research Finland (MTT)			11,5	11,1	11,2	17,5	19,8	71,0
The Finnish Forest Research Institute (Metla)			118,0	90,1	88,1	81,3	78,7	456,2
Finnish Game and Fisheries Research Institute (FGFRI)			15,4	14,6	11,6	8,8	8,5	58,9
Total			649,6	637,0	669,9	705,6	751,5	3413,6

FTE = full time work = min. 36.25 hours/week

Table 4c. Unit's staff total 2006–2010 (FTEs)

Organisation	Faculty	Department	(FTE)				%			
			Seniors	Other reserach active	Other staff	Total	Seniors	Other reserach active	Other staff	Total
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	31,1	160,9	27,4	219,4	14,2	73,3	12,5	100,0
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	19,2	80,2	0,0	99,4	19,3	80,7	0,0	100,0
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	70,6	496,7	65,0	632,3	11,2	78,6	10,3	100,0
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	37,7	40,5	18,8	97,0	38,9	41,8	19,4	100,0
	Faculty of Agriculture and Forestry	Department of Forest Sciences	51,3	221,4	1,5	274,1	18,7	80,8	0,5	100,0
	Finnish Museum of Natural History	Botany and Zoology Units	42,5	85,6	36,7	164,8	25,8	51,9	22,3	100,0
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	28,6	90,6	6,0	125,2	22,9	72,4	4,8	100,0
University of Oulu	Faculty of Science	Department of Biology	42,4	237,7	32,1	312,2	13,6	76,1	10,3	100,0
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	91,2	351,2	137,0	579,4	15,7	60,6	23,6	100,0
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	90,3	273,3	86,9	450,5	20,0	60,7	19,3	100,0
Finnish Environment Institute (SYKE)			96,3	188,3	17,5	302,1	31,9	62,3	5,8	100,0
Agrifood Research Finland (MTT)			41,9	29,1	30,6	101,6	41,2	28,6	30,1	100,0
The Finnish Forest Research Institute (Metla)			313,8	142,4	240,2	696,4	45,1	20,4	34,5	100,0
Finnish Game and Fisheries Research Institute (FGFRI)			21,6	37,3	55,8	114,7	18,8	32,5	48,6	100,0
Total			978,4	2435,1	755,5	4169,0	23,5	58,4	18,1	100,0

FTE = full time work = min. 36.25 hours/week

Table 5a. Unit's total funding 2006–2010 (thousand euros)

Organisation	Faculty	Department	2006	2007	2008	2009	2010	Total
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	1276,8	1332,8	1867,6	1913,9	2644,9	9036,0
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	1081,0	1253,0	1059,0	1383,0	1533,0	6309,0
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	5312,2	5914,8	6323,7	6931,8	7165,8	31648,4
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	1135,6	1009,8	1164,2	1407,9	1611,0	6328,5
	Faculty of Agriculture and Forestry	Department of Forest Sciences	2170,3	2513,9	2974,5	3378,5	3013,1	14050,4
	Finnish Museum of Natural History	Botany and Zoology Units	2880,0	3068,0	2949,0	2804,0	3050,0	14751,0
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	1556,6	1476,8	1553,9	1961,2	1980,9	8529,3
University of Oulu	Faculty of Science	Department of Biology	2885,5	3185,9	2988,6	2701,3	4185,7	15947,0
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	5834,0	6705,0	7194,0	8330,0	8449,0	36512,0
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	4936,4	5560,0	5972,5	6455,3	5420,1	28344,4
Finnish Environment Institute (SYKE)			4891,6	4675,9	5204,6	5195,9	5206,4	25174,4
Agrifood Research Finland (MTT)			780,7	736,0	887,8	1374,9	1268,3	5047,9
The Finnish Forest Research Institute (Metla)			16032,0	12049,0	7578,0	6064,0	6008,0	47731,0
Finnish Game and Fisheries Research Institute (FGFRI)			1802,0	2128,0	2087,0	1729,0	1543,0	9289,0
Total			52574,8	51608,9	49804,4	51630,8	53079,3	258698,3

Table 5b. Unit's core funding 2006–2010 (thousand euros)

Organisation	Faculty	Department	2006	2007	2008	2009	2010	Total
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	456,7	741,4	715,0	975,2	1053,6	3941,9
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	618,0	816,0	614,0	637,0	605,0	3290,0
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	2092,0	2477,0	2415,0	2588,0	2455,0	12027,0
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	253,6	257,3	276,2	294,4	347,5	1429,0
	Faculty of Agriculture and Forestry	Department of Forest Sciences	554,3	572,6	693,3	637,5	685,9	3143,6
	Finnish Museum of Natural History	Botany and Zoology Units	1795,0	1881,0	1753,0	1919,0	2111,0	9459,0
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	476,6	522,3	493,7	515,0	562,6	2570,2
University of Oulu	Faculty of Science	Department of Biology	1427,8	1761,1	1763,7	1723,2	1489,8	8165,6
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	3100,0	3324,0	3608,0	3596,0	3925,0	17553,0
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	1628,4	1726,7	1792,7	1804,1	1898,7	8850,6
Finnish Environment Institute (SYKE)			2565,6	2711,3	2697,1	2860,3	2841,9	13676,1
Agrifood Research Finland (MTT)			398,5	410,0	436,9	781,0	725,9	2752,4
The Finnish Forest Research Institute (Metla)			13660,0	9294,0	5908,0	4369,0	4508,0	37739,0
Finnish Game and Fisheries Research Institute (FGFRI)			1097,0	1069,0	1041,0	862,0	744,0	4813,0
Total			30123,4	27563,7	24207,7	23561,8	23953,9	129410,5

Table 5c. Unit's external funding 2006–2010 (thousand euros)

Organisation	Faculty	Department	2006	2007	2008	2009	2010	Total
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	820,1	591,4	1152,6	938,7	1591,3	5094,1
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	463	437	445	746	928	3019,0
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	3220,2	3437,8	3908,7	4343,8	4710,8	19621,4
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	882	753	888	1114	1264	4900
	Faculty of Agriculture and Forestry	Department of Forest Sciences	1616,092	1941,323	2281,179	2740,998	2327,226	10906,8
	Finnish Museum of Natural History	Botany and Zoology Units	1085	1187	1196	885	939	5292,0
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	1080,0	954,5	1060,2	1446,2	1418,3	5959,1
University of Oulu	Faculty of Science	Department of Biology	1457,7	1424,8	1224,9	978,1	2695,9	7781,4
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	2733,0	3381,0	3585,0	4734,0	4524,0	18957,0
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	3308,0	3833,3	4179,9	4651,2	3521,4	19493,8
Finnish Environment Institute (SYKE)			2326,1	1964,6	2507,5	2335,6	2364,6	11498,3
Agrifood Research Finland (MTT)			382,2	326,0	450,9	593,9	542,4	2295,4
The Finnish Forest Research Institute (Metla)			2372,0	2755,0	1670,0	1695,0	1500,0	9992,0
Finnish Game and Fisheries Research Institute (FGFRI)			705,0	1059,0	1046,0	867,0	799,0	4476,0
Total			22450,4	24045,3	25595,8	28069,0	29125,4	129285,9

Table 5d. Unit's Academy of Finland funding 2006–2010 (thousand euros)

Organisation	Faculty	Department	2006	2007	2008	2009	2010	Total
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	219,7	269,9	527,0	368,5	459,0	1844,1
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	149,0	109,0	218,0	293,0	487,0	1256,0
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	2691,0	2550,0	2830,8	2832,1	3354,0	14258,0
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	477,5	304,0	399,0	374,0	409,5	1964,0
	Faculty of Agriculture and Forestry	Department of Forest Sciences	1011,8	1162,7	1192,5	1288,3	1435,9	6091,2
	Finnish Museum of Natural History	Botany and Zoology Units	305,0	306,0	328,0	351,0	553,0	1843,0
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	213,0	128,0	143,4	420,3	360,3	1265,0
University of Oulu	Faculty of Science	Department of Biology	854,1	840,8	97,9	103,8	1433,3	3329,9
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	2029,0	2759,0	3059,0	3715,0	3355,0	14917,0
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	2130,8	2400,9	2435,8	2772,9	2116,0	11856,4
Finnish Environment Institute (SYKE)			397,8	366,0	394,2	685,5	864,5	2707,9
Agrifood Research Finland (MTT)			104,4	139,7	172,7	281,4	314,9	1013,2
The Finnish Forest Research Institute (Metla)			385,0	500,0	751,0	660,0	520,0	2816,0
Finnish Game and Fisheries Research Institute (FGFRI)			84,0	76,0	26,0	20,0	20,0	226,0
Total			11052,1	11912,0	12575,4	14165,7	15682,4	65387,6

Table 6. Refereed publications 2006–2010

Organisation	Faculty	Department	Refereed journals			Edited volumes and conference proceeding			
			Articles in refereed international journals	Articles in refereed Finnish scientic journals	TOTAL articles	International edited volumes and conference proceeding	Finnish edited volumes and conference proceeding	TOTAL edited	TOTAL
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	221	3	224	19	20	39	263
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	278	0	278	15	0	15	262
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	556	17	573	37	7	44	617
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	243	0	243	5	0	5	248
	Faculty of Agriculture and Forestry	Department of Forest Sciences	246	39	285	95	12	107	392
	Finnish Museum of Natural History	Botany and Zoology Units	377	64	441	79	72	151	592
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	119	4	123	10	0	10	133
University of Oulu	Faculty of Science	Department of Biology	330	6	336	15	1	16	352
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	489	4	493	12	4	16	509
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	759	13	772	45	36	81	853
Finnish Environment Institute (SYKE)			444	37	481	106	17	123	604
Agrifood Research Finland (MTT)			134	2	136	114	42	156	292
The Finnish Forest Research Institute (Metla)			299	36	335	53	44	97	432
Finnish Game and Fisheries Research Institute (FGFRI)			115	41	156	11	5	16	172
Total			4610	266	4876	616	260	876	575

Table 7. Doctoral degrees and post doc periods 2006–2010

					Mean and median age for doctoral degrees			
Organisation	Faculty	Department	Doctor degrees	Post doc periods	Mean	Median	Share of women (%)	Doctoral degrees/ senior ftes
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	19	5	37,0	36,0	57,9	0,6
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	27	10	34,3	33,0	25,9	1,4
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	65	41	32,0	31,0	46,2	0,9
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	49	0	38,0	36,0	65,3	1,3
	Faculty of Agriculture and Forestry	Department of Forest Sciences	31	8	38,0	37,0	61,3	0,6
	Finnish Museum of Natural History	Botany and Zoology Units		5				
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	16	10	34,6	33,5	68,8	0,6
University of Oulu	Faculty of Science	Department of Biology	43	9	34,8	34,0	62,8	1,0
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	40	38	32,7	31,0	47,5	0,4
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	47	30	33,6	33,0	63,8	0,5
Finnish Environment Institute (SYKE)			34	6	33,6	33,0	55,9	0,4
Agrifood Research Finland (MTT)			5	2	34,2	32,0	80,0	0,1
The Finnish Forest Research Institute (Metla)			15	17	34,6	32,0	47,4	0,0
Finnish Game and Fisheries Research Institute (FGFRI)			14	1	35,0	35,0	28,6	0,6
Total			405	182,0	34,8	33,6	54,7	0,7

Table 8. Visits abroad and to the unit 2006–2010

Organisation	Faculty	Department	Visits					
			abroad			to the unit		
			visits	months	mean	visits	months	mean
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	17,0	9,5	0,6	13,0	31,5	2,4
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	5,0	31,2	6,2	11,0	24,5	2,2
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	38,0	n.a		22,0	81,8	3,7
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	12,0	30,0	2,5	1,0	0,8	0,8
	Faculty of Agriculture and Forestry	Department of Forest Sciences	70,0	398,8	5,7	56,0	104,5	1,9
	Finnish Museum of Natural History	Botany and Zoology Units	66,0	74,1	1,1	70,0	92,8	1,3
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	27,0	42,7	1,6	19,0	28,3	1,5
University of Oulu	Faculty of Science	Department of Biology	17,0	24,3	1,4	20,0	114,0	5,7
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	96,0	147,8	1,5	25,0	60,5	2,4
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	82,0	163,3	2,0	111,0	252,2	2,3
Finnish Environment Institute (SYKE)			29,0	42,8	1,5	30,0	44,7	1,5
Agrifood Research Finland (MTT)			17,0	80,5	4,7	10,0	14,0	1,4
The Finnish Forest Research Institute (Metla)			9,0	36,0	4,0	14,0	67,0	4,8
Finnish Game and Fisheries Research Institute (FGFRI)			2,0	24,8	12,4	0,0	0,0	0,0
Total			487,0	1105,7	3,5	402,0	916,4	2,3

mean=months/visits

Table 9. Foreign researchers and doctoral students 2006–2010

Organisation	Faculty	Department	Researchers (1-3)	Doctoral students (4)	Visiting res. (5)	Sum
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	1	5	1	7
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences	3	9	0	12
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	42	n.a.	0	42
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	2	1	0	3
	Faculty of Agriculture and Forestry	Department of Forest Sciences	8	22	1	31
	Finnish Museum of Natural History	Botany and Zoology Units	9	3	0	12
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	2	7	0	9
University of Oulu	Faculty of Science	Department of Biology	3	7	0	10
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	4	3	27	34
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	11	8	0	19
Finnish Environment Institute (SYKE)			5	0	0	5
Agrifood Research Finland (MTT)			1	0	1	2
The Finnish Forest Research Institute (Metla)			4	2	5	11
Finnish Game and Fisheries Research Institute (FGFRI)			0	0	0	0
Total			95	67	35	197

Table 10. Units research profile in relation to the staff

Organisation	Faculty	Department	Evolutionary ecology and biology	Behavioral ecology	Population biology and genetics	Community ecology	Ecosystem ecology	Environmental ecology	Forest ecology	Aquatic ecology	Other	Total
University of Eastern Finland	Faculty of Science and Forestry (Joensuu)	Department of Biology	5	5	5	10	5	15	15	40		100
	Faculty of Science and Forestry (Joensuu)	School of Forest Sciences							100			100
University of Helsinki	Faculty of Biological and Environmental Sciences	Department of Biosciences	56	6	21	5	0	1	2	0	10	100
	Faculty of Biological and Environmental Sciences	Department of Environmental Sciences	2			1	19	15		54	9	100
	Faculty of Agriculture and Forestry	Department of Forest Sciences	5		5	5	30	0	55			100
	Finnish Museum of Natural History	Botany and Zoology Units	2	5	15						78	100
Åbo Akademi University	Division for Natural Sciences and Technology	Department of Biosciences (Environmental and marine biology)	9	11		16	4	22		39		101
University of Oulu	Faculty of Science	Department of Biology	10	15	50	15		4		6		100
University of Jyväskylä	Faculty of Mathematics and Science	Department of Biological and Environmental Science	40	10	20	1	3	3	7	14		98
University of Turku	Faculty of Mathematics and Natural Sciences	Department of Biology	5	8	13	13	8	7	5	7	34	100
Finnish Environment Institute (SYKE)			0		4	4	7	18	4	65		100
Agrifood Research Finland (MTT)			10		55	4	24	7				100
The Finnish Forest Research Institute (Metla)					10	5	10	10	65			100
Finnish Game and Fisheries Research Institute (FGFRI)			22	9	47	4	4	5	1	8		100
Total			17	5	17	6	7	7	20	13	8	100

Ecology and evolutionary biology research in Finland has been evaluated by an international expert panel. This evaluation report presents the panel's findings as to the quality of the evaluated research fields. The evaluation covers 14 units and the years 2006–2010. The assessment is based on the interviews with and the background material provided by each unit.

In the evaluation, the panel considered issues such as research quality, research environments, funding and the training of young researchers. The report also includes proposals and recommendations for future development of research in the field both on a general and on unit level.

ACADEMY OF FINLAND

Hakaniemenranta 6 • PO Box 131, 00531 Helsinki
Tel. +358 9 774 881 • Fax +358 9 7748 8299
www.aka.fi/eng • viestinta@aka.fi