NATUR VÅRDS VERKET

International evaluation of Swedish Wildlife Research 2003–2014

funded by the Swedish Environmental Protection Agency through the Wildlife Management Fund

BERNT-ERIK SÆTHER, MARK S. BOYCE, GRETE K. HOVELSRUD, THOMAS LUNDHEDE, JUHA MERILÄ, THOMAS D. NUDDS

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Cover photo: Left: Rovdjurcentret De 5 Stora. Upper right: Roe deer, photo by Anders Jarnemo.
Lower right: Lynx, photo by Henrik Andrén. Photos used by permission.

Preface by SEPA

Since 1967, when the Swedish Environmental Protection Agency (SEPA) was founded, funding of wildlife research has been one of its commissions. Anually, the agency receives financial means by the government from the Wildlife Management Fund to support wildlife research.

SEPA views its remit as a funder of research in a broad perspective where knowledge obtained from research on wildlife must serve not just the knowledge needs of the agency but also needs of regional and local management. We work in a similar way as research councils and fund research of high scientific quality. The research shall also be highly relevant for and applicable to work concerning wildlife and hunting.

Knowledge from research that SEPA funds is intended to reach target groups concerned and to be transferred into practice, for example, the use of new methods and effective tools. Through knowledge dissemination, the understanding of different aspects of wildlife management is increased and improves our overall ability to meet challenges of today and tomorrow for managing wildlife in an ecologically, socially, culturally and economically sustainable way. SEPA should always work in an adaptive manner.

SEPA, as do other funding agencies and research councils, regularly performs evaluations of research. The first time its wildlife research was evaluated by an international panel was in 2001. This evaluation is the second one and covers the period 2003–2014.

The international panel that was appointed by SEPA for this evaluation included the following scientists:

Bernt-Erik Sæther (Chair; Norwegian University of Science and Technology, Trondheim, Norway)
Mark S. Boyce (University of Alberta, Edmonton, Canada)
Grete K. Hovelsrud (Nord University, Bodø, Norway)
Thomas Lundhede (University of Copenhagen, Copenhagen, Denmark)
Juha Merilä (University of Helsinki, Helsinki, Finland)
Thomas D. Nudds (University of Guelph, Guelph, Canada)

The dedicated work done by the Evaluation Panel is of great importance for both research and management at our agency, in particular at this point when a new research strategy for the Wildlife Management Fund for the period 2021–2025 will be developed and completed by SEPA and its Scientific Committee for Wildlife Research in the years to come.

Per Sjögren-Gulve and Anders Lundvall at SEPA's Wildlife analysis unit were responsible at SEPA for leading and coordinating the evaluation project, with assistance from Ingemar Näslund (County Administrative Board of Jämtland) and Annica Forsberg (Forsberg Natur & Kommunikation AB). Two other reports, in Swedish with English summaries, have also been produced (Forsberg et al. 2018, Sandström 2018).

This is the Panel's own report, with the Panel's views and recommendations. They shall not be interpreted as SEPA's.

SEPA thanks the Panel and all others who have taken part in this evaluation.

Stockholm, February 2019

Anna Otmalm,
Head, Environmental Analysis Department

Preface by the Evaluation Panel

To the Swedish Environmental Protection Agency

At the request of the Swedish Environmental Protection Agency (SEPA), we evaluated the wildlife research funded by the Wildlife Management Fund (SEPA) during the period 2003–2014. The evaluation is based on reports from the projects, a report summarizing a bibliometric evaluation of the projects (Sandström 2018), a survey to evaluate the relevance of the funded research for Swedish wildlife management (Forsberg et al. 2018), and presentations at a workshop to the Evaluation Panel from a sample of principal investigators.

Our assessments were from an international perspective, though we respected the traditions and practices of wildlife management in Sweden. The Evaluation Panel acknowledges the contributions by Anders Lundvall and Per Sjögren-Gulve at the SEPA to the sections in the report describing the Swedish wildlife management system and overviews of the bibliometric analyses and the relevance survey. These contributed valuable background to the Evaluation Panel's deliberations.

We present our assessments, conclusions and recommendations in this report, for which we are in collective agreement and take full responsibility.

January 2019,

Bernt-Erik Sæther,
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Thomas D. Nudds.

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1 Summary

The Evaluation Panel concludes that the wildlife research funded by the Wildlife Management Fund (through SEPA) has been highly influential in developing a management system of Swedish wildlife based on scientific knowledge. Some areas of this field of research in Sweden have produced results with implications not only for wildlife biology, but also more broadly for population ecology as a whole. The Evaluation Panel also appreciates that Swedish wildlife researchers are developing novel research approaches that merge scientists from social and economic research disciplines with wildlife biologists into interdisciplinary research projects. The establishment of the research programme "Adaptive Management of Wildlife and Fish" was instrumental in this development. Thus, continued funding by the Wildlife Management Fund will be necessary to maintain and develop an evidence-based wildlife management system in Sweden.

The previous evaluation of Swedish wildlife research (Boyce et al. 2001) proposed several actions to improve its scientific quality and impact on the management of wildlife in Sweden. The Evaluation Panel concludes that most of the recommendations were included in the development of two research strategies by SEPA and its Scientific Committee for Wildlife Research and implemented into project funding. These actions widened the scientific scope of Swedish wildlife research. For example, there is now a larger element of social science and stronger focus on ecosystem processes than during the previous evaluation period. However, few projects include a substantial element of modelling of dynamical processes, thereby reducing the possibility of generalizing results (e.g. regarding the effects of harvesting) across study systems or from species to species.

The Evaluation Panel recommends the following actions be taken to further improve the quality and impact of Swedish wildlife research:

Establish a new integrated research programme

The success of the programme "Adaptive Management of Wildlife and Fish" should strongly encourage SEPA to launch a specific research programme to focus on the use of adaptive management to aid in decision-making for *sustainable management of wildlife in changing ecosystems*. This will necessarily result in a programme that will encourage inter-disciplinarity and a strong commitment to long-term monitoring as part-and-parcel of integrating research with management to evaluate policy. Furthermore, it should be evaluated as a whole and clearly include a component particularly aimed to promote recruitment of researchers at an early stage of their scientific career into wildlife research. An ecosystem perspective on both management and scientific questions makes it necessary that funding structures enhance collaboration across projects.

Establish a monitoring programme of selected wildlife species in Sweden

As concluded from the previous evaluation (Boyce et al. 2001), the Evaluation Panel proposes that there is a need to establish a monitoring programme, or improve the integration of existing ones, to organize and maintain the unique time-series established by research projects funded by SEPA's Scientific Committee for Wildlife Research. Some of these time series represent important assets for Sweden to develop science-based management principles for several species of huge public interest.

Facilitate recruitment of early-career scientists into wildlife research

The Evaluation Panel suggests that a proportion of the projects funded by SEPA's Scientific Committee for Wildlife Research are allocated to younger project leaders (from 3 to 8 years after their graduation date) to facilitate recruitment and retention of internationally leading senior scientists in Swedish wildlife research.

Enhance EU-funding of Swedish wildlife research

The framework programmes of the EU provide important sources of funding of European science. The Evaluation Panel suggests that SEPA facilitate development of projects aimed at securing EU-funding. Furthermore, SEPA should consider supplemental funding of successful proposals, e.g., by providing support for additional PhD students.

Extend the use of modelling in Swedish wildlife research

The Evaluation Panel reiterates the recommendation from the previous evaluation (Boyce et al. 2001) to encourage application of theoretical models and advanced quantitative methods among wildlife researchers and research groups to improve the tools available for predicting the long-term consequences of management decisions on wildlife and ecosystem processes.

2 Sammanfattning

Utvärderingspanelen drar slutsatsen att den viltforskning som finansierats av Naturvårdsverket 2003–2014 via Viltvårdsfonden har haft stor betydelse för utvecklingen av viltförvaltningen i Sverige så att den baseras på vetenskaplig kunskap. Några områden inom detta forskningsfält i Sverige har genererat resultat som inte bara har betydelse för viltbiologi utan också för populationsekologi i sin helhet.

Utvärderingspanelen värdesätter också att svenska viltforskare utvecklat en unik forskningstradition där forskare från samhällsvetenskapliga och ekonomiska forskningsdiscipliner tillsammans med viltbiologer utvecklar och genomför interdisciplinära forskningsprojekt. Inrättandet av forskningsprogrammet ”Adaptiv förvaltning av vilt och fisk” var avgörande för denna utveckling. Således är fortsatt finansiering av viltforskning från Viltvårdsfonden, åtminstone på nuvarande nivå, en förutsättning för att upprätthålla och utveckla ett evidensbaserat förvaltningssystem för vilt i Sverige.

Den förra utvärderingen av viltforskningen i Sverige (Boyce m.fl. 2001) föreslog flera åtgärder för att höja forskningens vetenskapliga kvalitet och inflytande på viltförvaltningen i Sverige. Utvärderingspanelen drar slutsatsen att de flesta av rekommendationerna har inkluderats i utvecklingen av de två viltforskningsstrategierna 2003–2007 och 2009–2014 och även implementerats i finansieringen av forskningsprojekt. Dessa åtgärder har vidgat den vetenskapliga inriktningen inom viltforskningen i Sverige. Till exempel finns det nu ett större inslag av samhällsvetenskaplig forskning och ett starkare fokus på ekosystemprocesser än under föregående utvärderingsperiod. Det finns emellertid fortfarande få projekt som innehåller ett väsentligt inslag av modellering av dynamiska processer, vilket minskar möjligheten att generalisera resultat (t.ex. om effekterna av beskattning) mellan studiesystem eller från art till art.

Utvärderingspanelen rekommenderar följande åtgärder för att ytterligare förbättra kvaliteten och effekten av viltforskningen i Sverige:

Etablera ett nytt integrerat forskningsprogram

Framgången med programmet ”Adaptiv förvaltning av vilt och fisk” är en stark uppmuntran till Naturvårdsverket att ånyo etablera ett specifikt forskningsprogram som bör fokusera på användningen av adaptiv förvaltning i beslutsfattandet till stöd för en hållbar förvaltning av vilt i föränderliga ekosystem. Detta kommer med nödvändighet att resultera i ett program som främjar tvärvetenskap och ett starkt åtagande för långsiktig viltövervakning, vilken är en fundamental del av nödvändig integration av forskning och förvaltning för att kunna utvärdera politiken. Dessutom bör programmet värderas som en helhet och tydligt inkludera en komponent som särskilt syftar till att främja rekrytering av forskare i ett tidigt skede av sin vetenskapliga karriär inom viltforskningen. Ett ekosystemperspektiv inom förvaltningen och i de vetenskapliga frågorna gör det nödvändigt att finansieringsstrukturerna stärker samarbetet mellan projekt.

Upprätta ett övervakningsprogram för utvalda viltarter i Sverige

I likhet med den tidigare utvärderingen (Boyce m.fl. 2001) påtalar utvärderingspanelen att det finns behov av att upprätta ett övervakningsprogram alternativt att förbättra integrationen med befintliga, för att organisera och vidmakthålla de unika tidsserier som har genererats via forskningsprojekt som finansierats via Naturvårdsverkets Vetenskapliga kommitté för viltforskning. Vissa av dessa tidsserier utgör viktiga tillgångar för att utveckla vetenskapligt baserade förvaltningsprinciper för flera viltarter som är av stort allmänt intresse.

Underlätta rekrytering av forskare som är i ett tidigt karriärsteg inom viltforskningen

Utvärderingspanelen föreslår att en del av de projekt som finansieras genom Naturvårdsverkets Vetenskapliga kommitté för viltforskning tilldelas yngre projektledare (från 3 till 8 år efter doktorsexamen) för att underlätta rekrytering och karriär, och för att säkerställa internationellt ledande seniora forskare inom svensk viltforskning.

Förbättra EU-finansiering inom svensk viltforskning

EU:s ramprogram utgör viktiga källor för finansiering av europeisk vetenskap. Utvärderingspanelen föreslår att Naturvårdsverket inför finansiering för att utveckla projekt som syftar till EU-finansiering. Dessutom bör Naturvårdsverket överväga kompletterande finansiering av beviljade EU-ansökningar, t.ex. genom att ge stöd till ytterligare doktorander.

Utvidga användningen av modellering i svensk viltforskning

Utvärderingspanelen upprepar rekommendationen från den tidigare utvärderingen (Boyce m.fl. 2001) att särskilda åtgärder bör genomföras för att inkludera forskare och forskargrupper i viltforskning som tillämpar teoretiska modeller och avancerade kvantitativa metoder för att förbättra de verktyg som finns tillgängliga för att förutsäga långsiktiga konsekvenser av förvaltningsbeslut om vilt och ekosystemprocesser.

3 Background

3.1 Wildlife in Swedish Society

Wildlife is important to society, and wildlife and its management concern many people in Sweden. Wildlife is important for many people's livelihood, and hunting as sustainable resource use is highly accepted among the public in Sweden. Ljung et al. (2014) has shown that game meat in Sweden was consumed at least once every month in 22% of the households, and Ljung et al. (2015) that 87% of non-hunters in northern Sweden expressed favourable attitudes toward hunting. In Sweden, 43 species are hunted regularly (general hunting season) and in addition approximately 20 species can be hunted under license or protective hunting (SFS 2018:632). In Swedish Society, game meat is about 2–3% of the total meat consumption (Jordbruksverket 2017).

The basic principle of wildlife management in Sweden is that all animal species naturally present in the country are to be conserved as viable populations and managed as a sustainable way. For the large carnivores, the Swedish Parliament, for example, passed the *Sustainable Predator Policy* (Government Bill 2012/13:191), the overall, long-term objective of which is that wolf, bear, wolverine, lynx and golden eagle in Sweden shall attain and maintain favourable conservation status under the Habitats Directive (Council Directive 92/43/EEC), without significantly impeding the keeping of livestock/domesticated animals and taking into account other socioeconomic factors.

An objective of Swedish wildlife management is that one should be able to use wildlife in a sustainable way as a resource for food, hunting and other experiences. The concept of sustainability encompasses ecological, social, cultural and economic aspects and wildlife management must integrate these interests. Sustainable wildlife management is therefore often a matter of balancing different interests and contributing to resolving conflicts. Different targeted measures are used in wildlife management to conserve wildlife by balancing between protection and use, for example, through harvesting (hunting) and through measures to conserve and favour wildlife populations (e.g., protection, regulated hunting periods, restoration of wildlife habitats and other wildlife management actions), to reduce damage by wildlife (e.g., hunting or preventive measures) and/or measures to improve the knowledge base for decisions (e.g., inventories and other wildlife monitoring).

In the report *Strategy for Swedish Wildlife Management* (SEPA 2016), five areas of actions are highlighted: 1) Promote the sustainable use of wildlife as a resource, 2) Prevent damage and other problems caused by wildlife, 3) Create clear and predictable wildlife management, 4) Build wildlife management on quality-assured knowledge and 5) Cooperate actively with other countries (http://www.naturvardsverket.se/Om-Naturvardsverket/Publikationer/ISBN/8700/978-91-620-8797-5/).

3.2 Wildlife Management in Sweden

SEPA, the County Administrative Boards and the Swedish Association for Hunting and Wildlife Management have defined responsibilities for wildlife management designated by the Swedish Parliament.

As the national authority, SEPA has the overall responsibility for ensuring that Swedish wildlife management policy from the political level (government, parliament) is implemented and that the objectives for wildlife and hunting are attained at the national level. SEPA has the overall national responsibility for wildlife management, conservation and sustainable use which includes cooperation to address international obligations. The agency produces regulations (legislation), guidelines for County Administrative Boards, and develops national management plans for game species and action plans for threatened species. SEPA administers national advisory councils for large carnivores, ungulates and large birds and funds a Wildlife Damage Centre, genetics labs and regional information centres for carnivores. The agency keeps a register of hunting fees and hunting exams and administers national databases with associated IT-systems used by national and regional authorities as well as those used by the public (such as citizen scientists). One example is a Swedish-Norwegian database of monitoring data of large carnivores. SEPA also funds monitoring of wildlife and pays out wildlife damage compensation.

The regional authority, the County Administrative Boards (Länsstyrelserna) (in total 21), and its Wildlife Management Delegations (Viltförvaltningsdelegationerna, in total 21), has a key role in implementing wildlife management policy at the regional level. The Swedish Association for Hunting and Wildlife Management (Svenska Jägareförbundet) is responsible, on behalf of the Government, for the practical management of hunting and wildlife management, entitled the "Public Commission on Game Management".

In addition, several other authorities have responsibilities regarding different tasks in wildlife management, among them the Swedish Veterinary Institute (Statens Veterinärmedicinska Anstalt), Swedish Forest Agency (Skogsstyrelsen), Swedish Board of Agriculture (Jordbruksverket), Swedish Agency for Marine and Water Management (Havs- och vattenmyndigheten) and the Sami Parliament (Sametinget).

Further information about wildlife management in Sweden can be found on SEPA's website (http://www.naturvardsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Viltforvaltning/).

SEPA's responsibility as a research funding agency is described in section 3.3.

3.3 Wildlife Research in Sweden

3.3.1 Wildlife research at SEPA and the Wildlife Management Fund

Since 1968, SEPA is the single largest funder of wildlife research (relevant to sustainable management) and, by government direction, is assigned the task of funding needs-driven research on wildlife issues with resources from the Wildlife Management Fund. Research projects have been funded as part of specific research strategies (framework programmes) since 1973.

The purpose of research funding, according to SEPA's present research strategy for the Wildlife Management Fund, is to develop scientifically based knowledge in support of long-term sustainable management of wildlife as a natural resource. Research funding should be focused in particular on game or potential game species, as well as species that today or in the near future will necessitate action, for example, to regulate numbers or distribution or to reduce damage. In addition, research should also focus on people's relationship with wildlife and to wildlife management. SEPA should fund research and research-related initiatives in support of wildlife management authorities and organizations at central, regional and local levels. The knowledge needs of SEPA as the responsible wildlife management authority at the national level, the County Administrative Boards as the responsible authorities for wildlife and hunting at the regional level, and the Swedish Association for Hunting and Wildlife Management for the "Public Commission on Game Management" should also be taken into account. Under the Hunting Act (SFS 1987:259, Section 41), the Wildlife Management Fund is to be used to "promote wildlife management or other similar aims which are compatible with the purpose of this law".

SEPA applies annually to the Government (the Ministry of Enterprise and Innovation) for resources from the Wildlife Management Fund for research. The government bill *Conditions for Hunting* (Government Bill 1999/2000:73) clarified the responsibility of SEPA for distributing all research funding from the Wildlife Management Fund.

An annual wildlife management fee, which everyone who hunts must pay, was introduced by the Government in 1938 and contributes to the Wildlife Management Fund. The Government annually allocates money from the fund. The size of the fund, and the resources available to allocate, depend mainly on the number of paying hunters and capital management. A state hunting license is issued as evidence of having paid the fee. In 2018, the annual fee was SEK 300. Approximately 283 000 hunters paid the fee in the hunting year 2017/2018. The number of paying hunters has been decreasing in Sweden for a long time.

Governmental allocation of funds (million SEK / year) from the Wildlife Management Fund to SEPA for wildlife research and its administration between 1990 and 2018 is shown in Figure 1. The large increase from 2000 to 2001 resulted from a decision by government that money previously allocated to the research unit at the Swedish Association for Hunting and Wildlife Management (Svenska Jägareförbundet) instead be allocated to SEPA for funding of wildlife research.

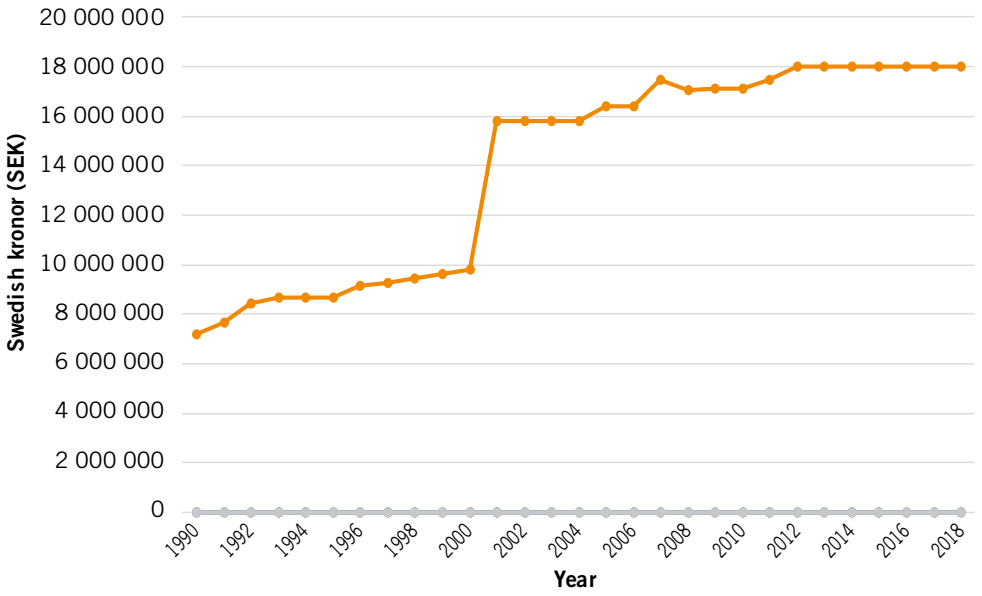

Figure 1. Governmental allocation of funds (in Swedish kronor SEK) from the Wildlife Management Fund to SEPA for funding of wildlife research during 1990–2018.

SEPA's overall distribution of money from the Wildlife Management Fund 2003–2014 is shown in Figure 2. The funding included 1) grants to individual research projects, 2) the programme "Adaptive Management of Wildlife and Fish", 3) money to disseminate knowledge compilations, pilot studies, congresses, etc., 4) an annual operating budget for wildlife research technicians at Grimsö Research Station (the Swedish University of Agricultural Sciences), as well as support for 5) the Nordic Council for Wildlife Research (NKV), 6) the research secretariat at SEPA and 7) research communication by SEPA. During 2003–2014, SEPA received in total 204 MSEK from the government, of which approximately 165 MSEK was allocated to research projects from the Wildlife Management Fund including the research programme Adaptive Management of Wildlife and Fish (20 MSEK). See Figures 3 and 4. In 2018, SEPA received 18 MSEK, an amount that has been the same since 2012.

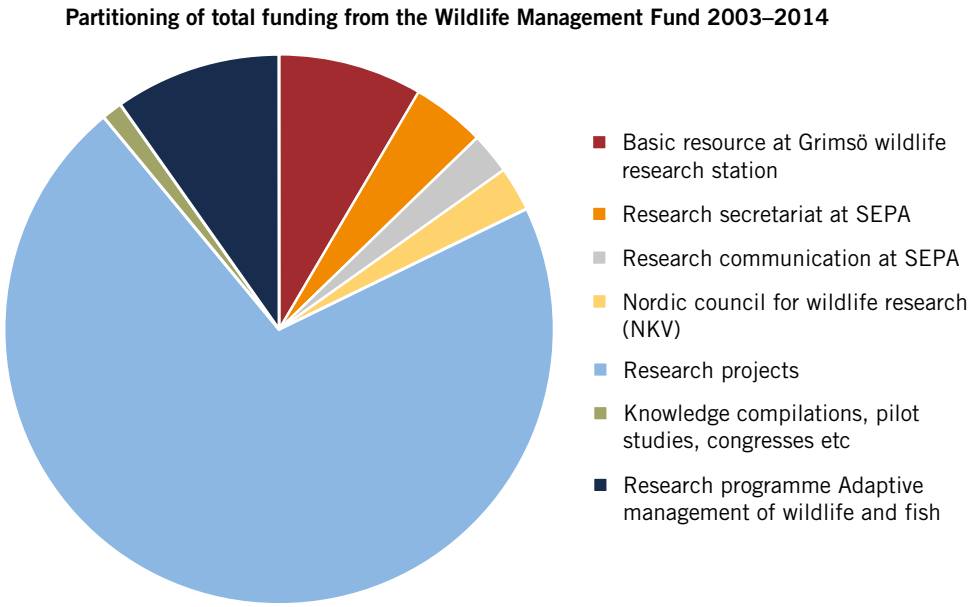

Figure 2. Partitioning of SEPA's distribution of funds from the Wildlife Management Fund for research, secretariat, communication and dissemination, etc. during 2003–2014.

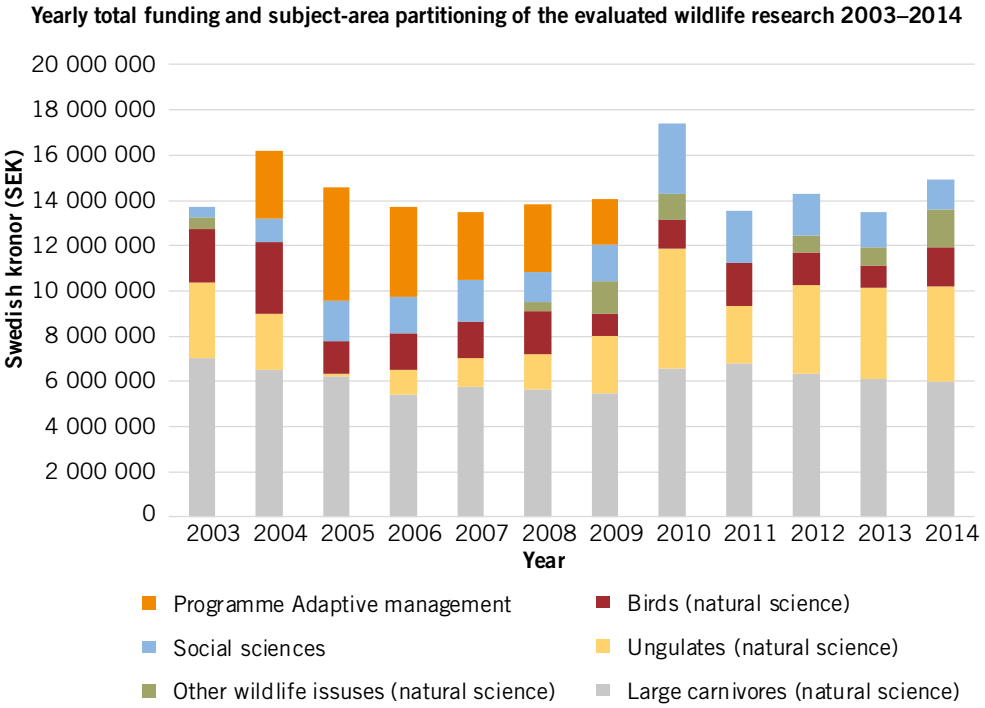

Figure 3. The partitioning of the annual funding of wildlife research from the Wildlife Management Fund through SEPA during 2003–2014 among different research areas including the multidisciplinary research programme 'Adaptive Management of Wildlife and Fish (Figure 4).

The greatest proportion of government funding from the Wildlife Management Fund is allocated to wildlife management issues. The Swedish Association for Hunting and Wildlife Management (Svenska Jägareförbundet) receives funding for its work with hunting and game management in practice (52.2 MSEK in 2017), which includes providing information about hunting and wildlife management, wildlife monitoring, moose management, wildlife and traffic, and hunter training. The National Association for Hunting and Wildlife Management (Jägarnas Riksförbund) receives a basic grant and a membership-related grant (7.5 MSEK in 2017). The National Veterinary Institute (Statens Veterinärmedicinska Anstalt, SVA) also receives annual funding for monitoring of wildlife diseases (4 MSEK in 2017). SEPA receives, besides funding for research, also funding to administer a register of hunting fees and hunting exams (7 MSEK in 2017).

In addition, the County Administrative Boards, the Swedish Society for Nature Conservation (Svenska Naturskyddsföreningen), the Swedish Forest Agency (Skogsstyrelsen) and the Swedish University of Agricultural Sciences (Sveriges Lantbruksuniversitet), periodically over the last two decades, received grants from the Wildlife Management Fund for specific assignments or projects related to wildlife.

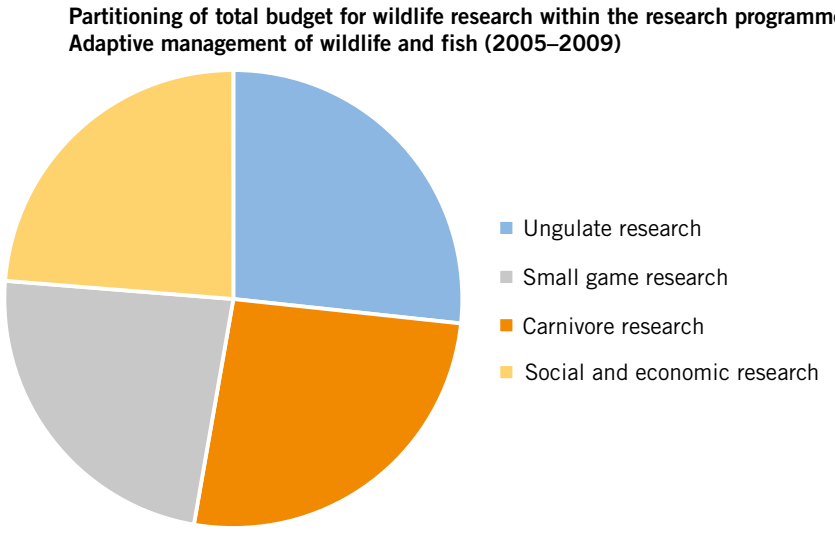

Figure 4. Partitioning of the total budget for wildlife research among subject areas within the research programme Adaptive management of wildlife and fish (2005–2009).

Apart from the Wildlife Management Fund, SEPA also administers the Environmental Research Grant from the government (78.8 MSEK in 2018) to fund research in support of the agency's work to implement Sweden`s environmental policy that targets 16 environmental objectives (http://sverigesmiljomal.se/miljomalen/).

Further information about the distribution of resources from the Wildlife Management Fund, the Environmental Research Grant and the administration of research can be found on SEPA's website (http://www.naturvardsverket.se/Amnen/Forskning/).

3.3.2 Other Funding of Wildlife Research in Sweden

Sweden has a pluralistic system of research funding, which also applies to research on wildlife and its management. Since 1968, SEPA has been the largest funder of wildlife research (relevant to sustainable wildlife management). Roughly 40–50% of the total funding for the projects in this evaluation derived from sources other than the Wildlife Management Fund, which ranged from less than 20% to 100%. Principal investigators (PIs) reported more than fifty sources of other funding, including research councils such as the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) and the Swedish Research Council (Vetenskapsrådet); other research-funding governmental agencies, public research foundations, private research foundations and private companies (e.g., from the forestry-sector); SEPA funding other than research grants; County Administrative Boards; and research-funding bodies in Norway as well as the EU. The Swedish Association for Hunting and Wildlife Management also funded research on wildlife, often in cooperation with SEPA. Universities allocated funding that included both academic positions and research support.

3.3.3 The Scientific Committee for Wildlife Research

The Scientific Committee for Wildlife Research (the Wildlife Committee; Viltkommittén) is SEPA's advisory expert committee for the allocation of research funding from the Wildlife Management Fund and other matters concerning research on wildlife. The Committee's principal task is to assess and prioritize research proposals scientifically and in terms of relevance according to the purpose of the Wildlife Management Fund and SEPA's current research strategy for the Fund.

In 2018, the Wildlife Committee consisted of nine members, of whom five were researchers representing different research disciplines, and the rest were representatives of SEPA, County Administrative Boards and the Swedish Association for Hunting and Wildlife Management. The scientific members of the committee are recruited from Sweden and abroad. Research proposals are usually also reviewed by external scientific experts before the Wildlife Committee makes a combined evaluation and proposes a priority order of approvals of the proposals. The Wildlife Committee is an advisory body and makes recommendations for decisions to SEPA. The Committee has had its current role and responsibilities since 1989.

SEPA has an annual call for proposals for funding from the Wildlife Management Fund. Individual research projects, as well as larger research programmes consisting of several cohesive subprojects, can be funded. SEPA grants research funding for a maximum of three years at a time, but projects can continue for a longer period than three years, subject to renewed evaluation of scientific quality and relevance by the Wildlife Committee.

In addition to conventional research, other research-related activities can, to a certain extent if warranted, be funded through resources from the fund. For example, workshops, seminars, conferences, development of tools and

techniques, reviews of the current state of knowledge, scientific syntheses and investigations are eligible, as well as activities to disseminate research results to managers and other stakeholders.

A research strategy with its prioritized research areas is the basis for SEPA's annual call for project proposals for funding from the Wildlife Management Fund, but the Wildlife Committee may also point out other areas of research or forms of funding in certain years. The Wildlife Committee can also propose smaller, specific calls for proposals, for example for funding of specific knowledge reviews.

SEPA, as a funder of research, does not, either through the Environmental Research Grant or through the Wildlife Management Fund, hold responsibility for the long-term provision of knowledge and expertise by announcing funding for academic positions. Funding of, for example, doctoral student positions is assigned to the national research councils. The universities and university colleges themselves also have a responsibility to fund academic positions. Still, research funded by SEPA can be conducted by doctoral students provided that the principal investigators (applicants) have doctoral degrees.

Decisive factors in the committee's assessment of the proposals, within the framework and the prioritized areas of research, are the scientific quality of the research, competence of the applicants and relevance to wildlife management. For more detailed information on assessment criteria etc., see instructions for applicants on SEPA's website (http://www.naturvardsverket.se/Stod-i-miljoarbetet/For-forskare-och-granskare/Viltvardsfonden/).

Research proposals that do not fall within the scope of the prioritized research areas of the framework, but which are relevant to the overall aim of research supported by the Wildlife Management Fund, may also be eligible for funding to a limited extent during the program period. This may, for example, apply to research of a particularly innovative nature, research on problems and challenges in wildlife management that were previously unanticipated, or where there is a need for knowledge in support of current government commissions. The priorities may thus change if the Wildlife Committee has overlooked, or not been able to predict, knowledge needs of high relevance and priorities in wildlife management.

SEPA supports applied and need-motivated research. This means that the research has to develop knowledge that will be of use in nature management. For the outcome of the research to be disseminated and applied, researchers need to look at end-users' needs in the initial planning of the research. At this stage, a dialogue between researchers and managers is important, in which management experiences and questions also are addressed. Researchers who receive funding from SEPA have an important task to communicate the results of the research undertaken, both during the course of the research period and at the end of the project. As well as publishing the results in scientific journals, researchers are expected to regularly supply information to everyone concerned by, or who may be interested in, the research results, for example through popular-science publications. A requirement is that all

projects must submit a final report to SEPA. The final reports (in Swedish) are available on SEPA's website. The researchers' responsibility to inform and communicate the results of research also follows from what is every researcher's responsibility at universities and university colleges.

Guidelines about how researchers are expected to make results available, inform about and communicate their results and conclusions are presented in more detail in SEPA's instructions for applicants, which are updated annually at the time of the call for proposals.

Historically, many projects have been dependent on a large voluntary involvement of hunters and others to be carried out. The involvement of the hunting community in research and monitoring linked to wildlife and hunting has been, and will continue to be, of key significance in conducting the research supported by the Wildlife Management Fund. The hunting community also has an important role to play in ensuring that research results are disseminated and put to practical use.

3.3.4 Research Strategies

Since 1973 research funded by the Wildlife Management Fund at SEPA has been run within frameworks of targeted temporary (5–6 years) research strategies. Those strategies define prioritized research areas that are considered essential to address current and anticipated challenges, problems and opportunities in wildlife management, or where there are particularly great needs for more building long-term knowledge in support of current and future management. A research strategy forms the basis for SEPA's calls for proposals for research funding during the actual period. A research strategy is primarily aimed at researchers applying for funding, and secondarily at authorities and organizations with responsibility for wildlife management and for which research supported by the Wildlife Management Fund is to provide operational knowledge support. The strategies also are aimed at other funders of research concerning wildlife, whose own resources may be limiting and for whom potential areas for co-funding may be of interest. The limitation of a strategy in time (usually 6 years) is not considered absolute. For example, the research strategy for 2003–2007 was extended to 2008. The initiation of a new research strategy is decided by SEPA and depends on the development of the research in the priority areas, and what needs arise in wildlife management for society generally.

In the process of developing new research strategies, SEPA and the Scientific Committee for Wildlife Research promote the participation of various wildlife stakeholders to identify knowledge needs through questionnaire-based surveys, sent to both researchers and managers, and through workshops and research seminars. Measures of identifying the state of the art regarding different wildlife issues are also part of the process run by the Committee. The process of identification of the knowledge and research needs prior to developing new research strategies includes several steps. Based on outcomes of this process, prioritized areas of research within the strategies are formulated by the Wildlife Committee.

Box 1
The following were the prioritized areas of research in the strategy "*Research for sustainable management of wildlife – framework program for the period 2003–2007 for Swedish Environmental Protection Agency funding through the Wildlife Management Fund*" (Forskning för hållbar förvaltning av vilt – ramprogram för perioden 2003–2007 för Naturvårdsverkets medel ur Viltvårdsfonden)

- **Adaptive management**
- **The human dimension of wildlife management**
- **Large carnivores, prey and humans**
- **The effects of hunting – harvest, disturbance and ethics**
- **Changing wildlife populations**

Box 2
The following were the prioritized areas of research in the strategy "*Research for sustainable management of wildlife – framework program for the period 2009–2014 for Swedish Environmental Protection Agency funding through the Wildlife Management Fund*" (Forskning för hållbar förvaltning av vilt – ramprogram för perioden 2009–2014 för Naturvårdsverkets medel ur Viltvårdsfonden)

- **A changing landscape – the effects on and by wildlife from a systems perspective**
- **Wildlife, hunting and society**
- **The biological effects of hunting and wildlife management**
- **Large predators, prey and society**

4 Procedures for the Evaluation

4.1 Introduction

The Scientific Committee for Wildlife Research encouraged SEPA to conduct an international scientific evaluation of the wildlife research funded during the period 2003–2014, i.e., the two research strategies for the Wildlife Management Fund for the periods 2003–2007 and 2009–2014 (Boxes 1, 2). SEPA accepted this recommendation in 2016 and decided also to include the targeted research programme "Adaptive Management of Wildlife and Fish" funded in the period 2004–2009.

The evaluation included: 1) short term research projects, normally 1–3 years long completed during 2003–2014; 2) longer-term large carnivore research (brown bear, wolf, lynx and wolverine); and 3) projects concerning wildlife within the specific research programme "Adaptive Management of Wildlife and Fish". In total, 95 projects were included in the evaluation (Appendix 2).

The overall evaluation by SEPA consisted of three parts: 1) a bibliometric evaluation of the research (Sandström 2018); 2) a survey to evaluate the relevance of the funded research for Swedish wildlife management; and 3) an evaluation performed by an international scientific evaluation panel (i.e. this report) into which aspects of the first two parts provided by SEPA were incorporated.

The bibliometric evaluation was published by SEPA in June 2018 (Sandström 2018). The major conclusions are summarized in section 4.3.5. The results from the relevance survey were published by SEPA in May 2018 (Forsberg et al. 2018, see section 4.3.6 for a summary).

For the third part of the evaluation SEPA appointed an international Evaluation Panel consisting of:

- Professor Bernt-Erik Sæther, Norwegian University of Science and Technology, Trondheim, Norway (Chairman)
- Professor Mark S. Boyce, University of Alberta, Edmonton, Canada
- Professor Grete K. Hovelsrud, Nord University, Bodø, Norway
- Associate Professor Thomas Lundhede, University of Copenhagen, Copenhagen, Denmark
- Professor Juha Merilä, University of Helsinki, Helsinki, Finland
- Professor Thomas Nudds, University of Guelph, Guelph, Canada.

Brief research profiles are in Appendix 1.

The Evaluation Panel was presented the results and conclusions of the reports of the bibliometric analysis (I) (section 4.3.5) and the relevance survey (section 4.3.6). The Evaluation Panel independently reviewed raw material, i.e., written reports provided by the Principal Investigators (PIs) and hearings with the PIs (section 4.3.2 and 4.3.4). All material and procedure for the evaluation are summarized in section 4.3. and titles of the evaluated projects are presented in Appendix 2.

4.2 Tasks and Mandate of the Evaluation Panel

SEPA's overarching objective for the evaluation was to review, from an international perspective, the scientific quality (strengths and weaknesses), and efficiency of the research as well as its contribution to sustainable use and sound management of Swedish wildlife. In addition, the Evaluation Panel's task was to identify weak as well as strong aspects of science related to wildlife management more generally that need to be considered by SEPA today and in future research programs.

The Evaluation Panel was given the following tasks and mandate for its evaluation:

- From an international wildlife research perspective, assess and present a general picture of the overall scientific quality of the funded research as a whole (without necessarily commenting on individual projects).
- Assess the scientific quality of the research performed within each subject area/scientific discipline from an international wildlife research perspective.
- Assess to what extent the recommendations for future research from the previous evaluation (Boyce et al. 2001) were met.
- Evaluate to what extent and how the two research strategies 2003–2007 and 2009–2014, respectively, were taken into consideration by the Wildlife Research Committee while prioritizing research for funding.
- Identify strong wildlife research areas.
- Identify unique research areas for Sweden.
- Identify important but weak and/or neglected areas of wildlife research in Sweden.
- Evaluate to what extent interdisciplinary research was performed.
- Suggest new and important areas for future wildlife research to support wildlife management in Sweden.
- Assess the relevance of research results for Swedish and international wildlife management with the help of the relevance survey.
- Write a report that will be published in SEPA's report series.
- Present the evaluation result at a hearing at SEPA.

Based on these considerations, taken together, the Evaluation Panel rated research areas within several broad areas of emphasis (see below) on the five-grade scale used by SEPA when evaluating research proposals: outstanding, excellent, very good, good or insufficient.

Outstanding

Outstanding research from an international perspective; of great international interest with broad impact and with publications in internationally leading journals; the entity/grant holder is among the international leaders in the evaluated field of research. Research with outstanding relevance for

wildlife management and for society; widespread impact on society; cooperation with stakeholders is integrated in the project, which is well designed and executable.

Excellent
Research at a very high international level; of international interest with impact within its field and with publications in internationally leading journals; the entity/grant holder is competitive in the evaluated field of research from an international perspective. Research with excellent relevance for wildlife management and for society; with positive impact on society; cooperation with stakeholders is well designed.

Very good
Research at a very good international level with publications in internationally well-known journals; the entity/grant holder has a good international reputation within the field. Research with high relevance for wildlife management and for society; with some impact on society; cooperation with stakeholders is thought through.

Good
Research of good international standard and partially published in renowned international journals. Research with moderate relevance for wildlife management and for society; with fair impact on society; cooperation with stakeholders is minimal.

Insufficient
Research of low international standard. Research with no or limited relevance for wildlife management or society; with no or limited impact on society; cooperation with stakeholders is insufficient.

4.3 Material and Procedure

4.3.1 Selected Projects

During the years 2003–2014, 103 individual wildlife research projects were supported from the Wildlife Management Fund; 95 of those were included in this evaluation including 7 of 9 projects from within the programme "Adaptive Management of Wildlife and Fish". Altogether these projects were led by 55 different PIs. Projects that were not included were, for example, those which started in 2001 or 2002 and ended in 2003. Several of the 95 projects consisted of more than one research contract with SEPA and such consecutive projects were aggregated as they were essentially the same project.

4.3.2 Written Material Provided by the Principal Investigators

PIs were asked by SEPA to provide a complete publication list from each of their projects funded by the Wildlife Management Fund during the period 2003–2014 to be used by the Evaluation Panel. The publication list was to include peer-reviewed publications, books and book chapters, popularized publications, abstracts or proceedings, submitted manuscripts, a list of doctoral dissertations, honours thesis work, other exams or equivalent, and organization of, and/or participation in, professional meetings related to the research project(s). They were also asked to deliver a comprehensive list of all communication/dissemination activities to the public, stakeholder groups, authorities etc., and a list of remittance work or other report writing fulfilled with respect to wildlife management and administration at SEPA or County Administrative Boards (CABs) etc. They were also to estimate the total effort per year invested in "communication/ dissemination" and in "wildlife management and administration at SEPA/CAB", etc. They were also asked to deliver a short summary in English of the project(s) including, among other things, research questions, results and conclusions. The summary was to include information about the project budget from SEPA and any other sources of funding (private foundations, research councils, university funding etc.) to give as complete a picture as possible of the overall funding for the project. Any other information of importance for the Evaluation Panel to understand the project and its performance and impact, in addition to what was asked for above, could also be added to the publication list and the summary.

Of SEPA-funded projects, 43 out of 55 PIs sent material according to SEPA's request; 12 did not for various reasons, although they were nevertheless included in the bibliometric evaluation (Sandström 2018). The Evaluation Panel did not have material from 20 of 95 projects.

4.3.3 Other Material Provided to the Evaluation Panel

- An English translation of the final delivery report to SEPA from the research programme "Adaptive Management of Wildlife and Fish".
- The previous evaluation report: International Review of Swedish Wildlife Research 1997–2001 (Boyce et al. 2001).
- English translations of the research strategies (framework programs) 2003–2007 and 2009–2014 for the Wildlife Management Fund, respectively:
  - *Research for sustainable management of wildlife – framework programme for the period 2003–2007 for Swedish Environmental Protection Agency funding through the Wildlife Management Fund* (*Forskning för hållbar förvaltning av vilt – ramprogram för perioden 2003–2007 för Naturvårdsverkets medel ur Viltvårdsfonden)*
  - *Research for sustainable management of wildlife – framework programme for the period 2009–2014 for Swedish Environmental Protection Agency funding through the Wildlife Management Fund (Forskning för hållbar förvaltning av vilt – ramprogram för perioden 2009–2014 för Naturvårdsverkets medel ur Viltvårdsfonden)*

- An example of a research call (2016) from SEPA for the Wildlife Management Fund.
- SEPA's instructions (2016) to applicants for research projects to the Wildlife management fund.
- Power-point presentations from the PIs who took part in the workshop with the Evaluation Panel during 13–15 March 2018 in Sigtuna.
- English abstracts from SEPA's research database for the research projects selected to be included in the evaluation, which did not provide the Evaluation Panel with written reports.
- SEPA-report *Strategy for Swedish Wildlife Management – with objectives and measures by the Swedish Environmental Protection Agency 2016–2020* (SEPA 2016).

4.3.4 Workshop with Principal Investigators

As part of the Evaluation Panel's work, a workshop was held in Sigtuna on 13–15 March 2018 between the Evaluation Panel and a sample of 15 out of the 55 PIs who were included in the evaluation. They were selected to give as comprehensive a picture as possible of the wildlife research funded during the period given the limited time for the workshop. The selection of PIs was decided by Bernt-Erik Sæther, after dialogue with Per Sjögren-Gulve and Anders Lundvall, to include as large variety of types of project, scientific disciplines and universities.

The PIs that participated in the workshop and gave presentations were Ann-Marie Dalin, Katarina Elofsson, Göran Ericsson, Karin Hårding, Maria Johansson, Petter Kjellander, Simon Matti, Jens Persson, Håkan Sand, Anneli Sjölander-Lindquist, Jon Swenson and Tomas Willebrand. Per Söderquist replaced Johan Elmberg. Project collaborators but not PIs of two projects, Mikael Åkesson and Göran Spång, were invited for specific discussion about genetics in wildlife management and research. Göran Ericsson presented the research programme "Adaptive Management of Wildlife and Fish", for which he was deputy leader, in addition to presenting his own research projects. Tomas Willebrand and Petter Kjellander were asked to present their own research projects and to discuss international collaboration in wildlife research. The PIs were, among other things, asked to present their projects and results as well as their basis as researchers at the universities and finally give their view of the future for their research. Each invited researcher had approximately 60 minutes for presentation and discussion with the Evaluation Panel.

Prior to the workshop, Ulf Sandström presented the bibliometric evaluation he had conducted (see section 4.3.5). Per Sjögren-Gulve presented a summary of the published relevance survey (see section 4.3.6). Anders Lundvall reviewed how wildlife research and management in Sweden are organized (summarized in section 3).

4.3.5 Bibliometric Evaluation

The bibliometric evaluation (citation analysis) of the wildlife research funded was performed during 2017 and published in 2018 (Swedish title: Bibliometrisk analys av Naturvårdsverkets viltforskning 2003–2014; Sandström 2018). The report highlights the productivity and citation rates of the publications by the funded research leaders and co-applicants from 2003 to 2014.[1]

The following questions guided the bibliometric evaluation:

1) Has the SEPA program for wildlife research paid off in relation to the input of resources?
2) Has SEPA and its Wildlife Research Committee chosen the best available researchers for the projects?
3) Does SEPA's funded wildlife research represent a reasonable project portfolio from an international perspective?
4) Does SEPA have a gender-wise, and equitable distribution of research funds?

The citation rates and level of productivity of published papers were compared to the average national and international levels within each discipline. In addition, the amount of funding received from SEPA was used as a measurement of efficiency. Impact factor of the journals was also discussed but the main focus was normalized number of citations.

The bibliometric evaluation results suggested that SEPA has received a good return from its investment of resources with respect to numbers of articles and expected citation response from the larger research community. During the program period 2003–2014, citation frequency increased significantly, from 40% to 60% of the researchers showing strong achievements, i.e., they are included in the top 20% of Swedish researchers. There were no significant gender effects. Overall, the results indicated that SEPA and the Scientific Committee for Wildlife Research selected good researchers for the implementation of the research strategies.

According to the report, productivity increased, but not as the result of an increase in "least publishable units" at the expense of fewer substantive ones; instead the growth is largely an effect of increased collaboration between researchers. This was shown to mainly be an effect of national rather than international co-operation.

[1] See Sandström's (2014) Appendix 1 for details. For example, the number of publications (SCI, SSCI, A&HCI), "Letters", proceedings papers or reviews (p), and the field-normalized citation score (NCSf) calculated as $\frac{1}{P}\sum_{i=1}^{P}\frac{c_i}{[\mu_f]_i}$ where c is the number of cites to paper i, and [μf]i is the average number of citations received by papers in the normalization group (e.g. scientific subject area) of paper i at the global level.

A question that was raised was whether this productivity had been achieved within the framework of a limited research portfolio or is the portfolio broad and fairly dynamic. The bibliometric evaluation (Sandström 2018) suggests that the portfolio is relatively broad and that it covers all essential aspects of international wildlife research.

4.3.6 Summary of Survey Regarding Relevance

A web-based survey regarding relevance of the wildlife research funded by SEPA during 2004–2014 was carried out by SEPA in 2017. The survey was published in SEPA report series as *Webbaserad enkät om viltforskningen finansierad av Naturvårdsverket 2004–2014* (Forsberg et al. 2018).

The purpose of the analyses was to examine to what extent this research yielded relevant results and knowledge for sustainable wildlife management in Sweden, if it was disseminated and communicated in appropriate ways, and if any important aspects were missing.

Invitations to fill out the questionnaire (14 questions) were emailed to 775 persons with interest/roles in wildlife management, for example, delegates of regional wildlife management advisory councils, employees at government agencies, municipalities and county administrative boards, researchers and other university employees, persons affiliated with hunters' associations, conservation organizations, reindeer husbandry, mountain farming, or parties in other ways interested in wildlife. A total of 396 respondents fulfilled the complete survey; an additional 50 either began or filled out part(s) of the questionnaire. Differences among respondent groups – derived from their responses in the survey's first question "In what role do you work / are you primarily involved with wildlife management?" – were analyzed using non-parametric statistical tests.

Of the respondents who had an opinion, the majority (51%) thought that wildlife research during 2004–2014 had contributed useful knowledge for sustainable wildlife management at national, regional and local scales in Sweden. Many (27%) also specified needs for more research – foremost, socioeconomic and other social science investigations regarding wildlife issues: research on multispecies management, large carnivores and prevention of wildlife damages was also mentioned. Furthermore, many of the respondents emphasized that the accessibility and dissemination of the research results need to be improved, and that the research needs to be more useful for wildlife management. Most respondents thought that multidisciplinary research had not been funded to the extent necessary. This opinion was particularly strong among respondents with an affiliation to reindeer husbandry, primary interests in forestry and agriculture, and/or affiliations with wildlife management advisory councils.

The majority of respondents across all groups thought that reviews of existing scientific knowledge about wildlife biology and management had not been produced to the extent needed. Of the respondents who had an opinion, most thought that Nordic research collaboration contributed added value to

developing knowledge for sustainable wildlife management. More collaboration with Finland, Norway and Russia was viewed as important.

The survey also showed that most of the respondents (52%) used a normal Google search on the internet to seek knowledge derived from wildlife research, 47% of them used SEPA's website, and 43% asked colleagues within their own organization for such information. Of the respondents who had an opinion, most thought that SEPA had not succeeded in its communication of wildlife research results to key stakeholders in the Swedish wildlife management; only 16% thought SEPA had done a good job in this respect. This indicated that it is important that SEPA invests more in its dissemination and communication of research findings to people involved in wildlife management in Sweden.

Most (28%; 11 respondents) of the researchers that filled out the survey thought that SEPA's administration of grants had worked very well. About 23% thought the administration was acceptable and 18% that it was satisfactory, but both these groups also proposed improvements, such as faster administration of the funds and quicker response in written communication.

The Evaluation Panel had a major focus on the scientific assessment of Swedish wildlife research but found that the survey of the relevance provided some useful input as to how the results from the research were assessed and put to practical use.

5 Summary of the Previous Evaluation of Swedish Wildlife Research

Swedish wildlife research funded by SEPA during the period 1997–2001 was evaluated by an international panel of experts consisting of Mark S. Boyce, Peter J. Hudson and Esa Ranta (Boyce et al. 2001). They made the following recommendations:

1. Large-scale adaptive management should be performed.
2. Models for harvesting in an uncertain environment should be developed.
3. Projects that combine the strengths of traditional wildlife biology with strengths of other disciplines should be encouraged.
4. Research careers of young scientists interested in wildlife research should be supported as well as clearer career structures of wildlife managers should be implemented, involving close interactions with leading research groups.
5. Funding duration should be long enough to allow a long-term perspective.
6. Evaluation of the scientific output of wildlife biologists should occur at regular intervals.
7. A targeted wildlife research program should be supported, providing the foundation for a science-based decision system.
8. The knowledge transfer from research to management should be promoted by developing an integrated wildlife-monitoring system.
9. A national planning process for wildlife management and research should be initiated.

A part of the mandate for the current Evaluation Panel was to evaluate to what extent these recommendations have been implemented in the subsequent research strategies (framework programmes) for wildlife research funded by SEPA. The panel focused on recommendations related to the scientific content and organization of research rather than suggestions for structural changes of the wildlife management system in Sweden.

6 General evaluation

6.1 Temporal Changes in the Project Portfolio

This evaluation covers two framework programme periods): 2003–2007 (extended to 2008) and 2009–2014. Some projects ran continuously through both periods. A major proportion of these long-term projects involved research related to large carnivores such as the wolf project "Skandulv" and the "The Scandinavian brown bear project". The only non-carnivore, long-term project examined how cervids affected biological diversity and ecosystem processes. The Evaluation Panel acknowledged that this demonstrates a willingness of SEPA to fund long-term research provided they are of high scientific quality which, from an international perspective, is rare and provides opportunities for Swedish wildlife researchers.

Despite a number of long-term projects, there still have been changes in the topical focus of the projects funded in the two programme periods (Figure 3). A major change happened in 2004 with the establishment of the targeted research programme "Adaptive Management of Wildlife and Fish" (2004–2009). This programme was funded by a special 20 MSEK grant from the Environmental research grant at SEPA in addition to 20 MSEK from the Wildlife Management Fund. In addition, more than 50 MSEK came from other funding agencies like research councils, forest companies, and from faculty funds at the universities involved. Seven projects from this programme included wildlife research and thus provided a substantial strengthening of this field of research during the first programme period. A common characteristic of most of these projects was that they involved a cross- or inter-disciplinary perspective, and even included some research groups with no former experience with wildlife research.

The previous evaluation (Boyce et al. 2001) suggested that greater emphasis should be given to research on societal aspects of wildlife. In accordance with this recommendation, the Evaluation Panel finds that several non-biological projects in wildlife research were funded, especially in social sciences and socio-economics. In addition to the projects included in the research programme "Adaptive Management of Wildlife and Fish", several projects funded during the first programme period included social sciences or included a component of humanities or social sciences. This trend was also continued in the second programme period. In total, during the period 2003–2014 approximately 20% of SEPA's total funding of wildlife research was allocated to humanities or social sciences.

During the first period (2003–2007), there was a focus on problems related to management of traditionally important Swedish wildlife species such as moose, roe deer and large carnivores. In the second programme period (2009–2014), a shift in the composition of the species of principal interest for the research occurred. Several large projects funded during this last program period included research on introduced or re-introduced species

such as the wild boar, raccoon dog and fallow deer. In addition to those projects related to the ecological and socio-economic effects of alien species, several projects funded during this period also addressed the role of wildlife as vectors for different diseases. The Evaluation Panel found that this illustrates a willingness by the community of Swedish wildlife researchers to respond to new problems of interest for the public and/or for wildlife management. The responses to these challenges have in many cases resulted in research questions that have wider scientific interest.

Another trend apparent among projects funded during the second period was a shift in focus from questions related to the management of single populations to problems related to interspecific interactions or how large-scale, landscape-ecological considerations factor into management decisions. The Evaluation Panel found that this illustrates an increased interest by Swedish wildlife researchers in questions related to the effects of wildlife on ecosystem structures and functions, which is in line with the international development of this field of research.

A characteristic of Swedish wildlife research 2003–2014 (except the projects included in the programme "Adaptive Management of Wildlife and Fish") was that there were few scientific interactions even among scientists involved in projects dealing with related problems. This may be a consequence of the fact that external funding occurred through an open competition among research proposals.

6.2 Small game research

The research on Swedish small game species consisted of loosely connected projects, dealing mainly with management of ducks and grouse. The overall research focus was on processes affecting the dynamics of single species. No single project was funded by SEPA throughout both programme periods.

The field normalized citation score of research on small avian game species in Sweden was 1.10 (Sandström 2018). This means that the wildlife researcher in this field on average is cited 10% more frequently than the average citation rate of the peers in the same scientific field(s). The corresponding field normalized citation score for other small game was 0.95, indicating a lower citation rate of publications in this field.

Projects dealing with research on avian game can be divided into two focal areas of research. One cluster of researchers deals with questions related to the ecology and management of waterfowl, whereas the other focuses on the dynamics and management practices of grouse species, especially in mountainous areas in northern Sweden. There appears to be few interactions among researchers belonging to these two fields of small game research (Sandström 2018).

Strengths
The research in both areas of small game research in Sweden had a clear management focus. The waterfowl researchers addressed questions related to the effects of harvest on the population dynamics of migratory duck species. As a consequence, Swedish waterfowl researchers were heavily involved in international collaboration, resulting in a flow of papers, especially by researchers from the Kristianstad University. Many of these papers caught the interest of researchers and managers outside Sweden. The researchers also have been willing to address rather acute management problems, for example how individuals raised in captivity affect the ecology and genetics of natural populations subjected to introductions of those captive birds.

Similarly, an important issue for the research especially in mountainous areas in Sweden has been how hunting regulations affect the sustainability of the harvest of grouse. An important approach was to vary hunting tactics spatially and, from the population responses in this semi-experimental set-up, to identify optimal harvest tactics. The Evaluation Panel finds this to be an innovative approach perfectly aligned with adaptive management that could potentially have general implications for the choice of harvest strategies for many hunted species.

Weaknesses
This area of wildlife research showed large variation in scientific output. Whereas some projects resulted in a large number of papers of high relevance, other projects have produced little scientific output in terms of papers in international journals. The Evaluation Panel is therefore worried about how unique time series of fluctuations in population size and individual-based demographic data, especially of willow grouse, are maintained and used scientifically.

Overall grading
The Evaluation Panel separated the grades in this field of research. They rated the waterfowl research ***Excellent***, whereas the grouse-related research was rated ***Very good*** due to the limited scientific output despite that the results were highly relevant for management.

6.3 Ungulate research

Swedish ungulate research during both program periods was characterized by an ecosystem focus extending far beyond understanding of factors affecting fluctuations in the abundance of single species. This is line with the recent international developments of this field of research in which questions related to trophic interactions and the effects of large herbivores on ecosystem structure and functions have received increased attention.

The field normalized citation score of ungulate research in Sweden was 1.07 (Sandström 2018). This indicated that the average Swedish ungulate

researcher was cited slightly more than the average peer in the field of ungulate research. Several of the papers were published in leading ecological journals (e.g. *Ecological Monographs*, *Ecology* and *Journal of Animal Ecology*).

Strengths

Central to Swedish ungulate research were studies of plant-herbivore interactions. For example, the only ungulate project that continued through both programme periods focused on the effects of ungulates on biodiversity and ecosystem processes in forested landscapes. Similarly, several new projects funded during the second programme period dealt with the ecological effects of introduced species such as wild boar and fallow deer on Swedish ecosystems. Furthermore, SEPA also funded projects that contributed to building Swedish expertise about the role of cervids in the spread of diseases (e.g., P. Kjellander's project on tick-borne diseases), which is likely to be a more important area of research in the future.

Ungulate researchers were also heavily involved in inter-disciplinary scientific collaboration. In particular, the projects included in the programme "Adaptive Management of Wildlife and Fish" were instrumental in developing this research tradition in Swedish wildlife research, where senior researchers were heavily involved in developing inter-disciplinary projects. Based on statements from several participants in hearings between the Evaluation Panel and researchers, this interdisciplinarity would not have been achieved without substantial commitments by a number of senior researchers. The Evaluation Panel underlines that such strong involvement by leading scientists is a prerequisite for the development of successful inter-disciplinary collaboration.

Weaknesses

Swedish wildlife research on ungulates generally had a descriptive focus. For examples, several of the projects involved description of inter-specific or trophic interactions at a single locality at a given point of time. This ignored that such interactions are dynamic and strongly influenced by different kinds of human activities. For example, there is now a strong indication that interactions between different deer species are related to the structure of the landscape, which is strongly affected by forestry practices. Similarly, several studies have shown that moose strongly influence biological diversity and ecosystem processes in boreal ecosystems. However, variation in harvest pressure is a major determinant of moose densities in most parts of Sweden and is therefore likely to affect plant herbivore interactions in many Swedish terrestrial ecosystems. Thus, the Evaluation Panel found that the foundations for making projections about the ecological consequences of changes in numbers of ungulate species in Sweden were rather limited. Consequently, it may be difficult to predict how changes in forest practices, climate and harvest strategies will affect future abundances of ungulates in Sweden.

With regard to moose research, a shift in the location of the major study areas occurred between the first and second period of the programme. During 2003–2009, the major sites for Swedish moose studies were located in northern Sweden. The aim of these studies was closely related to the research goals for the programme "Adaptive Management of Wildlife and Fish". From 2007 onwards, several new study sites were established along a latitudinal gradient from 56° N to 67° N. This facilitated studies of variation in several important characteristics of moose such as migration patterns, range sizes and habitat use. The drawback of such an approach is that it may become logistically challenging to ensure continuity in time series of demographic data that are essential for detecting changes in size and structure of moose populations. Perhaps as a consequence of this, there is a lack of studies on population dynamics of Swedish ungulates (but see Elofsson et al. 2017 for a notable exception).

Although some results appeared about how moose interact with their predators in space use in areas where they co-exist, the Evaluation Panel found that carnivore and ungulate research in Sweden were poorly integrated and few synergy-effects among projects were evident. As a consequence, interesting questions of both scientific and management interest about how future abundances of ungulates and carnivores will be affected by changes in herbivore-ungulate interactions have so far been addressed only to a limited degree.

Overall grading

The scientific output as well as the heavy involvement of senior ungulate researchers in interdisciplinary collaboration led the Evaluation Panel to rate ungulate research in Sweden as ***Excellent.***

6.4 Carnivore research

The research on large carnivores in Sweden was mainly organized as single-species studies of brown bear, lynx, wolf and wolverine. Several of the projects received funding throughout the entire period 2003–2014 included in the evaluation by this panel. Accordingly, a considerable proportion of the total funding available for wildlife research at SEPA was allocated to studies of these four species (Figure 3). In addition, a large project on the ecology of red fox was also funded during the second funding period.

The Swedish research on large carnivores had a major scientific impact far beyond the field of carnivore research, as evidenced by the fact that the field normalized citation score of carnivore research funded by SEPA and the Wildlife Management Fund was 1.66, the highest recorded for any of the subject areas included in the citation analysis of Sandström (2018). These researchers on average were cited far more than the average international carnivore researcher. Similarly, 11.38 % of the papers were above the 95 % citation percentile of the papers in this research field (i.e., more than twice the expected proportion). Swedish large carnivore researchers are well-cited even within the whole field of population ecology.

Strengths

The long-term funding of the research on the autecology of large carnivores produced individual-based demographic data and time series of lengths that are rare for any vertebrate species in the world. This enabled large carnivore research in Sweden to address problems not only of relevance for Swedish management practices of these species, but which also are of interest for the whole field of research in population ecology. For example, the studies of brown bear in southern Sweden revealed that the population response to removal of individuals depended on complex social interactions, strongly affected by infanticide by incoming new males. The notable impact of Swedish large carnivore researchers is also well illustrated by the large number of highly influential papers published in leading general journals such as Nature (2), Science (5) and Proceedings of the Academy of Sciences USA (3).

A major reason for the large impact of Swedish carnivore research was that the researchers started to apply modern molecular genetic methods already at an early stage of development of the technology. This extended the scope of the studies far beyond what was possible in traditional ecological studies and provided tools, e.g., for individual recognition, that are useful to management. Considering the pace of technical development in molecular genetics, it is of crucial importance that the close interactions between wildlife biologists and internationally leading molecular research groups are further developed and continued in the future.

In addition to the biological studies, several projects in both programme periods studied various aspects of the societal impact of large carnivores in Sweden. For example, analyses were done on causes and consequences of fear, which showed that a deeper understanding of the public's fear of wolf and brown bear must be included when implementing management practices of these species.

Weaknesses

Many of the same senior researchers were involved throughout both programme periods as principal investigators of the projects on large carnivores in Sweden. The Evaluation Panel underlined that continuity is an important advantage considering the logistical challenges involved in this kind of research and that the high level of conflicts related to the four large carnivore species in Sweden makes efficient project management in a scientific sense demanding. A disadvantage is, though, that the research becomes quite dependent on the experience and commitment of a limited number of people, which may cause large carnivore research in Sweden to be vulnerable to changes in the level of involvement of key individuals. This problem is illustrated by the retirement of the project leader of the Scandinavian brown bear project, which was at the time of writing had yet to be replaced by a senior scientist. The Evaluation Panel suggested that SEPA in collaboration with other funding agencies, takes action to ensure recruitment of senior scientists to long-term large carnivore research in Sweden.

Although the large carnivore research projects produced several unique long-term individual-based demographic data sets, there was still a lack of long-term time series from northern Sweden where the ecological conditions faced by these species are quite different from those in southern Sweden. Strong conflicts involving large carnivores also occur in these northern areas. The Evaluation Panel therefore regretted that some of the long-term studies in these areas were not continued (e.g., on the population ecology of wolverine).

Overall grading
The Evaluation Panel rated, mainly on the basis of the high number of publications in leading international journals, carnivore research in Sweden as ***Outstanding***. Swedish carnivore research produced excellent science, highly relevant to society.

6.5 Social and economic research

The research in humanities and social science funded by SEPA covered a wide range of topics. Many of the projects dealt with problems related to the fact that Swedish wildlife management seems to include an array of disagreements and low trust and legitimacy among the actors. As a consequence, several controversies are present about methods for providing reliable knowledge, definition of management goals in terms of size and composition of populations, and who should influence policy and have the mandate for decisions. In particular, there are high levels of conflict regarding many aspects of management of large carnivores in Sweden. The Evaluation Panel concluded that Swedish researchers without any doubt have made important contributions to improve our understanding of the underlying drivers behind many of these conflicts.

The citation analyses revealed that Swedish wildlife researchers in this field, with a field normalized citation score of 0.87 (Sandström 2018), were less frequently cited than the average peer in humanities and social sciences. Similarly, only 2.02 % of their papers were above the 95 % citation percentile of papers in this research field.

Strengths
Social and economic research now increasingly includes a wide array of topics and institutions without a former tradition in wildlife research. According to the view of the Evaluation Panel, this improved understanding of how interdisciplinary approaches to wildlife research help to better understand interactions between society and wildlife; identify potential and real conflicts; and changes in societal processes, policies and public attitudes that affect management practices of wildlife in Sweden. In addition, the projects revealed a number of directions further studies may take with respect to the costs and benefits of economic aspects, and societal interactions with wildlife including

fear, hunting and desires for biodiversity conservation. These studies should spur further research into the relationships between wildlife ecology and human activities.

Weaknesses

The citation analyses revealed that the scientific impact of the research funded in this sector was smaller than within the ecological areas of research. This is a trend in all social sciences working in an inter-disciplinary context. Social science projects typically do not produce as many publications per unit funding as natural sciences, and the Evaluation Panel finds therefore that citation analyses may not necessarily be comparable between these two research fields even when done in a standardized way. This also might be a consequence of a time frame too short to yet properly evaluate such a new research tradition. If the greater majority of researchers in social and economic sciences were more interested in other focal areas and issues of their scientific disciplines than in the issues funded by SEPA, this will necessarily result in lower citation rates of papers in wildlife research.

Overall grading

The Evaluation Panel rated the research in this field ***Very good*** because of its high societal relevance and many innovative approaches. The rate is influenced by the fact that the scientific output is still small and variable among projects. However, the Evaluation Panel anticipated that this will increase when this research tradition becomes more firmly established in the humanities and social sciences and the required participation by researchers in these areas is better appreciated by researchers in the natural sciences.

6.6 The Research Programme "Adaptive Management of Wildlife and Fish"

This research programme was in addition to the Wildlife Management Fund supported by the Environmental Research Grant at SEPA. The goal for the programme can be summarized as developing a scientific basis for adaptive management of wildlife and fish populations and strengthening linkages between management and research. This should provide the foundation for scientific collaboration between researchers in wildlife and fish-oriented disciplines as well as close cooperation among various scientific disciplines in the natural and social sciences. This interdisciplinary focus should facilitate transfer of knowledge to wildlife and fish management at local, regional and national levels. Consequently, a new generation of researchers with a broad scientific basis is expected to emerge.

Between 2004 and 2009, seven proposals for wildlife-related projects were evaluated by the Wildlife Research Committee and funded to a total of approximately 23 MSEK. This included funds for common programme

administration and communication. These projects included a wide variety of topics such as monitoring and spatial aspects of harvest of wildlife in forest ecosystems, social prerequisites for adaptive management, cost-benefit analyses of game resources, and challenges to implementation of adaptive management in Sweden. Thus, the programme "Adaptive Management of Wildlife and Fish" provided a widening of the scientific scope of wildlife research in Sweden.

Strengths

According to the Evaluation Panel, the research programme "Adaptive Management of Wildlife and Fish" represented a milestone in Swedish wildlife research by providing a new arena for developing interdisciplinary collaboration. Several participants in the hearings between Swedish wildlife researchers and the Panel expressed their gratitude to the efforts and commitments made by the leadership of the programme to facilitate interactions and communication among groups in fields of research that had very little or no experience with collaboration on scientific investigations into problems related to the management of Swedish wildlife. It is the opinion of the Evaluation Panel that this programme contributed to the establishment of a new research tradition in Sweden, focusing more on the societal impact of wildlife than is usually the case in the more discipline-oriented research programmes. The research results of this program also had high scientific impact; 80 of its internationally published papers that were analysed bibliometrically were cited 41% more than the average papers by peers within the same scientific fields (Sandström 2014). Accordingly, the Evaluation Panel found it encouraging that several of the project groups included in this programme later obtained funding by SEPA for projects within the field of wildlife research.

Weaknesses

From the perspective of the Evaluation Panel, expected synergistic effects among the wildlife and fish-projects included in the project portfolio, as well as with social scientists could have been stronger, reflecting the inevitable challenges to meaningful integration among disciplinary and institutional world-views, such as that also between academic researchers and the civil service. One reason for this may be that the project proposals were evaluated on an individual basis with less focus on potential synergy with other projects within the larger research programme. Another may be that the goal of the programme implied that research was to facilitate the scientific *basis* for adaptive management, rather than to embrace that adaptive management *is* "doing science" and develop projects that would undertake practical actions in a scientifically robust fashion, including monitoring to evaluate policies.

Overall grading

This research programme initiated new areas for wildlife research consistent with the trend internationally to blend, where appropriate, social and natural sciences to address societal concerns relating to wildlife management. Furthermore, the implementation of adaptive management as a research realm represented one of the most comprehensive attempts to apply this principle in practical management. Several of the papers published from this programme also have been widely cited. The Evaluation Panel therefore ranks this programme as ***Outstanding*** for its time.

7 General Conclusions

The Evaluation Panel concludes that Swedish wildlife research projects funded by SEPA from the Wildlife Management Fund over the period 2003–2014 produced high quality scientific results highly relevant to society generally and which provided an excellent foundation for an evidence-based management system for many wildlife species with significant ecological impacts and/or of great public concern in Sweden. The projects included in this evaluation (Appendix 2) probably represented for SEPA one of the most important sources for an evidence-based decision-making about management of wildlife in Sweden. Some of the insights gained through these projects also had an influence on the development of ecology as a research discipline. The Evaluation Panel therefore thinks that it is of uttermost importance that funding is maintained for SEPA's Scientific Committee for Wildlife Research to exercise an open competition among proposals based on scientific quality and relevance.

The previous evaluation by Boyce et al. (2001) provided several recommendations for changes in the organization of Swedish Wildlife Research (see section 5). The Evaluation Panel found that the recommendations from that evaluation were largely included in the strategies for wildlife research in Sweden and implemented in the development of the research framework programmes (Box 1, 2) in both of the programme periods included in the current evaluation. For example, encouragement of inter-disciplinarity was clearly stated in the research calls, resulting in a widening of the scientific focus in Swedish wildlife research. The establishment of the targeted research programme "Adaptive Management of Wildlife and Fish" represented a clear strategic action to provide a foundation for stronger inter-disciplinarity. The Evaluation Panel considers this programme instrumental to the recent development of wildlife research as a scientific discipline that currently in Sweden extends far beyond biology.

The previous evaluation (Boyce et al. 2001) suggested that an increased focus should be devoted to include more mathematical models in Swedish wildlife research, especially when it comes to sustainable harvesting strategies. This could provide the foundation for development of more general principles across species and ecosystems for achieving sustainable harvesting. However, with a few exceptions, there have been few quantitative projects funded in both programme periods reviewed by the current Evaluation Panel. We reiterate the potential value of improving this direction.

Another suggestion from the previous review of the Swedish wildlife research was to ensure funding regimes that allow for a long-term perspective on the research questions addressed. The continuity of several large research projects throughout both programme periods (especially in large carnivore research) demonstrates that it is possible to maintain long-term time series in Sweden, which has enabled Swedish wildlife researchers to address fundamental problems that hardly can be examined in many other parts of the world.

The previous evaluation recommended strategies for developing research careers especially for younger wildlife scientists. This materialized into concrete actions only to a small degree. There seems to be (with some notable exceptions, e.g., Kristianstad University) a lack of institutional commitment to provide internal support to research projects funded by SEPA's Scientific Committee for Wildlife Research. As a consequence, a large proportion of Swedish wildlife research is conducted by graduate students and senior researchers, the latter whom are approaching, retirement, in some cases soon. This may result in a lack of the necessary high-level scientific competence for management and development of several of the most highly productive and relevant projects in Swedish wildlife research.

8 Recommendations

The Evaluation Panel suggests the following actions to further improve the scientific quality and societal impact of wildlife research in Sweden:

Establish a new integrated research programme

The impact of the programme "Adaptive Management of Wildlife and Fish" should strongly encourage SEPA to launch a specific research programme that focuses on the use of adaptive management to aid in decision-making *for sustainable management of wildlife in changing ecosystems*. This programme should reinforce the foundation of natural and social science-based decision making in wildlife management (Artelle et al. 2018), by directly engaging researchers in the realm of socio-economic and other humanities-related fields and with affected stakeholders. This will necessarily result in a programme that will encourage inter-disciplinarity and a strong commitment to long-term monitoring as part-and-parcel of the required integration of research with management to evaluate policy. Such a programme could be funded by SEPA but should also involve additional funding sources. The launch of such a programme also will address a structural problem in Swedish wildlife research that there are surprisingly few interactions between projects that scientifically, and also often logistically, could benefit from more extensive collaboration. An ecosystem perspective on both management and scientific questions will by necessity require such strengthened interactions and it is therefore important that funding bodies such as SEPA introduce structures that enhance such collaboration. This programme also could offer an excellent opportunity for a rigorous foundation for an integrated theoretical approach for analyses of wildlife management in an ecosystem setting.

Establish a monitoring programme of selected wildlife species in Sweden

The Evaluation Panel re-iterates the proposal from the previous evaluation (Boyce et al. 2001) that there is a need to establish a monitoring programme or improve the integration with existing ones to organize and maintain the unique time-series which have been established by research projects funded by SEPA's Scientific Committee for Wildlife Research. Some of these time series are unique in an international setting and represent an important asset for Sweden to develop science-based management principles for several species of significant public interest. International collaboration (e.g. with Norway) should be implemented to improve the applicability of these time series. Maintenance of these time series should not be dependant only on the success of individual projects in obtaining funding. The Evaluation Panel regrets that some scientifically unique and important for management time series have been terminated without any cost-benefit analyses. Several of the studies included in such a goal-orientated programme (Yoccoz et al. 2001) involve highly controversial species such as large carnivores. Thus, such a monitoring programme can form the basis for developing stake-

holder-engaged structured decision making in the management of Swedish wildlife (Gregory et al. 2012), that involves establishing structures that facilitate co-production of knowledge through collaborative learning between scientists and users. The experience gathered through the targeted research programme "Adaptive Management of Wildlife and Fish" can provide the foundation for establishing such a programme in Sweden.

Facilitate recruitment of early-career scientists into wildlife research

One important challenge especially for wildlife biological research in Sweden will be to secure recruitment of senior scientists. Several leading researchers in this field are close to retirement or have already retired. The Evaluation Panel suggests that *a proportion of the projects funded by SEPA's Scientific Committee for Wildlife Research can only be allocated to project leaders who are between 3 and 8 years after their graduation date* to facilitate recruitment of internationally leading scientists into wildlife research.

Another reason for poor recruitment of more senior researchers to wildlife research in Sweden is that a large proportion of the research activity is funded by projects, often with poor institutional support. The Evaluation Panel suggests that the degree of institutional funding should be included by SEPA's Scientific Committee for Wildlife Research as a separate criterion for the evaluation of project proposals.

Enhance EU-funding of Swedish wildlife research

Several Swedish wildlife research projects have extensive research collaboration with researchers in several European countries. Still, EU-funding is almost totally absent. The Evaluation Panel suggests that SEPA introduce ad hoc-funding of small projects to establish international consortia to develop projects aimed for EU-funding. Furthermore, SEPA should consider supplemental funding of successful proposals, e.g. by providing support for additional PhD-students.

Extend the use of modelling in Swedish wildlife research

In the previous evaluation of Swedish wildlife research Boyce et al. (2001) proposed an increased focus on application of theoretical models. This recommendation has been followed up during the subsequent two programme periods only to a limited degree. The Evaluation Committee will therefore reiterate that specific actions should be implemented to include research groups applying theoretical models and advanced quantitative methods into Swedish wildlife research. This competence is necessary for predicting the long-term consequences of management decisions during a time when the environmental conditions are expected to change e.g. due to climate change.

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10 Appendix 1: Biographies of members of the Evaluation Panel

Bernt-Erik Sæther is Professor in Population Ecology at the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. Since 2013 he has been the Director of the Centre for Biodiversity Dynamics, which is a Centre of Excellence funded by the Research Council of Norway for a period of 10 years. Sæther's research profile is located in the interface between ecology and evolution with a focus on application of stochastic models in analysis of dynamics at the genetic, population and community level. The main focus of his research in wildlife biology is related to population ecology of ungulates and population viability analyses. Sæther has published more than 260 papers, 6 book-chapters and co-authored 1 book (Stochastic Population Dynamics in Ecology and Evolution).

Mark S. Boyce is Professor of Ecology and Alberta Conservation Association Chair in Fisheries and Wildlife in the Department of Biological Sciences at the University of Alberta. Boyce's research attempts to link ecological theory with wildlife management and conservation. His early work focused on demography and life history evolution whereas during the past 20 years the primary focus has been the connection between wildlife habitats and population biology. He has developed and has applied methods for resource selection functions and most recently methods for linking movement ecology with habitat selection. Most of his research has been on field studies of large mammals but also other vertebrates. Boyce is a Certified Wildlife Biologist and a Fellow of the Royal Society of Canada.

Grete K. Hovelsrud is Professor in Environmental Sociology, Nord University, Bodø, Norway. She is an arctic anthropologist focusing on interdisciplinary studies of adaptation to changing climatic and societal conditions, adaptive capacity of coupled social-ecological systems, and on the transformation to a low-emission society in the context of climatic and societal change. Hovelsrud has a particular interest in perceptions of risk, cultural theory of risk, co-production of knowledge and adaptive co-management of natural resources with respect to changing climatic, environmental and societal conditions. Hovelsrud has 6 years of experience in managing wildlife through her position as General Secretary of the North Atlantic Marine Mammal Commission. Hovelsrud has led numerous major long-term research projects and published extensively in scientific peer reviewed journals and books, and popular science. She is the upcoming president of the Norwegian Scientific Academy for Polar Research.

Thomas Lundhede is Associate Professor of Environmental Economics at University of Copenhagen, Denmark. His research has focused on the economics of ecosystem services, which includes valuation of non-marketed

environmental goods such as wildlife, game and biodiversity. He also works with the economics of applied forest and nature management and economic incentive instruments for conserving biodiversity in forests. Using stated and revealed preference methods he is interested in understanding how the underlying factors affect peoples' preferences for environmental goods.

Juha Merilä is Professor in Population Biology and Genetics at the University of Helsinki, Finland. His research interests reside in the interface of ecology and genetics, and in evolutionary biology in particular. The main foci in his research has been in animal adaptation to new and changing environmental conditions, as well as in understanding factors explaining phenotypic and genetic divergence among populations. He has worked mostly on vertebrate models, birds, amphibians and fish in particular. He has published more than 400 peer-reviewed papers.

Thomas D. Nudds is an Emeritus Professor of Ecology at the University of Guelph in Ontario, Canada. His broad research program encompassed the pure and applied ecology of waterfowl, from individual behaviour to community interactions; biogeography and the design of protected area networks; and applications of decision analysis and adaptive management to wildlife disease ecology, species translocations, and sustainable commercial fisheries. He currently advises collaborative multistakeholder-government projects to better resolve scientific uncertainties that threaten to thwart conservation efforts.

11 Appendix 2: Projects 2003–2014 included in the evaluation

Principal investigator	Research strategy period	Project title
Ulrika Alm-Bergvall	2009–2014	Female behaviour and habitat exploitation influencing population growth?
Ulrika Alm-Bergvall	2009–2014	Effects of capture and handling on behavioural and physical parameters.
Ulrika Alm-Bergvall	2009–2014	Effects of capture and handling on blood values and behaviour in roe deer.
Henrik Andrén	2003–2008	Lynx population dynamics in time and space within the reindeer husbandry area.
Henrik Andrén	2009–2014	Lynx population dynamics and interaction with competitors and prey.
Henrik Andrén	2003–2008	Interactions between lynx and roe deer.
Henrik Andrén	2003–2008	Colonization of southern Sweden by lynx – conditions and problems.
Jon Arnemo	2003–2008	Physiological effects of capture and anaesthesia in brown bear and wolf.
Roger Bergström	2003–2008	Wildlife and wildlife habitat in Sweden – a new tool and knowledge base.
Åsa Boholm	2003–2008	Threat or threatened? Controversies about wolf propagation and containment.
Emil Broman	2003–2008	Validation of coverage ratio as a measurement of available moose forage.
Guillaume Chapron	2009–2014	Planning for sustainable management of large carnivores.
Guillaume Chapron	2009–2014	Making decisions under uncertainty in management of large carnivores.
Fredrik Dahl	2009–2014	New knowledge from raccoon dog management data.
Fredrik Dahl	2009–2014	The Swedish raccoon dog research project.
Anne-Marie Dalin	2009–2014	Health and survival of moose calves on Öland.
Anne-Marie Dalin	2009–2014	Reproductive patterns and potential among Swedish wild boar.
Anne-Marie Dalin	2009–2014	Moose reproduction in Sweden – basic physiology, behaviour and impact of disease.
Lars Edenius	2003–2008	Wildlife and browsing damages.
Marcus Ednarsson	2003–2008	Management of large carnivores as a resource for tourism.
Johan Elmberg	2003–2008, 2009–2014	Adaptive management of European ducks for hunting, conservation & disease.
Johan Elmberg	2009–2014	Local incentives and international obligations: adaptive goose management.
Johan Elmberg	2003–2008	Sustainable harvesting and effective management of ducks: experimental studies of density dependent population processes.
Johan Elmberg	2003–2008	Population regulation of ducks in a national and international perspective: experimental studies as a basis for management.
Johan Elmberg	2009–2014	Large-scale introductions of native species: mallard as a predictive model system.

Principal investigator	Research strategy period	Project title
Katarina Elofsson	2009–2014	Alternative regimes for joint management of large herbivores.
Göran Ericsson	2009–2014	Why do some moose (Alces alces) populations do better than the others?
Göran Ericsson	2003–2008	Moose habitat selection, dispersal and movement under static and dynamic disturbance.
Göran Ericsson	2003–2008	Ungulates and browsing – a population model for deciduous trees.
Göran Ericsson	2003–2008	Variable moose reproduction, survival and condition: Climate, competition or?
Åsa Fahlman	2009–2014	Wildlife capture: Evaluation of health and welfare by physiological measures.
Annika Felton	2009–2014	Understanding nutritional drivers of moose health and impacts in the landscape.
Pär Forslund	2003–2008	Harvesting wildlife populations – strategies, extinction risks and uncertain population estimates.
Pär Forslund	2003–2008	Modelling the future of the Scandinavian wolf population.
Jens Frank	2009–2014	Wolf movements around fences, livestock, and humans with dogs.
Dolores Gavier-Widen	2009–2014	Disease awareness in the management of wildlife species – the tularemia example.
Ing-Marie Gren	2009–2014	Economics of wild boar management in Sweden.
Lars Hallgren	2003–2008	Democracy and knowledge efficiency in wildlife management – Communicative and social aspects.
Karin Hårding	2009–2014	How do hunting, spatial structure and food limitation affect the harbour seals?
Jacob Höglund	2003–2009	Hunting, genetic variation and population structure of willow ptarmigan.
Maria Hörnell-Willebrand	2003–2008	The capercaillie in Sweden.
Maria Hörnell-Willebrand	2009–2014	Management of grouse – theory, practice and implementation.
Maria Hörnell-Willebrand	2003–2008	Correlation between willow ptarmigan and gyrfalcon.
Maria Hörnell-Willebrand	2009–2014	Modelling moose populations .
Maria Hörnell-Willebrand	2009–2014	Effect of harvesting willow ptarmigan on gyrfalcon populations.
Maria Hörnell-Willebrand	2009–2014	Secondary effects of supplement feeding of wild bore on other species.
Maria Hörnell-Willebrand	2009–2014	Investigating the need for a more adapted management system for Rock Ptarmigan.
Maria Hörnell-Willebrand	2009–2014	Evaluating a new, low cost aerial survey method for moose (Alces alces).
Magdalena Jacobson	2009–2014	Wild boar – can good management secure the food safety at hunting and slaughter?
Gunnar Jansson	2009–2014	Monitoring technique and population prognosis of wild boar.
Gunnar Jansson	2009–2014	Man and wild boar – management tools for Swedish populations.
Anders Jarnemo	2009–2014	Bark-stripping by red deer: a question of forage, landscape structure or density.

Principal investigator	Research strategy period	Project title
Anders Jarnemo	2009–2014	Impact of landscape structure on red deer home range size and habitat choice.
Maria Johansson	2009–2014	Fears of large carnivores among the public.
Maria Johansson	2003–2008	Fear, a factor to count with in the management of large carnivores.
Annica Jägerbrand	2009–2014	Understanding human and wildlife behaviour in traffic and accident reduction.
Petter Kjellander	2003–2008, 2009–2014	Interspecific competition between large herbivores: the fallow deer – roe deer case.
Petter Kjellander	2009–2014	The interplay between ticks, tick-borne diseases and wildlife in Sweden.
Linda Laikre	2009–2014	Managing metapopulations for long term survival of Fennoscandic carnivores.
Henrik Lange	2009–2014	Is the rock ptarmigan really declining?
Kjell Larsson	2009–2014	Population dynamics of the long-tailed duck.
Nils-Gustav Lundgren	2003–2008	Legitimacy of Swedish hunting politics.
Simon Matti /Carina Lundmark	2009–2014	Legitimate institutions for carnivore management.
Johan Månsson	2009–2014	Local culling – behavioral and numerical response of large grazing birds.
Wiebke Neumann	2009–2014	Predicting the spatiotemporal distribution of wildlife-human interactions.
Jonas Nordström	2009–2014	Effects of wild boar supplemental feeding on behaviour in red fox.
Görel Nyman	2003–2008	Physiological effects of immobilization in wildlife.
Inga-Lill Persson/ Kjell Danell	2003–2008, 2009–2014	Impact of Cervids on Biodiversity, Ecosystem Processes and Wildlife.
Jens Persson	2009–2014	Ecology of wolverine and lynx in the reindeer husbandry area.
Jens Persson	2009–2014	Ecology of wolverines in forested landscape.
Jens Persson	2003–2008	The Swedish Wolverine Project – ecology and conservation.
Martin Peterson	2003–2008	Ethical aspects of hunting.
Håkan Sand	2009–2014	Demography, genetics and ecosystem effects of Scandinavian wolf (Skandulv).
Håkan Sand	2003–2008	New technique for wildlife research.
Håkan Sand	2003–2008	Population ecology, conservation and management of the Scandinavian wolf population (Skandulv).
Håkan Sand	2009–2014	Vitality, predator-prey dynamics, ecosystem effects of Scandinavian wolf (Skandulv).
Camilla Sandström	2003–2008	Participation as a goal or as an instrument? A comparative analysis of management of large carnivores in Finland, Norway and Sweden.
Camilla Sandström	2009–2014	Understanding drivers of wildlife value orientation.
Navinder Singh	2009–2014	Making Right decisions at right scales: A Spatial approach to Moose management.
Annelie Sjölander-Lindqvist	2009–2014	Innovative Management Strategies: Integrating National Predator Policy Locally.
Jon Swenson	2009–2014	Nuisance large carnivores.
Jon Swenson	2003–2008, 2009–2014	The Scandinavian Brown Bear Research Project.

Principal investigator	Research strategy period	Project title
Carl-Johan Svensson	2009–2014	Extinction risk of Baltic grey – and ringed seal enhanced by global warming?
Carl-Johan Svensson	2003–2008	Hunting of seals; effects of variability, density dependence and structure.
Tomas Willebrand	2003–2008	Grouse hunters functional response and the use of hunting statistics in management.
Tomas Willebrand	2009–2014	Red fox – Here, there and everywhere.
Mattie Åhlund	2003–2008	Management systems for common eider and other coastal birds on the Swedish west coast.
Henrik Andrén	2004–2009	Research program Adaptive management of wildlife and fish: Project Monitoring: Wildlife monitoring in the forest ecosystem.
Roger Bergström	2004–2009	Research program Adaptive management of wildlife and fish: Project Impact: Management of wildlife impact in forest ecosystems.
Lars Carlsson	2004–2009	Research program Adaptive management of wildlife and fish: Project Prerequisites: Prerequisites for adaptive management of fish and wildlife.
Göran Ericsson	2004–2009	Research program Adaptive management of wildlife and fish: Project Harvest: Spatial requirements for management of wildlife in forest ecosystems – foundations for adaptive management of harvest.
Bengt Kriström	2004–2009	Research program Adaptive management of wildlife and fish: Project Values § welfare. Benefits and costs of fish and game resources: welfare foundations for efficient management.
Per Lundberg	2004–2009	Research program Adaptive management of wildlife and fish: Project Modelling: Fish and wildlife management under uncertainty.
Gabriel Michanek	2004–2009	Research program Adaptive management of wildlife and fish: Project Law: Legal limits and adaptive management in relation to the use of natural resources.

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This report presents the international evaluation of the Swedish wildlife research during 2003–2014 funded by the Wildlife Management Fund through the Swedish Environmental Protection Agency. The review and evaluation was commissioned by the Swedish Environmental Protection Agency and carried out by a scientific, multidisciplinary panel of experts. The report presents their assessments, conclusions and recommendations.

Rapporten är skriven på engelska och har svensk sammanfattning. Den redovisar den internationella utvärderingen av viltforskningen 2003–2014 som finansierats av Viltvårdsfonden genom Naturvårdsverket.

Utvärderingen organiserades av Naturvårdsverket och utfördes av en mångvetenskaplig expertpanel vars arbete, omdömen och rekommendationer presenteras här.

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