COUNTRY REPORTS

THE STATE OF **NORWAY'S** BIODIVERSITY FOR FOOD AND AGRICULTURE

NIBIO
NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

NORWEGIAN GENETIC RESOURCE CENTRE
genressurser.no

NIBIO RAPPORT | NIBIO REPORT VOL.: 2, NO.: 57, 2016

THE STATE OF BIODIVERSITY FOR FOOD AND AGRICULTURE IN NORWAY

KIM-ANH TEMPELMAN MEZZERA AND NINA SÆTHER
Norwegian Genetic Resource Centre, NIBIO

TITTEL/TITLE

THE STATE OF BIODIVERSITY FOR FOOD AND AGRICULTURE IN NORWAY

FORFATTER(E)/AUTHOR(S)

KIM-ANH TEMPELMAN MEZZERA AND NINA SÆTHER

DATO/DATE:	RAPPORT NR./ REPORT NO.:	TILGJENGELIGHET/AVAILABILITY:	PROSJEKT NR./PROJECT NO.:	SAKSNR./ARCHIVE NO.:
12.04.2016	2/57/2016	Open	792003	2016/621

ISBN-NR./ISBN-NO:	ISSN-NR./ISSN-NO:	ANTALL SIDER/ NO. OF PAGES:	ANTALL VEDLEGG/ NO. OF APPENDICES:
978-82-17-01626-7 (print)	2464-1162 (print)	159	4

OPPDRAGSGIVER/EMPLOYER:	KONTAKTPERSON/CONTACT PERSON:

STIKKORD/KEYWORDS:	FAGOMRÅDE/FIELD OF WORK:
Assosiert biologisk mangfold økosystemtjenester, vill mat dyr, planter og mikroorganismer	Biomangfold
Associated biodiversity, ecosystem services and wild foods Food and agriculture, animals, plants and micro-organisms	Biodiversity

SAMMENDRAG/SUMMARY:

The report is based on information Norway provided in an electronic questionnaire that was prepared by FAO to collect national data as a contribution to *The State of the World's Biodiversity for Food and Agriculture*. The report presents information on the status and trends of biodiversity for food and agriculture, including animals, plants and micro-organisms with a direct or indirect role in agriculture, forestry and/or fisheries. A lot of data on these issues is available in Norway; however it is mostly spread across different monitoring systems and fragmented. The report draws attention to the use and conservation of biodiversity for food and agriculture and to the function(s) of and interactions between its components in production systems. The report focuses more on associated biodiversity, ecosystem services and wild foods than on plant, animal and forest genetic resources as these are presented in other reports. Even if the awareness on the importance of associated biodiversity to food production and food

security is increasing, safeguarding associated biodiversity in and around production systems needs to move higher up on the political agenda. This will require awareness raising activities targeting decision-makers, farmers and consumers. The preparation of the national biodiversity action plan provides an excellent opportunity for stakeholders from different sectors to agree on and be jointly committed to the conservation and sustainable use of biodiversity in Norway.

Rapporten er basert på det elektroniske spørreskjemaet som ble utarbeidet av FAO for å samle nasjonale data til Den globale statusrapporten for biologiske mangfold for mat og landbruk. Rapporten presenterer status og trender for dyr, planter og mikroorganismer med en direkte eller indirekte funksjon i jordbruk, skogbruk og / eller fiske. Det er mye informasjon tilgjengelig om dette i Norge, men informasjonen er spredt og dermed fragmentert. Rapporten retter oppmerksomheten mot bruk og vern av biologisk mangfold for mat og landbruk og til funksjonen (e) og interaksjonene mellom disse komponentene i jordbrukets produksjonssystemer. Rapporten fokuserer mer på assosiert biologisk mangfold, økosystemtjenester og vill mat enn plante-, husdyr- og skogtregenetiske ressurser da disse er presentert i de respektive nasjonale statusrapportene. Selv om bevisstheten om betydningen av assosiert biologisk mangfold i matproduksjonen og matvaresikkerhet er økende må sikring av assosiert biologisk mangfold i og rundt produksjonssystemer komme høyere opp på den politiske dagsorden. Dette vil kreve utvikling av holdningsskapende aktiviteter rettet mot beslutningstakere, bønder og forbrukere. Utarbeidelse av Norges handlingsplan for biologisk mangfold gir en utmerket mulighet for aktører fra ulike sektorer til å bli enige om, og i fellesskap forplikte seg til, bevaring og bærekraftig bruk av biologisk mangfold i Norge.

LAND/COUNTRY:	Norge/Norway
FYLKE/COUNTY:	–
KOMMUNE/MUNICIPALITY:	–
STED/LOKALITET:	–

GODKJENT /APPROVED	**PROSJEKTLEDER /PROJECT LEADER**
Geir Harald Strand	Kim-Anh Tempelman Mezzera
NAVN/NAME	**NAVN/NAME**

CONTENT

1 ACKNOWLEDGEMENT

We would like to thank the following participants and institutions for their kind and invaluable support and contributions in the preparation of Norway's country report on biodiversity for food and agriculture.

- Thanks to the Reference group composed of Aina Bartmann, Wenche E. Dramstad, Erik Framstad, Erik Joner, Per Christian Rålm and Eirik Selmer-Olsen for their guidance during the preparation of the country report and fruitful discussions.

- Thanks to the Ministries of agriculture and food (LMD), climate and environment (KLD) and trade, industry and fisheries (NFD), as well as the Sámi Parliament of Norway (Samediggi) and the Norwegian Environment Agency for their continuous feedback. With a special thanks to Elisabeth Koren, Grethe Helene Evjen, Beate Løken, Morten Floor, Gaute Voigt-Hanssen, Alessandro AndresTøvik Astroza, Jon Petter Gintal, Gunn Paulsen, Egil Roll and Dordi Mogstad.

- Thanks for the valuable sectoral inputs provided by the Norwegian Genetic Resource Centre, the Norwegian Forest and Landscape Institute, the national committees on animal, plant and forest genetic resources and the Svalbard Global Seed Vault. With special thanks to Åsmund Asdal, Kjersti Bakkebø Fjellstad, Anna Caroline Rehnberg, Morten Rasmussen, Tore Skrøppa, Stein Tomter, Svein Olav Krøgli, Grete Stokstad, Barbi Nilsen, Astrid Bjørnerød and Ola T. Westengen.

- For the analysis of the status and trends of associated biodiversity and wild foods we would like to thank the Norwegian Biodiversity Information Centre, with special thanks to Arild Lindgaard and Lisbeth Gederaas, as well as Bjørn Dahle from the Norwegian Beekeepers Association (Norges Birøkterlag) and Per Harald Salvesen from University Museum Bergen/Arboretum and Botanical Garden, Milde.

- Thanks to the scientists from Bioforsk and VitalAnalyse for their significant inputs on the use of diversity promoting practices in agriculture. With special thanks to Nina Trandem and Berit Swensen.

2 FOREWORD

Biodiversity underpins food security, ecosystem resilience, coping strategies for climate change, adequate nutritional requirements and the management of biological processes needed for sustainable agricultural production.

To achieve sustainable food production and ensure environmental sustainability, agricultural, forest and marine production systems need to focus more on the effective conservation and utilization of biodiversity and ecosystem services. This requires a comprehensive understanding and enhanced use of the role of biodiversity, genetic resources and their ecosystem functions.

In this context, the Food and Agriculture Organization of the United Nations (FAO) initiated the preparation of the first ever global report on the state of the world's biodiversity for food and agriculture in 2007, which should be ready by early 2017. This report will primarily be built on country based information and it will draw on thematic studies and on reports from international organizations.

In 2014, as a contribution to The State of the World's Biodiversity for Food and Agriculture, Norway filled in the electronic questionnaire that was prepared by FAO to collect national data. The questionnaire provided a useful framework to structurally bring together relevant information on the status and trends, as well as on the conservation and use of animals, plants and micro-organisms in Norwegian agriculture, forestry and fisheries.

The present document proposes a "reader-friendly" version of the FAO questionnaire. It includes distilled information from the questionnaire, highlights matters that are of specific relevance to Norway and addresses a number of highly relevant issues in more depth. This report aims to inform decision-makers on the national status and trends of biodiversity for food and agriculture, to reflect on policy development that could strengthen the conservation and use of biodiversity for food and agriculture and to raise awareness on existing knowledge and capacity gaps.

3 EXECUTIVE SUMMARY

In 2007, the Food and Agriculture Organization of the United Nations (FAO) initiated the preparation of the first ever global report on the state of the world's biodiversity for food and agriculture following a country-driven approach. The report should be ready in 2017.

As a contribution to *The State of the World's Biodiversity for Food and Agriculture*, Norway prepared a country report presenting information on the status and trends of animals, plants and micro-organisms with a direct or indirect role in agriculture, forestry and/or fisheries. The country report also draws attention to the use and conservation of biodiversity for food and agriculture and to the function(s) of and interactions between its components in food production systems. In areas for which little or no empirical evidence was found the report's findings are preliminary and incomplete.

3.1 Status, trends and drivers of change

Animal, plant and forest genetic resources

The status, trends and pressures with regard to Norway's animal, plant and forest genetic resources are well documented. Most of the trends that are described in this report have been assessed over a period of ten years. Norway's commercial agricultural and forest production are based on a small number of mostly local species, varieties and breeds. The largely Norwegian-run breeding companies are known for the sustainable management of genetic variation within livestock breeds and forest tree species. With respect to plant breeding programmes there is extensive cooperation between the Nordic plant breeding companies. Even so, the number of programmes has declined over the last decades, whereby the remaining programmes focus on the more commercial varieties. More detailed information on animal, plant and forest genetic resources is presented in Norway's sectoral country reports on plant, animal and forest genetic resources.

3.1.1 Associated biodiversity

The Norwegian Biodiversity Information Centre (Artsdatabanken) plays a crucial role in the assessment of the status and trends of and pressures on different species of associated biodiversity in the agricultural landscape, forests and marine environments. Since 2005, Artsdatabanken has worked on a series of periodically revised assessments that provide important tools for decision makers, such as the Norwegian Red List of Species, the Red List for Ecosystems and Habitat types, and the risk assessment on alien and invasive species in Norway. The latter includes a "black list" of alien species that (could) pose a threat to biodiversity, including to biodiversity for food and agriculture.

Artsdatabanken's work has significantly contributed to increase the knowledge of the many "inhabitants" in the different ecosystems and habitats across Norway, including those of relevance to food and forestry production. In 2010, Artsdatabanken estimated that approximately 20% of the red-listed species occur in cultivated landscapes.

Artsdatabanken, *inter alia*, documented that changing livestock keeping practices over the past decades, involving less outfield grazing, have led to the disappearance of many open landscape dependent grass and wild plant varieties, as well as of other associated biodiversity species.

With respect to forest-related biodiversity, while half of the threatened and near threatened red-listed species in Norway occur in forests, the Norwegian Red Lists for Species indicate that the status of these species has not deteriorated between 2006 and 2010.

As to the state of vertebrates in capture fisheries, several sea birds show a severe negative trend, whereas most fish species seem in good or even excellent state.

Regarding micro-organisms, still little is known on how their status has evolved in the different production systems over the past ten years.

3.1.2 Ecosystem services

The importance and value of ecosystem services with respect to food and forestry production is widely acknowledged among the relevant stakeholder groups, as is the need to monitor their status and trends. To date, however, hardly any of the regulating or supporting ecosystem services (e.g. pollination, soil formation, etc.) essential to the country's production systems have systematically been studied or monitored. Neither have there been any regular assessments of species in relation to their functions in relevant ecosystem processes. In the opinion of an expert commission that reported on the value of ecosystem services in Norway, the state of ecosystems in the country is relatively good, despite the commission's findings that the country's biological diversity and ecosystems are under a series of pressures (e.g. land use change, climate change, ocean acidification and invasive species) (NOU 2013:10).

3.1.3 Wild foods

Extensive data is available on the status and trends of wild food species. Many wild food species are monitored on a regular basis, such as, for example, wild cervids (i.e. the Norwegian Institute for Nature Research runs a National monitoring programme for wild cervids) and marine fish (i.e. the Institute of Marine Research manages data on Norway's marine environment and fish). Generally speaking, the status of the country's wild food species has remained relatively stable over the past years and there is no evidence of a significant threat of extinction or loss of any important wild food species.

3.2 State of use

The use of biodiversity for food and agriculture varies among sectors and production systems. In the forestry and marine fishery sectors, where the application of an ecosystem approach is general practice, more components of biodiversity for food and agriculture tend to be actively used and managed (by definition, ecosystem approaches aim to manage the ecosystem, based on the multiple functions that ecosystems perform and the multiple uses that are made of these functions).

In agriculture, several management and diversity based practices[1] favor the integrated use of the different biodiversity components, such as for example organic farming (more than 5% of Norway's total arable land is organically farmed) and integrated pest management (an estimated 30% of Norwegian growers followed the IPM principles in 2008).

Overall, the diversity of animal breeds, plant varieties and aquatic and forest tree species is valued and used quite optimally. Between 1970 and 2005, the country's self-sufficiency rate in food (excluding fish) remained stable at around 50% (based on dietary energy intake). During that period, Norway was, *inter alia*, 100% self-sufficient in milk and dairy products derived from milk produced by Norwegian Red dairy cattle, and 80% in potatoes, using locally developed potato varieties (Norwegian Agricultural Economics Research Institute 2007). However, old traditional plant varieties and endangered native livestock breeds are still underutilized, even if they have the potential to contribute both to Norway's food production and to the delivery of ecosystem services that are of key importance to the country's agricultural sector (e.g. management of low alpine cultural landscapes through outfield grazing).

The active management of components of associated biodiversity for food and agriculture is still very limited in Norwegian production systems. However, in commercial fruit growing, some growers are known to either buy or rent bee hives to ensure maximum pollination of their berries.

Wild food species that are hunted, fished, harvested or picked, including wild animals, such as different types of deer, birds and fish and a broad variety of berries, edible fungi and wild fruit trees, are usually of marginal importance to the population's food supply and nutrition. However, this being said, both the non-herding and reindeer-herding Sámi, especially those who speak a Sámi language, tend to retain a traditional life style, still using wild foods like for example fresh water fish and wild berries in their daily diet (Nilsson et al., 2011).

3.3 State of interventions on conservation and use

With the 2009 Nature Diversity Act, Norway has entered into a new era of biodiversity management. This Act aims to protect biological diversity and ecological processes through their conservation and sustainable use across all sectors. It also includes provisions on alien species and on access to (most) terrestrial components of biodiversity, including genetic resources for food and agriculture.

Norway has many national policies, programmes and enabling frameworks that support or influence the conservation and sustainable use of biodiversity for food and agriculture, one of the most effective being the Regional Environment Programme (RMP). The RMP's priorities, like for example on the species and habitats to conserve, are set by the Agricultural Agreement (Jordbruksavtalen), while the decisions on the work programme are taken at county level. The RMP has particularly been successful with respect to the conservation of biodiverse meadows and grassland and to maintain associated biodiversity species, such as for example salamanders.

[1] Management and diversity based practices that are believed to support the use and conservation of biodiversity for food and agriculture are respectively described in Annex 5 and 6 of the FAO questionnaire (see:

The wide adoption of ecosystem approaches in forestry and fisheries promotes sustainable production, thereby also taking into account the environmental conditions. Tools such as the Forest Certification Scheme (PEFC), whereby forest properties and forest products can be awarded with a sustainable forest management certification, significantly contribute to the conservation and sustainable use of biodiversity for food and agriculture.

A large number of Norwegian organizations, institutes, associations, private companies and other groups are involved in the country's efforts to conserve biodiversity for food and agriculture on-farm and through *in situ* and *ex situ* conservation activities. Some of these actors collaborate on activities of mutual interest by: i) sharing information from their respective recording and monitoring systems on the status and distribution of species, breeds and varieties; ii) undertaking promotion and awareness raising initiatives; and iii) engaging into joint research projects.

Artsdatabanken's Species Map Service, for example, retrieves most information from the Species Observation System, a database that contains digital information from more than 30 Norwegian and foreign data providers working in different sectors on the presence of species in Norway. Data providers include the Norwegian Institute of Bioeconomy Research (NIBIO),[2] the Institute of Marine Research, the Norwegian Association of Fungi and Useful Plants, the Norwegian entomological society, the Norwegian Institute for Nature Research (NINA) and the Norwegian Institute for Water Research (NIVA).

Norway's educational system also puts a lot of attention on the conservation, and to a lesser extent on the sustainable use, of associated biodiversity, ranging from school projects focusing on the role of earthworms to higher education programmes on microbiology, sustainable breeding of animal and forest genetic resources and on the importance of the diversity of marine organisms in fisheries.

Finally, Norway is involved in the implementation of numerous regional and international initiatives targeting the conservation and sustainable use of biodiversity for food and agriculture. Many of these initiatives also undertake activities relevant to components of associated biodiversity. Among others, Norway is a Member country of the FAO Commission on Genetic Resources for Food and Agriculture, of the International Treaty on Plant Genetic Resources for Food and Agriculture and of the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES); and a contracting party both to the Convention on Biological Diversity and the OSPAR Convention.

3.4 Future agenda's

3.4.1 Norway's national biodiversity action plan

The Government is currently in the process of drawing up an action plan to halt the loss of biodiversity and to implement relevant national environmental goals and targets, including those

[2] NIBIO is Norway's largest natural resources research institute. It was established in July 2015 following the merger of Bioforsk, the Norwegian Forest and Landscape Institute and the Norwegian Agricultural Economics Research Institute.

that are of relevance to agriculture, forestry and fisheries. Most of these goals and targets are linked to the Aichi biodiversity targets. The preparation of Norway´s national biodiversity action plan provides an excellent opportunity for stakeholders from different sectors to agree on and be jointly committed to the conservation and sustainable use of biodiversity in Norway.

3.4.2 Increasing production and consumption of organic food

The Norwegian government is committed to increase the production and consumption of organic food to 15% by 2020 (White paper Nr.9 (2011-2012)). To reach this target, incentives, including in the form of subsidies will continue to be allocated to enhance both the number of organic farmers and the area under organic cultivation.

3.4.3 Bringing national laws and regulations in line with international commitments

On 1 October 2013, Norway ratified the Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization to the Convention on Biological Diversity, which entered into force on 12 October 2014. Work to bring national legislation relevant to access and benefit-sharing of genetic resources, as laid out in the Nature Diversity Act, in line with the Nagoya Protocol is expected to be finalized in 2015.

Overall, efforts to raise public awareness on the importance of biodiversity for food and agriculture to food security and nutrition will be continued.

4 SCOPE OF THE REPORT

Following FAO's *Guidelines for the preparation of the country reports for The State of the World's Biodiversity for Food and Agriculture*, the scope of this report includes all components of biodiversity for food and agriculture.

Biodiversity is defined by the Convention on Biological Diversity as the diversity of life in all its forms, including the diversity of species, of genetic variations within one species, and of ecosystems. This definition includes biodiversity for food and agriculture, which is being referred to by FAO as the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the structures, functions and processes in and around production systems (whereby production systems include the livestock, crop, fisheries and aquaculture and forest sectors) and that provide food and non-food agriculture products.

Within biodiversity for food and agriculture, a distinction is made between the mostly domesticated species, such as livestock, crops, fish and trees that contribute directly to the delivery of provisioning[3] ecosystem services,[4] and species that are associated with regulating[5] and or supporting[6] ecosystem services within production systems. Species that are involved in the delivery of the latter two ecosystem services are referred to by FAO as associated biodiversity.

With regards to the conservation of biodiversity, it is important to be aware of the debate regarding the value of biodiversity and the need to protect it. As clearly described by the McGill University,[7] there are two main arguments for conserving biodiversity:

- Biodiversity has an intrinsic value that is worth protecting regardless of its value to human well-being. This argument focuses on the conservation of all species, including those that are ecologically equivalent; and
- Biodiversity performs a number of ecological services for humankind that have economic, esthetic or recreational value. This argument focuses on conserving ecologically nonequivalent species.

[3] Ecosystem services are the benefits people obtain from ecosystems. These include provisioning, regulating and cultural services that directly affect people and supporting services needed to maintain the other services (Millenium Ecosystem Assessment of the United Nations).

[4] Provisioning services are the products obtained from ecosystems, including food, fiber, fuel wood, raw materials, fresh water, biochemical and genetic resources

[5] Regulating services are the benefits obtained from the regulation of ecosystem processes, including climate regulation, disease regulation, water regulation, water purification and pollination.

[6] Supporting services are those that are necessary for the production of all other ecosystem services. They differ from provisioning, regulating, and cultural services in that their impacts on people are either indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people. Supporting services include soil formation, nutrient cycling and primary production.

[7] http://redpath-museum.mcgill.ca/Qbp/2.About%20Biodiversity/importance.html

Both points of view (intrinsic and human-centered) need not be contradictory, as they serve the same ultimate purpose. Yet they often are considered incompatible because they stem from two very different philosophies: one which views nature as innately valuable and one that regards it as economically valuable.[8]

The scope of this report includes all components of biodiversity for food and agriculture with a particular focus on associated biodiversity species and wild resources used for food. It also includes information on the provision of ecosystem services and on the implementation of an ecosystem approach. With respect to the maintenance of biodiversity for food and agriculture, the report tends to emphasize the conservation (mostly through use) of species that contribute either directly or indirectly to human well-being. This being said, the intrinsic value of biodiversity is also considered to be important, particularly with respect to the protection of associated biodiversity species. For these species still little is known about the complex interactions between them and about their function(s) in ecosystems of relevance to food and agriculture.

[8] The Redpath Museum of McGill University, website on Quebec biodiversity: http://redpath-museum.mcgill.ca/Qbp/2.About%20Biodiversity/importance.html

5 BIODIVERSITY FOR FOOD AND AGRICULTURE IN NORWAY

5.1 A brief introduction

Norway is one of Europe's northernmost countries. The country has a total land area of 323,787 km² that extends over some 1750 km between 58°N and 71°N (excluding the islands of Svalbard and Jan Mayen). It has a population of 5 million and a population density of 15.6 people per km² (Statistics Norway, 2013). Approximately 1% of Norway's population is from Sámi origin (Nordic Sámi Institute: http://www.sami-statistics.info/default.asp?nc=4&id=110).

Norway has substantial climate gradients. Inland areas in northern and eastern Norway have a typical continental climate, with warmer summers and cold winters, while the entire coastline has a maritime climate, with relatively cool summers and a mean temperature above 0°C in the winter months. The Finnmark Plateau is the country's coldest area, with mean winter month temperatures of around -15°C, while the southern parts of Østlandet and the coastal areas of Sørlandet have the highest mean summer temperatures. Annual precipitation also varies. Areas in Hordaland and Sogn and Fjordane have the highest annual precipitation. With an annual precipitation of 3575 mm, the village of Brekke, located in the Gulen district of Sogn and Fjordane, is the country's most pluvious area. The driest areas are in the eastern and northern parts of the country, in the Østerdalen and Gudbrandsdalen valleys and in Finnmark. As a result of this climatic variation, the length of the growing season[9] varies between 200 days in south-western Norway and 100 days along the coast of eastern Finnmark. In the mountainous regions, the growing season is even shorter (Meteorologisk institutt, 2015).

Norway's total agricultural area is 1.04 million hectares (ha). About 0.86 million ha of this land, or 2.7% of the country's total land area, is arable.
Forests and other wooded land cover 14 million ha, occupying 43% of the country's total land area. Approximately 8.6 million ha of the country's forests are productive forest land, which are forest areas that can produce more than 1m³ of wood per hectare per year. The most important tree species, both volume- and economic-wise, are spruce, pine and birch (Tomter & Dalen, 2014). Norway's remaining land area essentially consists of mountains, extensive grass- and other outlying lands (outfields), lakes and urban areas (Map 1.).

The sea areas under Norway's jurisdiction are about six times larger than its land area. Most of the important fish stocks in Norwegian waters are abundant and in good condition. Both pelagic (i.e. capelin, mackerel and North Sea herring) and demersal (i.e. cod, haddock, saithe and Greenland halibut) fish stocks are estimated to have tripled in Norwegian waters between 1985 and 2012 (Norwegian Ministry of Climate and Environment, 2014).

[9] Number of days with a mean temperature of more than 5°C.

The country's natural conditions are also favorable to fish farming. Norway's numerous fjords and islands along the coast are protected from the extreme conditions of the open sea and the water temperatures are ideal for the production of, *inter alia*, salmon, trout, cod and halibut.

Approximately 17% of the Norwegian mainland is protected as natural parks, nature reserves or landscape protected areas, the majority of which (64%) are located in alpine zones. Protected areas make up 65% (or 39,800 km²) of the Svalbard Archipelago. Norway also has 12 marine protected areas covering a total of 85,416 km², less than 3% of which lies outside the country's territorial waters. Other specific areas and species on both land and sea are protected and conserved in accordance with the provisions of the Norwegian Nature Diversity Act.

Norway's economy is characterized by a combination of free market activity and government intervention. In 2012, the service sector as a whole accounted for approximately 57% of the country's gross domestic product (GDP), petroleum industries for about 26% and manufacturing close to 7% (White paper Nr.12; The World Bank (2012)). In the same year, agriculture (0,4%), forestry (0,2%), fishing (0,4%) and aquaculture (0,3%) combined accounted for 1,3% of the country's GDP (SSB, 2012). Forestry and the manufacture of wood and wood products (excluding furniture and manufacture of paper and paper products) accounted for less than 1% and the food processing industry for about 1,2% of Norway's GDP.

Increasing oil-related activity in the mainland economy has provided income and employment at high wage levels in Norway (250,000 Norwegian jobs depend on oil). On the one hand, Norway's oil economy is creating attractive employment opportunities, but it is also pushing up unit labor costs and undermining the competitiveness of the other sectors of the mainland economy, including agriculture (IMF, 2013; Bjørke, 2013).

In 2013, 57,000 people, or 2.2% of Norway's total labour force, worked in agriculture, forestry and fishing, of which approximately 83% were men (SSB, 2013). In 2011, the forestry sector employed approximately 5,500 people, 17% of which were women (Tomter and Dalen, 2014; Steinset, SSB). Over the past fifty years, the number of people employed by the forestry sector has remained quite stable. During the same period, the number of active farmers and fishermen more than halved, mainly as the result of public policy, the country's general economic development and the increasing competition with goods and services from low cost countries. The declining number of farmers and fishermen can also partly be attributed to the increasing size of units combined with increased efficiency in farming and fishing methods and equipment. This has led to the gradual replacement of labour by capital (Directorate of fisheries, 2010).

Norwegian agriculture essentially consists of crop production, livestock farming, horticulture, forestry and reindeer farming, as well as of related activities, such as farm tourism. Grass production for fodder represents the largest and economically most important plant production in Norwegian agriculture (Bioforsk, 2014). In 2013, livestock grass-land based systems were estimated to cover an area of approximately 540,000 ha, while rainfed crops and mixed farming systems used an estimated area of respectively 305,000 and 130,000 ha (SLF, 2013).

In 2013, there were slightly over 43,500 farms in the country. The majority of farmers (59%) own both agricultural and forest land, 29% exclusively own agricultural land and 12% are forest owners without agricultural land (Statistics Norway, 2010).
One of the main characteristics of Norway's agricultural sector is the pluralism of its farmers. For generations, as the result of a series of circumstances intrinsic to Norway (geographic location,

climate, etc.), most farmers have generated their income from both on-farm and off-farm activities. Up until the 1970s, the off-farm income used to be generated through activities related to forestry and fishery. Nowadays, farmers tend to generate their "secondary" income from different economic activities, often working on payroll for an employer (Store Norske Leksikon, 2014). At present, approximately two out of three farmers are "part-time farmers".
Due to the variation in Norway's topography and production conditions and the country's forest ownership structure, the forestry sector is essentially driven by small-scale forest owners. In 2011, there were more than 130,000 forest properties with at least 2.5 ha of forest. 98% of these properties were privately owned, covering a total of 85% of the country's productive forest area (Tomter and Dalen, 2014). In 2012, Norway produced a volume an estimated 8,900,000 m^3 felled timber for industrial purposes and approximately 2,000,000 m^3 of fire wood.

Some of the main policies, regulations and laws that have played a significant role in shaping Norway's food and agricultural landscape, include:
- *The Annual agricultural agreements (Jordbruksavtaler)*: The Ministry of Agriculture and Food is responsible for drawing up government agricultural policies and the Norwegian Agricultural Authority (Landbruksdirektoratet) is the executive authority for their implementation. Government agricultural policy is modified on a yearly basis through annual agricultural agreements between the government and the two farmer's unions and through the annual state budget. The agreements address a range of issues, some of which also require environmental considerations to be taken into account (e.g. matters dealing with food safety and the management of biological processes). As laid out in its Environmental Strategy 2008-2015, integrating environmental challenges into agricultural policies is a key objective of the Ministry of Agriculture and Food.[10]
- *The Allodial Right (Odelsrett)*: to avoid the partitioning of agricultural land and preserve Norwegian farm culture, the inheritance of farms is regulated through the "Odelsrett". This is an ancient right by which the eldest child inherits the farm after his or her parent with the obligation to pay the other siblings their share of the estate. Before 1974, the eldest son would inherit the farm. Only if there were no sons, the eldest surviving daughter would be the farm's heir. With the "Odelsrett" having become gender neutral, the number of women farmers has continued to marginally increase. In 1999, women owned 26% of all agriculture holdings with their share being larger in smaller holdings than in larger ones (Steen Jensen, 2005);
- *The Land Act (Jordloven)*: the purpose of this Act is to provide suitable conditions to ensure that the land areas in the country, including forests and mountains and everything pertaining thereto (land resources), may be used in the manner that is most beneficial to society and to those working in the agricultural sector (this includes regulating farmland partitioning). According to this Act, land resource management shall be environmentally sound and, among other things, take into consideration protection of the soil as a production factor and preservation of land and cultural landscapes as a basis for life, health and well-being for human beings, animals and plants. The Act

[10] With respect to Norway's environmental goals and policies, this report includes information up until the publication of Proposal 1 S (2014-2015) to Parliament for the 2015 budget year.

also takes into account that resources shall be used to meet the needs of the present without compromising the ability of future generations to meet their own needs.
- *The public right of access (Allemannsretten)* is an old and important principle in Norway, allowing everyone free, public access to non-cultivated land, including forests. Cultivated land is only accessible outside the growing season from 15 October to 29 April. The general public may use the forests at any time of year for recreational activities, ranging from sports activities to collecting wild berries and fungi. Public access to nature is enforced through the *Outdoor Recreation Act (Friluftsloven)* (Det norske Skogselskap, 2011).

5.2 The roles of biodiversity for food and agriculture

The Norwegian government considers securing a safe, nutritionally adequate and culturally acceptable supply of food a priority. In this context, it formally recognizes, through its national biodiversity policy and action plan (White paper Nr.42 (2000-2001), the importance of maintaining the diversity of domesticated, wild, cultivated and uncultivated species; it acknowledges the value of life-sustaining processes and ecosystem services (e.g. soil formation, cleansing of air and water, regulation of carbon and nitrogen cycles); and it appreciates the ability of the environment to mitigate the effects of environmental pressures such as pollution.

The knowledge of biological diversity, including biological diversity for food and agriculture, has steadily increased over the past ten years. This has contributed to raising awareness on its importance among those who conserve and use this diversity, as well as among policy makers and the broader public. Furthermore, through the principle that each sector is responsible for integrating environmental concerns into its sectorial policies, Norway seems to be truly committed to the maintenance of biodiversity. Even so, it is also recognized that there are quite a few cross-sectoral challenges that need to be addressed. At times, trade-offs favoring the maintenance of biodiversity in one rather than in another sector need to be made (for example, wildlife policies protecting predators in sheep grazing areas; infrastructure expanding at the expense of farmland and farmland biodiversity).

Over the past decades, land use changes seem to have been the major factor behind the loss of biodiversity for food and agriculture in Norwegian production systems. Some of these changes are the result of the steady decline in number of farmers and the abandonment of traditional farming practices. These have had an impact on the status of many components of biodiversity for food and agriculture, including associated biodiversity species, as well as on the delivery of ecosystem services. The abandonment of outfield grazing practices, for example, has led to the overgrowth of a large proportion of former grazing areas. This has had a negative effect on the diversity of herb, clover and grass species, as well as of their associated, open landscape-dependent, species.

5.2.1 Increased recognition of the value of ecosystem services

Many research activities have been undertaken to improve the country's knowledge about, and to strengthen policy development on, ecosystem services and their role in sustainable food production. In 2013, a government-appointed expert commission published a report entitled *Natural Benefits-on the value of ecosystem services* (NOU 2013.10). In the Commission's opinion the state of Norwegian ecosystems is relatively good, even if Norway's biological diversity and Norwegian ecosystems are under a series of pressures (e.g. land use change, climate change, ocean

acidification and invasive species). According to the Expert Commission's report, particularly the state of forest and open lowland ecosystems deserve more attention. The state of these ecosystems was rated at 0,4-0,6 with a reference state of 1. The report also identified a great need for research and knowledge development and recommended to, *inter alia*, improve knowledge about biological diversity and ecosystem services, including by strengthening the monitoring of Norwegian ecosystems, populations and species. The report also encouraged the establishment of a special research programme that would look into biological diversity, ecosystem functions and ecosystem services and the connections between them, including from an interdisciplinary perspective. Such a programme would contribute to improving the integration of biological diversity and ecosystem services considerations in decision-making processes. The outcomes of this report are being used as a basis to improve natural resource management in Norway.

5.2.2 Increased activities on associated biodiversity

The Norwegian Biodiversity Information Centre (Artsdatabanken) plays a key role in raising awareness on the importance of associated biodiversity and their role in the delivery of ecosystem services. In 2013, the Centre released a publication on the state of knowledge of insect pollination in Norway (Totland et al., 2013). This publication highlights that the number and diversity of pollinators in Norway is declining and that seed production of many plant species either depend on or is favoured by insect visiting flowers (i.e. it is estimated that the seed production of 80% of Norwegian wild plant species is pollination-dependent).
In 2014, in the context of the FAO Global Pollination Project, the Norwegian Institute for Nature Research (NINA) published an assessment report of Norwegian pollination deficits (Åström et al., 2014). This report includes a brief description of the pollination deficits measurements that were performed in two crops (i.e. commercial apple orchards and red clover seed production) for two seasons by NINA, the PolliClover project and NIBIO. Through these measurements, Norway gained significant experience in working with the pollination deficit protocol.[11]

Research is also being undertaken on the distribution and diversity of associated biodiversity species living in forests. Research in this field is highly relevant, as approximately 60% of the 31,000 species[12] in mainland Norway are believed to be associated with forests (Gjerde, I., Brandrud, T.E., Ohlson, M. & Ødegaard, F., 2010). When mapping the spread and occurrence of Norway's 30 main tree species, for example, the Norwegian Forest and Landscape Institute also identified their pollen and seed dispersal vectors. Insects were among the main pollen vectors and birds and mammals were identified as the main seed dispersal vectors, next to water and wind (Myking & Skrøppa, 2001).

---

[11] The FAO Global Pollination Project seeks to build capacity for pollination studies internationally. It adds information to the knowledge base of the International Panel for Biodiversity and Ecosystem Services (IPBES) and implements the Pollination deficit protocol, which outlines a unified method to investigate pollination and measure pollination deficits in various agricultural systems around the world (Vaissière et al. 2011). The Pollination deficit protocol is being implemented in Norway, its applicability to Nordic conditions is being analyzed and its strength in relation to alternative research strategies is being evaluated.
[12] Including invertebrates, fungi, lichens and bryophytes and excluding micro-organisms.

5.2.3 The values of wild food resources

Norway also has a significant diversity of wild foods, including a broad variety of berries, edible fungi, wild fruit trees and wild animals, such as different types of deer, birds and fish. While those who harvest wild foods through hunting and picking essentially do so for leisure, it should be mentioned that some harvesting activities, in particular hobby fishing and hunting are also revenue-generating. In 2009, for example, the wild game meat value was estimated at about USD 78 million, with the value of moose meat accounting for approximately USD 47 million. In the same year, Norwegian forest owners earned more than USD 29 million by selling their hunting rights, with additional income being generated by providing hunting-associated services, such as renting out cabins (SSB, 2009). "Recreational use of private property" has also become a lucrative source of income for riparian landowners, who lease their fishing rights, especially for wild salmon fishing, and provide other services, such as accommodation, food and guiding tours. In 2008, 80% of the riparian land owners leased their fishing rights in one form or another. The remaining 20% indicated they either wanted to fish themselves, or that they considered the value of their fishing rights to be too low. The average net income generated from leasing fishing rights was slightly less than USD 5,000 per owner per year, a figure that significantly varied per owner based on the type of ownership, the form of lease and the quality of the fishing rights (Stensland, 2011).

Wild foods play a particularly important role in the diet and lifestyle of reindeer herding Sámi[13]. Before the 20th century, the traditional Sámi diet was composed almost exclusively of foods of animal origin (mainly reindeer) with the addition of fish and plant foods (e.g. cloud- and lingonberries) when available (Haglin, 1991). During the last century, the diet of many Sámi has progressively become more like the diet of the non-Sámi populations in Norway, with an increased intake of carbohydrates from plant foods and a decreased consumption of meat protein. Recent

surveys have found that the dietary patterns of the population in Norway tend to vary by geographic area rather than by ethnicity (Sámi or Norwegian). There does however seem to be a clear link between ethnicity and dietary pattern among the Sámi population living in the interior parts of the country. This part of the Sámi population still obtains most of its protein intake from reindeer meat supplemented by lake fish, thereby having a significantly lower incidence of iron deficiency to the Sámi living in coastal regions (Haglin, 1999; Fagleg analysegruppe for samisk statistikk, 2009). Generally speaking, Norwegian Sámi were found to have a higher intake of fat, table sugar, and coffee compared to non-Sámi Norwegians (Nilsen et al., 1999) and a lower intake of fruit and vegetables, with the exception of berries when they are available (Haglin, 1991; Haglin, 1999; Nilsen et al., 1991). Their consumption of dairy products is also lower (Ross et al., 2006).

[13] Throughout this questionnaire, most of the information that is provided on the Sámi relates to reindeer herding Sámi.

Photo: Still today, the protein-rich reindeer meat is the staple food of most reindeer herding Sámi; their blood is used to produce sausages. Other sources of protein in the Sámi diet include wild birds and fresh water fish that are consume boiled, grilled, dried, smoked or salted. Photo: Ragnar Våga Pedersen/NIBIO

Studies have shown that some types of traditional foods, such as reindeer meat and fresh cod, are particularly rich in essential nutrients. Some of these foods may however also contain contaminants. Contamination with persistent organic pollutants and heavy metals has been quite extensively documented for fish and other forms of seafood and more recently also for reindeer. Generally speaking, reindeer meat across Norway contains very low levels of pollutants, even if parts of South Sámi reindeer areas of Trøndelag were heavily polluted with radioactive cesium after Chernobyl. The effects of this pollution are still affecting the food safety risks with reindeer meat in these areas. The consumption of fish liver from fish caught in the fjords is not recommended due to its content of hazardous substances. The extent to which food safety issues in relation to traditional foods has affected the Sámi people's choices in terms of food and eating habits, is not known (Fagleg analysegruppe for samisk statistikk (2013)).

5.3 Norway's main food and agricultural production systems

There are many different types of food and agricultural production systems in Norway. For the purpose of this report, we have tried to cluster these various systems into seven main categories using as much as possible the official descriptions provided in Annex 2 of the FAO questionnaire.

5.3.1 Farming systems

A map with Norway's main farming systems is provided in Annex 1 to this report.

5.3.1.1 Livestock grassland-based systems

In livestock grassland-based systems, farmers typically keep ruminants, mainly consisting of cattle, sheep or goats, or of a combination of these species. The farm animals are fed on forage and feed concentrates. Farmers harvest a large part of their forage intake from cultivated and natural pastures, while the animals themselves also take up a significant proportion of their forage needs through grazing (in principle a minimum of 8 weeks per year). Approximately 50% of the dairy farmers let their animals graze in the outfield during the summer.

5.3.1.2 Rainfed crops

In the Norwegian climate, there is enough natural rainfall for crops to grow to their maximum potential.14 In contrast to most developed countries, Norway's crop cultivations do not depend on the artificial application of water to the land or soil. Crops that grow well under natural rainfall are described by FAO as rainfed crops contrary to irrigated crops. Norway's major agricultural crops

[14] A minor share of Norwegian crop producers has invested in an irrigation system as a precautionary measure. However, figures show that the existing irrigation systems are not used to their full potential and/or on a regular basis (SSB, 2010).

include cereals (including oats, barley, rye and wheat), rape oil seeds and potatoes. Forage crops, including tubers, green fodder and cultivated grassland varieties are also grown. The country's main horticultural crops include vegetables such as carrots, cabbage and other brassica, onions, lettuce and greenhouse tomatoes; and fruit, such as strawberries, cherries, raspberries, apple and plums.

Cloudberries, billberries and lingonberries are wild berry varieties that are harvested from the wild by hand.

5.3.1.3 Mixed systems

Quite a few production systems in Norway consist of a combination of livestock, crops and forest land. These so-called mixed systems consist of pig and poultry farms that also grow cereals, as well as of farms that keep several species of livestock (possibly a mixture of monogastrics and ruminants), cultivate land and own forest land. The vast majority of these systems are non-grassland based. By law, farmers of mixed systems need to spread their manure in compliance with the minimum spreadable acreage requirement.

5.3.2 Areas with semi-natural forests

The map provided in Annex 1 to this report reflects the area that is covered with semi-natural forests in Norway.

Norway's productive forest land covers an area of approximately 8.6 million ha, about 45,000 ha (0.5%) of which are clear-cut forest (including 14,700 ha regenerated by planting) (Table 357, Statistical Yearbook 2012). Of the country's productive forest area, respectively 22 and 4.3% are protective and protected forests.15

Norway has a mixture of planted and naturally regenerated forests. These forests are neither undisturbed by man nor plantations in the way the term plantations is being used at the global level. Norwegian forests are therefore probably best described as semi-natural forests (Interview with Tore Skrøppa on 19/02/2014).

Forestry in Norway is characterized by small-scale properties, most of which combine forestry and agriculture related activities. More than 80% of the country's total productive forest area is privately owned. In 2011, Norway counted 130,000 forest properties with more than 2.5 ha of forest, with the average size of privately owned farms with forest resources being 45 ha.

5.3.3 Distribution of fisheries and aquaculture

Maps showing Norway's main areas of marine capture fisheries and of areas where aquaculture permits are active are provided in Annex 2 and 3 to this report, respectively.

[15] Figures related to protected forests should be interpreted with caution. Different countries use different parameters to define the percentage of protected forests. Norway is known to have stricter reporting criteria, compared to countries like Sweden and Finland, for example (FRA 2010d; Søgaard et al., 2012).

5.3.3.1 Self-recruiting capture fisheries

Norway's marine capture fisheries provide employment to approximately 12,800 people (FAO, 2011). This sector uses relatively few, highly efficient, fishing boats, ranging from small coastal to large ocean vessels. From 2000 to 2011, the number of registered vessels reduced by more than half to a fleet of approximately 6,000 boats.

The main target species in capture fisheries include herring, cod, capelin, mackerel, saithe, blue whiting, and haddock. A few additional species with high commercial value are caught in smaller quantities (i.e. prawns, Greenland halibut and ling). From 2001 to 2010, the average annual total catch was around 2.5 million tonnes with an export value of more than USD 3 billion. Catch fluctuations are partially due to the natural variability of pelagic stocks such as capelin and herring. In addition to fish, Norway also exploits krill and sea mammals, including various species of seals and mink whales (FAO, 2011). The Norwegian Government is bound by international law to ensure sustainable harvesting of all fish stocks, including those that are used for human consumption and/or feed.

5.3.3.2 Fed aquaculture

Norway's long coastline and cold clear waters provide the perfect conditions for aquaculture production.

The Norwegian aquaculture industry started out with a few small players that essentially followed a "learning-by-doing" approach. Since then, the sector has grown into a very effective and professional industry. Aquaculture production more than doubled from 2000 to 2011, reaching 1.14 million tons in 2011. During this period, the number of fish farmers increased from about 4,300 to 5,800. At present, the industry employs approximately 5,900 people directly, mostly in coastal districts. Including ripple-effects, this number increases to 23,600.

The country's aquaculture production is dominated by Atlantic salmon farmed in marine cages (93% share in 2011). Other important farmed species include rainbow trout (5%) and Atlantic cod (1%). In addition, extensive development efforts are taking place to expand Norway's aquaculture activities to other species such as Atlantic halibut, wolf fish and shellfish.

Norway is a world-leading exporter of salmon. In 2013, Norwegian producers exported salmon and trout for close to USD 7.1 billion.

The government's policy for the aquaculture industry is to enable growth and competitiveness within a framework of environmental sustainability. In the short term, sea lice and farmed fish escapes are the two most important challenges to be dealt with. In the longer term, the use of coastal areas and feed resources will be among the main issues to address. Indicators to define an acceptable threshold of escaped farmed salmon in Norwegian rivers have been developed, and corresponding indicators to measure the effect of sea lice on wild stock are under development. Indicators are important tools to improve aquaculture management. Discharges of dissolved nitrogen, phosphorus and organic material from the aquaculture sector constitute a minor environmental problem in Norway.

5.3.4 Distribution of reindeer herding

A map with Norway's main reindeer herding areas is provided in Annex 4 to this report.

Reindeer herding is an important production system in Norway, particularly in Finnmark, the country's most northern, largest and least populated county. Norway's six reindeer pasture areas are East Finnmark, West Finnmark, Troms, Nordland, North Trøndelag and South Trøndelag/Hedmark, which are divided into reindeer pasture districts. There can be quite some variation between the management of reindeer herds in the different pasture areas, and even between different husbandry units within a single district.

Reindeer herding is an extensive production system based on seasonal migration of reindeer herds. It is of particular importance at the local level from central to northern Norway, especially for the Sámi population. Reindeer mainly feed on herbs and grasses during the summer and on lichen during the winter. To secure sufficient food supply, the reindeer herding sector depends on access to extensive land/pasture areas. The loss of grazing land and the obstruction of migration routes due to direct and indirect impacts from competing land use (e.g. infrastructure, industrial development or other human activity) are major challenges for reindeer herding.

The sustainability of reindeer husbandry in Norway is under several pressures, including from an excessive number of reindeers in West Finnmark. The maximum quota set by the Norwegian government would require a reduction in reindeer numbers to protect pastures (particularly the lichens) and secure a future for Sámi reindeer husbandry, while the reindeer herders consider encroachment by competing land-use interests to be the largest threat to pastures and the sustainable development of reindeer husbandry.

Southwards, pressures on land are also challenging with increasing infrastructure development and land-use activities competing for the same pastures (Johnsen, 2014). The authorities invested considerable resources to protect reindeer herding in these areas.

Climate change and different pasture rotation are challenges in all reindeer districts.

5.4 Conservation and use of biodiversity for food and agriculture: different options for different species

Norway recognizes that the conservation and use of genetic resources for food and agriculture is crucial to sustainable food production and food security. In this context, it supports *in situ*, on-farm and *ex situ* conservation as complementary approaches.

5.4.1 Conservation and use of plant genetic resources

As explained in more detail in Norway's country report on the state of plant genetic resources for food and agriculture (Asdal, 2008), the close collaboration and coordination between the Nordic Genetic Resource Centre (NordGen) and the Norwegian plant genetic resources programme is essential to the national conservation and use efforts of both food and feed crops and of their wild relatives. For more than 30 years, NordGen has been the main body for the conservation of Norwegian seed propagated crops and potatoes, in addition to administrating the documentation and database systems covering all Norwegian agricultural and horticultural crops, including material maintained in national field gene banks. The collections held and administered by NordGen are a common Nordic resource under Nordic management. The material is accessible to all free of charge and relevant material is included under the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture. NordGen also

coordinates Nordic participation in both European and international networks and projects (Asdal, 2008).

Within plant breeding, a regional Public Private Partnership for Pre-breeding was established in 2011 by the Nordic Council of Ministers. Using both public funds and funds from commercial breeding companies, the partnership supports Nordic plant breeding programmes for barley, rye grass and apple to meet long-term needs of the agricultural and horticultural industries, specifically regarding adaptation to climate change, setting targets for environmental policies, and responding to demands from consumers, markets, etc. Among others, within this partnership, the Nordic apple project will produce and disseminate knowledge concerning levels of susceptibility against fruit tree canker and storage diseases in apple cultivars of potential interest for plant breeding and cultivar development in the Nordic countries.

With respect to plant breeding programmes there is extensive cooperation between the Nordic plant breeding companies. Even so, the number of programmes has declined over the last decades. The remaining programmes tend to focus on commercial and semi-commercial crops. Norway has breeding programmes in place for oat, barley, wheat and forage crops, such as clover. The country neither has breeding programmes for vegetables nor for protein- and oil crops.

The sole commercial plant-breeding company in Norway is Graminor. Among others, Graminor develops new and improved plant varieties and tests imported varieties to provide Norwegian farming and horticulture with a diversity of disease-free field crops and horticultural plants that grow well under the existing conditions.16 A limited number of other non-commercial plant breeding initiatives are also being undertaken at the national level.

Small-scale farming and hobby gardening also contribute to the use and *in situ* conservation of landraces and traditional plant varieties. Natural selection and selection pressures imposed by farmers and gardeners ensure the continued evolvement of landraces, thereby strengthening local crop adaptation and improvement.

In Norway, there are also individuals who have cared for certain varieties over many years. The national programme on plant genetic resources for food and agriculture has supported such dedicated enthusiasts in establishing networks within different crop groups whereby farmers or gardeners are appointed custodians and maintain certain varieties each year. These custodians produce seeds or propagate plant parts for distribution and prepare annual reports about the conservation of each maintained variety. Through the establishment of a national PGR programme in 2001 and a public campaign in 2007, 12 of the missing mandate varieties of the country's four main fruit crops (apple, pear, plum and cherries) were found in old orchards or private gardens. These varieties are now being propagated and trees will be added to existing collections.

NordGen provides seeds from their collections to farmers and gardeners who want to cultivate varieties that are not available through the seed marketing system. This is a free service aiming at sustainable use of genetic resources and at raising public awareness.

[16] More information on this topic can be found in 6.2.1.

Botanical and public gardens, as well as open air museums are also important for the maintenance of traditional plant varieties.

5.4.2 Conservation and use of farm animals

Commercial livestock breeding plays an important role in the country's sustainable food production. There are four commercial breeding associations in Norway, namely GENO, Norsvin, the Norwegian sheep and goat association and the Norwegian Beekeepers Association. Each of these associations is run by farmer-owned enterprises. Norwegian animal breeding is often described as sustainable and is characterized by broad breeding goals, sustainable and effective breeding populations, the use of dual purpose breeds and strong farmer participation. The breeding associations provide breeding material of mainly commercial native breeds (about 98%) to farmers across the country. During the last ten to fifteen years Norwegian breeding associations have successfully exported breeding material. These exports play an important part in the conservation and use of Norway's native livestock diversity, as the export revenue is reinvested in commercial breeding programmes of Norwegian dairy cattle and pig breeding cooperatives.

The poultry sector is the only livestock sector in Norway whereby the breeding material is supplied by international breeding companies.

Norway's small-scale farm structure is believed to have considerably contributed to the use and conservation of old, native breeds in mainstream farming systems. This has been of major importance for the survival of these breeds and has contributed to the continued existence of viable populations of several historical breeds (Sæther, 2002). In 1989 and 1991, a national registration process was undertaken to record conservation worthy cattle breeds and herds. This process has since been expanded to also include other national livestock species. Following the breeds' classification criteria of the Norwegian Genetic Resource Centre Norway has 38 native breeds. According to FAO's categorization of risk status for livestock breeds 28 of these breeds are threatened or critically threatened (http://www.skogoglandskap.no/filearchive/de_nasjonale_husdyrrasene_i_norge_inndelt_etter_grad_av_truethet._september_2014.pdf).

In the mid-1990s, Norwegian Agriculture underwent quite some changes, mainly as a result of the reduction of economic incentives for small-scale farmers. This has had a negative effect, among others, on the maintenance and use of native endangered livestock breeds by small-scale livestock farmers.

5.4.3 Conservation and use of forest genetic resources

Norway also has a long history in tree breeding activities, with timber tree species Norway spruce (*Picea abies*) being the country's priority species. *Picea abies* is also the species that is best characterized both at provenance, family and clonal level. Among others, Norway's tree breeding program strategy (2010-2040) aims at producing improved reproductive material for resilience to climate change, increased growth and quality and a high genetic variation to ensure survival and future evolution. The improved material also promotes high sequestration of CO_2.

Species composition and distribution of forest trees in Norway are largely determined by the following factors: the invasion of tree species after the Ice Age, subsequent climatic changes and human activities. Twenty-five of the 34 native forest tree species have their northern limit in this

country. The genetic resources of 15 species are considered to be near-threatened or threatened either at the local or national level, among these eight are *Sorbus* species.

In situ conservation of genetic resources of forest tree species is done in nature reserves. Twenty-three such gene conservation units, comprising ten species, have been identified and included in the European database EUFGIS.

Ex situ conservation of forest genetic resources in Norway is performed by collections in arboreta and botanical gardens; long-term tests of clones, families and provenances in research plantations; progeny tests, clonal archives and seed orchards belonging to the national breeding programme; and storage of seed lots for forest regeneration. Since February 2015, some accessions of Norwegian spruce and pine seeds are stored at the Global Seed Vault in Svalbard.

5.4.4 Contribution of aquatic genetic resources to food consumption

Norway administers vast oceans with some of the world's richest fish resources. Both fisheries and aquaculture significantly contribute to the country's food security. In average, Norwegians between the age of 18 and 70 consume 79 grams of fish/fish-related products per day, making freshwater and saltwater fish an important part of the Norwegian diet (Totland et al., 2012). Commonly consumed fish species include cod, haddock, herring, mackerel, trout and salmon. Production is year-round, albeit with some seasonal variations, particularly for capture fisheries. Norway's domestic production of seafood would be able to substitute all inland needs for animal protein (FAO, 2011).

5.5 Production and exportation and their effects on biodiversity for food and agriculture

Norway's agricultural production has a strong domestic focus. Priority is given to maintaining domestic production and covering the national demand for products that grow naturally in the country. The limited quantity of exported products is believed to be of no major influence on the status of the country's biodiversity for food and agriculture.

In terms of animal, aquatic and plant genetic resources for food and agriculture and of forest genetic resources, Norway uses its biodiversity relatively well. Between 1970 and 2005, the country's calorie-based self-sufficiency rate in food remained stable at around 50%,[17] with a domestic food production largely based on locally developed plant varieties and native livestock breeds. During that period, Norway was for example more than 100% self-sufficient in dairy products and about 80% in potatoes (Norwegian Agricultural Economics Research Institute 2007). It should however be noted that the use of old traditional plant varieties and endangered native

[17] The FAO Statistics Division defines the Food self-sufficiency (calories) ratio as:
SSR = production x 100/(production + imports-exports). The SSR can be calculated for individual commodities, groups of commodities of similar nutritional values and, after appropriate conversion of the commodity equations, also for the aggregate of all commodities. In the context of food security, the SSR is often taken to indicate the extent to which a country relies on its own production resources, i.e. the higher the ratio the greater the self-sufficiency.

livestock breeds is still quite low. Their potential contribution to ecosystem services (e.g. management of low alpine cultural landscapes through livestock grazing), and to food security are thereby not optimally exploited.

Nearly all of the country's meat, milk and egg production is consumed locally and Norway is more or less self-sufficient with regard to these products. The two main exported animal products are skin from fur-bearing animals and wool with respectively 98 and 86% of their total production being destined for export (Sæther, 2013). In 2013, Norway also exported about 12,000 tons of cheese (mainly Jarlsberg). The revenue that is being generated through the exportation of breeding material is used to financially support the costly breeding programmes of Norwegian dairy cattle and pig breeding cooperatives. This is an interesting example of how Norway's exports are directly contributing to the maintenance and use of biodiversity.

Norway's exports in terms of food crops are very limited. Nearly 100% of the country's production of cereals, oil seed crops, vegetable varieties, potatoes, fruit, berries and fodder crops are consumed locally, with the production of wheat, rye, barley and oat covering approximately two thirds of the domestic demand (SSB, 2012).

Flowering potato field. Photo: Svein Skøien / Skog og landskap

Norway is an important producer and net exporter of forest-based products. The export revenue from forestry is substantial. In 2012, the country exported approximately 500,000 m3 of processed timber (80% of which was sawn timber from spruce and pine trees), 1.6 million m3 of logs (the highest volume for the past 25 years) and manufactured products (mostly pulp and paper) for a total value of more than USD 1.5 billion. 75% of this revenue was generated through the exports of

pulp and paper. Due to the down-scaling of the Norwegian pulp and paper industry this revenue decreased by approximately USD 240 million compared to 2011, (Tomter & Dalen, 2014; Steinset, SSB). Since 2000, Norway has also been exporting less processed timber. Whereas the country used to export between 700,000 to 800,000 m3 of processed timber per year in the 1990s, it exported a little less than 500,000 m3 in 2012. One of the major drivers behind the gradual decrease in the exports of processed timber has been the increasing demand for these products on the domestic market (Tomter & Dalen, 2014).

The quantity and diversity of tree species in Norway does not seem to have been affected by the exports of timber products and pulp and paper. On the contrary, the annual increment in tree volume has been bypassing the drain of wood[18] for nearly a hundred years.

95% of Norway's forest breeding activities are related to Norwegian spruce (Picea abies) and a well-developed breeding programme is in place to ensure the sustainable use and maintain the genetic diversity of the species. Breeding programmes have also been developed for pine and Christmas trees. Christmas trees are harvested before they reproduce (in average forest trees are fertile after 15 to 20 years), whereas other tree species regenerate naturally.

At present, 1% of Norway's total timber volume relies on foreign tree species. When extensively spread, foreign tree species can have negative effects on biodiversity. These effects are being evaluated through a specific regulation on the use of foreign tree species that is in line with the Nature Diversity Act.

The use of foreign tree species Sitka spruce (Picea sitchensis) in some parts of Norway is a much-discussed topic. Sitka spruce is recognized as a valuable resource by many. In total, approximately 50,000 ha are planted with Sitka spruce. These stands are mostly located on the country's southern and western coastlines. Sitka spruce thrives well in the rough Norwegian coastal climate and it retains more CO2 than the native spruce species (i.e. Norwegian Sitka spruce plantations bind approximately 600,000 tons of CO2 per year) (Andreassen, 2014).

At the same time, Sitka spruce is also a blacklisted species because when planted into coastal heathlands it can become invasive. Norway's coastal heathlands used to be actively managed through grazing and burning. With the disappearance of these traditional management practices the coastal heathlands have become an endangered nature type. Had there however been no Sitka spruce in these areas, similar ecological effects would have been caused through the invasion of pine, spruce and deciduous tree species.

Sitka Spruce has also caused some severe conflicts with goat and sheep herders who have been refused grazing access to the coastal heathlands planted with this tree species.

Fisheries and aquaculture production is year-round, albeit with some seasonal variations, particularly for capture fisheries. Even though approximately 95% of Norway's total seafood production is exported, the domestic market is still important to the national fisheries industry, as reflected in the high Norwegian consumption levels of fish and fish-related products.

[18] volume of harvested trees and of trees that have died from natural causes.

In 2013, the country exported 2,430,000 tons of seafood products from fisheries and aquaculture with a total export value of USD 9 billion.19 This figure increased by 17% compared to the previous

5.6 Key findings and remaining challenges

Key finding

a. The status, trends and pressures with regard to animal, plant and forest genetic resources are well documented in previous national status reports from each sector to the FAO (www.genressurser.no).

b. Norway's forests, farmlands and waters are rich in diversity in terms of domesticated, wild, cultivated and uncultivated species. The importance to maintain this diversity is recognized.

c. The value of ecosystem services is acknowledged.

Remaining challenges

a. The status, trends and pressures with regard to animal, plant and forest genetic resources have mainly been documented from a purely sectoral perspective. From a biodiversity for food and agriculture point of view it would make more sense to assess the different sectors using a holistic approach.

b. Maintaining the diversity of domesticated, wild, cultivated and uncultivated species often comes at the expense of other biodiversity components. In certain areas for example, protecting wildlife has had a negative impact on sheep herding.

c. There are still many "unknowns" with respect to the functions and the delivery of ecossystem services, particularly in forests and open lowland ecosystems.

[19] An equivalent of exporting 31 million meals per day.

6 DRIVERS OF CHANGE ON ASSOCIATED BIODIVERSITY[20]

Norway's landscapes, habitat types and thereby also the extent and distribution of biodiversity have to a large degree been determined by the country's physical and geographical conditions (i.e topography and climate) and by human activities. Many threatened or near threatened associated biodiversity species occur in areas that have been exposed to human interventions.

In and around Norwegian production systems the different components of associated biodiversity are exposed to a number of factors that are of influence on their habitat conditions and thereby on their population status and dispersal. The main factors in this respect are land use changes, pollution, climate change, alien species, harvesting and trade-off policies.

6.1 Main drivers of change in agricultural landscapes

In the surroundings of farmed land (and specifically intensively farmed land), a variety of elements, such as habitat islands in the fields, open field boundaries and road verges, small remnants of unfertilized grassland vegetation, ditches, streams, farm ponds and large, solitary trees offer refuge to many species of plants and animals.

Among the different forms of farmland, particularly meadows, pastures and rough grazing land are recognized for their species diversity and richness. They are believed to provide a habitat to more than 740 species (or 20% of all threatened and near threatened species), beetles, fungi, butterflies, moths and vascular plants being the dominating species. More intensively worked farmland, like arable land and sown grassland, are important habitats for nearly 120 threatened and/or near threatened species. While areas of constructed grounds like farmyards, residential areas including gardens and parks, sports grounds, industrial areas, roads and sand and gravel pits house nearly 250 threatened or near threatened species, 20 of which are almost exclusively found in these areas (Kålås et al., 2010).

The most significant threat to associated biodiversity in agricultural landscapes is caused by land use changes. Over the past fifty years, with the general economic development of the country, led by increasing oil-related activities, costs in other sectors of the economy such as agriculture have risen to unsustainable levels. This has led, among others, to farm exits, particularly of smaller farms, and a steady decline in the number of active farmers (Storm & Mittenzwei, 2013).

[20] Most of the information provided in this section was extracted from the document *Environmental conditions and impacts for Red List species* (Schartau et al., 2010). The Norwegian Biodiversity Information Centre began to compile information on environmental conditions and impacts on Red List species in different types of environment in 2007. This material was initially published as web articles from 2008 to 2010, which were updated with data derived from *The 2010 Norwegian Red List for Species*. Other information sources used include *Norway's National Report on Implementation of the Convention on Biological Diversity* (CBD, 2009) and 2014 data from the Ministry of Trade, Industry and Fisheries.

Forest succession as a result of the abandonment of farming is believed to have affected about 400 threatened and near threatened species (Kålås et al., 2010). Overgrown areas can, inter alia, lead to habitat fragmentation, whereby the distance between patches of adequate habitat for species that depend on semi-natural grassland can become considerable. This can hinder the exchange of genetic material with possible consequences on the genetic diversity within species. The distance between habitat patches is also of great importance for the reestablishment of declining species populations. Landscape and habitat fragmentation could also affect the pollination of crops, wild plants and forest trees (Totland et al., 2013). While there are relatively few studies on how landscape fragmentation affects pollination, poor access to pollinators has shown to have a direct negative effect on seeding in some plant populations (Sletvold & Ågren, 2010). At present, several species-rich habitats are merely surviving as isolated patches in the landscape. To maintain the biodiversity they are hosting processes that can create gene flow between such habitats are becoming more important. Strengthening knowledge in areas like these is needed to ensure the sustainable management of nature and land use. The number of managed honey bee colonies reduced by 40% over the past decade (B. Dahle, personal comments).21 This reduction might have a negative effect on seeding in some plant populations.

Farming intensification has also brought about quite a few alterations. In some areas, increased and "badly timed" ploughing has led to soil erosion, while the sustained application of manure and fertilizers, the use of pesticides and herbicides, poor drainage and changes in the use of field boundaries and border zones have also been of negative influence on biodiversity associated to farming.

Most of Norway's productive farmland is situated in the fertile lowlands where population and development pressures are the highest. Some of this prime agricultural land is taken over for urban expansion (e.g. roads, housing, shopping areas, etc.) resulting in the loss of many different components of biodiversity both above and below ground.

Pollution is the second largest threatening factor to Norway's red-listed species in and around farmland. Direct causes of pollution include the spraying of biocides and the use of pesticides. Pesticides are believed to particularly have an impact on pollinators in agricultural landscapes, even if a thorough evaluation on the full extent of this impact is not yet available.22

Indirect fertilization, through long-transported nutrients by both water and air, also affect a number of species that are present in agricultural landscapes. Excessive nitrogen deposits, for example, have a negative impact on species whose habitat consists of nitrogen-poor vegetation. Direct fertilization of semi-natural grassland is actually often avoided to preserve species-richness.

Similar to pollution, climate change is thought to pose a risk to approximately 6% of Norway's red-listed agricultural habitat related species. With the predicted variable onset of growing seasons and

[21] Bjørn Dahle is a senior advisor at the Norwegian Beekeepers Association.

[22] Wild bees are good indicators of valuable agricultural habitats due to their demand for both nesting sites and suitable pollen-producing plants.

prolonged periods of soil freeze-thaw cycles, climate change is likely to become an even more important threat to biodiversity for food and agriculture, including food crops, in the future.

At present, limited information is available on the extent to which alien species affect the biodiversity that is present in Norway's agricultural landscapes (Gederaas et al., 2012). As the dispersal of alien species in Norway continues to expand, caused by factors such as globalization,[23] uncritical planting,[24] the abandonment of farmland and subsequent succession,[25] and changing climatic conditions, [26] the (possible) impacts of alien species need to be better understood.

The introduction of non-native species, whether intentionally or accidentally, is a major component of human induced global change (Vitousek et al., 1997). However, little consideration has been given to the implications of introducing non-native subspecies or beneficial organisms such as pollinators (Goulson 2003; Moritz et al., 2005). Exposed to the extensive trade in bumble bees, Norway has imported non-native commercially reared subspecies of Bombus terrestris from the Netherlands for the pollination of glasshouse crops. Even if there is now clear evidence of the establishment and spread of the non-native Bombus terrestris L. as a result of its use in glasshouses in several countries (e.g. in Japan; Matsumura et al., 2004; Inari et al., 2005), inevitably many workers (Morandin et al., 2001), males and new queens (gynes) are escaping (Goulson et al., 2002a) through unobstructed glasshouse vents and from discarded nests (Ings, et al., 2006). There is therefore a risk of non-native subspecies of B. terrestris establishing in Norway putting native bumble bees at risk through competitive displacement and/or hybridization. The new regulation on alien organisms (Forskrift om fremmede organismer) put restrictions on the importation and spread of alien species such as foreign bumblebees that are being used for pollination in greenhouses.

In agricultural landscapes, collecting can be a threat to rare species of associated biodiversity that are relatively easy for collectors to find. This could contribute to the disappearance of small, residual populations of a species. Especially rare plants are at risk, as are butterflies, which are particular popular collecting items. Overall, most insects are relatively well protected from collecting, as they are often difficult to find. Moreover, insects may have large populations and thus the potential for reproduction, as long as their habitat remains intact (Schartau et al., 2010).

Egg collecting is an old tradition in Norway, both for supplementary food and for collecting as "scientific" material. The collection of eggs was a relatively common hobby until the end of the 1960s. Even if not completely harmless, egg collecting was not a highly organized activity and it was of no great threat to most threatened bird species. Today's illegal egg-collecting is far more

[23] Globalisation has increased international trade, resulting in the extension of road and water networks and an increased transportation of people and goods over national borders. Regulatory-wise, Norwegian food legislation has been harmonized with the European Union in line with the European Economic Area (EEA)-agreement, obliging Norway to follow the EU legislation on the food and veterinary area. This has at times led to the introduction of alien species into the country.

[24] Uncritical planting can lead to the dispersal of undesirable species.

[25] The overgrowth of abandoned farmland has given alien species better opportunities to become established.

[26] Particularly rising temperatures are expected to improve the survival rate of alien species.

systematic and it is of direct threat to many bird species, in particular wading birds. Eggs from bird species such as the Lesser White-fronted Goose (Anser erythropus), Gyr Falcon (Falco rusticolus), Broadbilled Sandpiper (Limicola falcinellus), Long-tailed Skua (Stercorarius longicaudus), White-tailed Eagle (Haliaeetus albicilla), Golden Eagle (Aquila chrysaetos), Red-throated Pipit (Anthus cervinus) and Temminck's Stint (Calidris temminckii), as well as from many common bird species, were among the confiscated eggs. Finnmark is the most targeted region by both Norwegian and foreign egg collectors with the peak egg collection period being between 10 to 25 June (http://www.bioforsk.no/ikbViewer/Content/109429/Fuglekriminalitet_Engelsk.pdf).

Finally, some agricultural policies are not necessarily favorable to the distribution of associated biodiversity in farmlands. As in any other country, the main goal of most Norwegian agricultural policies is to increase productivity. While such policies do aim to take the environmental conditions into account as much as possible, these are not their primary objective. On the other hand, some agricultural policies specifically favor the conservation of associated biodiversity species. Policies promoting summer farming, for example, have significantly contributed to the maintenance of some extremely species rich semi-natural grasslands by encouraging farmers to take their livestock to mountain pastures to graze.

6.2 Main drivers of change in forests[27]

About 50% (or 1840) of the threatened and near threatened species on the Red List are considered to have at least 20% of their occurrences in forests. The development of Norwegian forests and of the forestry sector is therefore of great importance to the conservation of biodiversity. This being said, it is interesting to note that there is no indication that the status of the red-listed species that are linked to forests has deteriorated between 2006 and 2010.

As part of the country's sustainable forest management approach many initiatives with a positive effect on the diversity of associated biodiversity components in forests have been undertaken. For example, the policy to increase the volume of standing and lying dead wood has contributed to securing the habitat for a number of associated biodiversity species. Around a third of the red-listed species in forests are linked to dead trees and an especially large diversity of insects and fungi (e.g. saprophytic fungi) live by degrading dead wood. Measurements show that the amount of dead wood in Norwegian forests is steadily increasing as a result of various important environmental measures that have been taken in forestry over the past twenty years. The National Forest Inventory estimates that the current volume of dead wood in Norway varies between 80 and 100 million m3. It also shows that the amount of dead wood is increasing by more than 3 million m3 per year. This could be of positive influence on the status of many red-listed species in forests.

[27] For this section of the report information and comments were provided by Artsdatabanken, NIBIO, the Norwegian Institute for Nature Research (NINA), the Ministry of Agriculture and Food and the Ministry of Climate and Environment.

There are also examples of species that are actually associated with managed forests. For example, several bird species depend on spruce plantations in areas that were not naturally colonized by spruce.

Felling and the subsequent removal of trees inevitably change the structure and composition of forests, as well as the local climatic conditions, which in turn affects the habitat of forest associated biodiversity. However, Norway's sustainable forest management approach aims to keep such effects localized and limited. In recent years, action has been taken, inter alia, to avoid or customize logging in areas that are of particular importance to red-listed species. In addition, the felling of trees is managed in such a way that the country has forests of all dimensions and age classes (e.g. a large share of today's "older" forests were newly planted following felling, storm felling or fire). Statistics from the National Forest Inventory show a steadily increasing volume of trees in all dimensions and age classes for the main types of forest, spruce, pine and deciduous forests. Over the past ten years, the area of forests with trees of over 100 years old has increased between 5 to 10%.

Where selection felling has shifted to clear felling (which is when nearly all the trees in the felled area are removed), the density of forests has increased. This might have a local impact on red-listed species that have a preference for open forests, including certain lichen and insect species. However, the shift towards clear felling is not the only reason for denser Norwegian forests, nor is this phenomenon only taking place at the local level.

Changing grazing patterns have also had an impact on forest associated biodiversity. Over the past 50 years there has been a significant decline in domestic livestock grazing in Norwegian forests, while grazing by wild ungulates (red deer, moose and roe deer) has increased. This new grazing regime, where leaf and twig eaters rather than grass eaters have become predominant, has changed the competitive relationships between species living on the forest floor. In addition, the rise in moose populations has enhanced pressure on the regeneration of deciduous trees, particular aspen (Populus tremula), rowan (Sorbus aucuparia) and goat willow (Salix caprea), which are important habitat providers for many red-listed species in coniferous forests. In some areas, the grazing pressure of wild ungulates on the ground vegetation may also affect the plant cover, as well as the occurrence and diversity of animals that live there. A study on the effect of moose grazing revealed the largest diversity of ground beetles where grazing pressure was moderate.

The building of roads, including the construction of (farm) roads for the transportation of timber, along with housing and commercial and industrial developments affects a small proportion of Norway’s forest area. At the same time, however, some of these newly constructed roads contribute to strengthening the use of renewable forest resources that are embedded in a sustainable forest management strategy.

Pollution is reported to be a threat for around 5 % of the threatened and near threatened species in forests. With respect to long-transported air pollution, the SO2-concentrations in precipitation have substantially decreased in recent years. Nitrogen inputs on the other hand are still high. In forests (not in agricultural habitats) this can be of negative influence on mycorrhizal fungi that are particularly sensitive to higher levels of nitrogen.

Little is known on the effects of climate change on forest associated biodiversity, which may explain why only around 1 % of the threatened and near threatened species in forests are reported to be threatened by climate change. However, the impacts of climate change on both forest trees and their associated biodiversity are likely to rise in the future due to the unstable onset of spring and the increasingly favorable conditions for pest species.

Species that have been introduced into Norway through human activity are reported to threaten only eight of the threatened and near threatened species in forests. However, in the absence of an exhaustive assessment of alien species in forest habitats, this figure could be underestimated.

6.3 Main drivers of change in marine and freshwater environments

Only about 3% (88 species) of all threatened and near threatened species on the Norwegian Red list occur in the marine environment. Most of these are mollusks (24), followed by fish (13), birds (13 or 25% of the breeding bird species in the marine environment), algae (12) and crustaceans (8).

Shallow bottoms near the coasts play an important role in the different life stages of many demersal fish species. Even if the exact effects of human activities on the different types of marine habitats are often still ambiguous, interventions such as dredging in shore zones and the construction of marinas, roads and leisure facilities are known to affect the habitat of marine associated species, such as algae and invertebrate species, thereby influencing the recruitment, growth, food supply and the need for protection of aquatic genetic resources such as demersal fish species.

Being rich in benthic flora and fauna, the seabeds of the North Sea, Skagerrak and adjoining coastal areas are important feeding and growing up grounds for dermersal fish species such as cod, haddock and flatfish (White paper nr.37 (2012-2013)). Bottom trawling and the construction of seabed installations, particularly in chronically trawled areas, could lead to reduced prey availability for demersal fishes, affecting their food intake, body condition and yield (http://rspb.royalsocietypublishing.org/content/282/1799/20142336).

Pollution and eutrophication28 are considered to have an impact on 17 of the threatened and near threatened marine related species. Eutrophication is mostly a problem in isolated coastal and fjord areas close to densely populated areas or areas with intensive farming. These areas usually also have to deal with long-transported nutrients from the Baltic Sea and the southern North Sea. Norway's northern areas are exposed to pollutants that are transported over long distances by air and with ocean currents. These pollutants enter the Arctic food chains, ending up in seabirds, seals and polar bears.

Acidification, mainly caused by excessive carbon dioxide, is believed to reduce the resilience of marine living organisms to pests and diseases.

Natural acidification of freshwater has been taking place since the last ice age. Over the last century, however, the acidification rate of many of the lakes and rivers has considerably increased,

[28]excessive input of nutrients

mainly as the result of industrial and power generation activities across Europe. Some of the factors affecting freshwater acidity are related to changing land-use practices, such as the use of nitrogen fertilizers, increased drainage and the wet deposition of sulphuric and nitric acids. As a result of freshwater acidification, many algal, as well as soft-bodied species, such as leeches, snails and crayfish disappear. Other species such as dragonfly larvae, water beetle and bloodworms can grow abnormally large in population size in the absence of their competitors. As to freshwater fish, while pike and eel have shown to be relatively resistant, salmon, trout and roach at all life stages are very much at risk from freshwater acidification. In addition, "new" pollutants with potentially severe and complex impacts are continuously being discovered.

Excessive harvesting is no longer a severe threat for commercially exploited fish species. However, overfishing can endanger the survival of seabirds that are in fact in direct competition with human fishermen. When the supply of fish, like for example herring, drops to less than a third of maximum capacity, seabirds such as common gulls and Atlantic puffins suffer significant declines in birth rate. Seabird species are among the most endangered bird species, owing to the lack of food but also to other factors such as climate change and the destruction of coastal habitats where, once again, they are in competition with humans for space along the water's edge (Cury, et al., 2011). Some seabirds also drown in nets and inflict other injuries caused by fishing gear. "Ghost fishing", where gear that is lost continues to fish for months or years, is one of the inadvertent negative effects of fishing on marine biodiversity.

Climate change is considered to be a threat to just a few marine associated species, even if great uncertainty is attached to the scale and extent of climatic effects on marine ecosystems.

British scientists suggest that a rise of about 4°C in summer temperature will cause all the major seaweed species to go extinct from large parts of southern Norway. This could have fatal consequences for the region's kelp forest. In the Skagerrak, sugar kelp is already declining due to rising temperatures. Photo: http://www.imr.no/nyhetsarkiv/2014/april/matproduksjon_med_klimalosninger_i_norske_fjorder/nb-no

Over the past 30 years, mainly due to the steady increase in shipping between different harbours and the use of more and faster ships that empty their ballast water with reduced time intervals, the introduction and spread of alien species increased considerably. In Norway, problems related to the spreading of alien species have so far been limited, even if some species such as the Japanese wireweed (Sargassum muticum) in southern Norway and the red king crab (Paralithodes camtschaticus) in Finnmark have significantly increased their range. Both these species have spread from neighbouring countries to which they were also originally introduced.

The competition for area caused by the expansion of aquaculture, in particular open fish farms, could have a negative effect on wild fish resources (e.g. competition between escaped farmed fish and wild salmon for food and habitat).

6.4 The effect of climate change on associated biodiversity

The Norwegian Biodiversity Information Centre (NBIC) estimates that climate change is affecting 3% (117) of the threatened and near threatened species listed on Norway's 2010 Red List. The majority of these species are vascular plants, followed by bryophytes and lichens, half of which are found in arctic and alpine habitats. Even if only a small number of associated biodiversity species in agricultural land, forests and marine environments are believed to be affected by climate change, relevant figures are limited and need to be interpreted with caution.

Over the past decades, average temperatures on land, in freshwater and in the sea have risen due to the climate change. This has led to a longer growing season (two to three weeks longer than in the 1980s) with increased production and reproduction rates as a result. Other effects of the changing climatic conditions include the increased abundance of certain types of mosses and lichens in Norwegian forests, trees coming into leaf earlier, salmonids leaving rivers for the sea at a younger age and shifts in the fish spawning areas as a result of increasing sea temperatures (Norwegian Environment Agency, 2013).

With the annual mean temperature in Norway being estimated to rise between 2.3 to 4.6 degrees by the end of this century, ecological transformations of an unprecedented scale since the end of the last ice age are expected to bring a wide range of changes to species and ecosystems (Norwegian Ministry of Climate and Environment, 2014). According to regional and local climate scenarios developed for Norway, future climate change is expected to have an effect on all habitat types and on the species they shelter. Such scenarios also assume that rising temperatures will increase the length of the growing season by one to two months in most lowland areas and by two to four months in high-mountain areas. Some of the predicted changes could thus turn out to be favorable to Norway's agricultural productivity, even if the precise effects remain to be seen.

At the same time, unstable onsets of spring, higher frequency of heavy precipitation and floods and increased pest loads are also expected. Increasingly humid autumns, milder winters and longer growing seasons will provide the perfect conditions for the establishment of "new" pests, as well as of pests that might have been present in Norway previously, but did not find the appropriate conditions to survive, spread and become established. Worldwide, invasive alien species are considered to be the second most important threat to biodiversity, behind land-use change. Steps to prevent the spread of such species will therefore be vital as the Norwegian climate changes (Norwegian Environment Agency, 2013). It also remains to be seen how climate change will

interact with other factors, such as the overgrowth of open habitats, construction and development, and pollution (Norwegian Environment Agency, 2013).

With rising mean temperatures, both the volume of standing wood and the total area of Norwegian forests are expected to rise. The proportion of tree species that thrive well in warmer climates is also likely to increase. Species with a southerly and south-westerly distribution are expected to get better conditions, whereas the few tree species that are confined to the northernmost forests in Norway will most likely experience poorer conditions. On the whole, trees may become more vulnerable to insect and fungal pests under milder average temperatures and changing rain- and snowfall patterns (Norwegian Environment Agency, 2013).

Northern birch forests are a characteristic type of forest for the Nordic countries. Approximately every ten years birch forests are attacked by inchworms29 whereby serious attacks can lead to the forests dying and being renewed over large areas. Climate change may increase the frequency and location of such attacks, which could in turn affect birch tree populations and their associated biodiversity.

With respect to pollinators, climate change could have an impact on population densities and species composition due to phenological or spatial mismatches, which could be of influence on the interaction between plants and pollinators (Hegland et al., 2009).

In marine areas, rising temperatures may favor the expansion of threshold species30 in Norway, such as the Pacific cupped oyster (Crassostrea gigas) that has spread rapidly and out of control in the Wadden Sea, as well as in Danish and Swedish west-coast waters, and recently reached the Norwegian Skagerrak coast.

As a result of climate change, the number of parasite species and diseases is also expected to rise, threatening aquatic genetic resources both in the marine environment and in fish farms.

6.5 Main drivers of change in the delivery of ecosystem services

The National Biodiversity Information Centre (NBIC) is documenting drivers affecting species and their habitat using information and data from many different sources such as natural history museums, research institutions, environmental agencies and Non-governmental organizations run by professional and amateur biologists. NBIC does not systematically provide information on the functions the documented species have in their respective habitats neither does it link any of the species to the delivery of specific ecosystem services. Overall, the knowledge on the delivery of ecosystem services and on the drivers that are affecting them is still inadequate according to the report Natural Benefits-on the value of ecosystem services (NOU 2013:10).

[29]Larvae of moths of the Geometridae family.

[30]species that have been introduced into neighbouring countries and are causing problems there.

6.6 Main drivers of change with respect to wild food resources

Even if the more commonly consumed wild food species like wild Atlantic salmon, lobsters, freshwater crayfish and deep water shrimp are exposed to over-exploitation from commercial and/or recreational harvesting, the overall availability and diversity of wild foods in Norway are not estimated to be under any major threat. There are a few examples of over-harvesting affecting a small number of very rare wild food types, as well as of some wild food species that are known to be threatened by pests and diseases. The European crayfish (Astacus astacus) is for example threatened by the introduced disease-causing fungus Aphanomyces astaci, while the canine tapeworm (Dipylidium caninum) could pose a threat to the harvesting of wild berries in the future.31

With less (particularly younger) people being interested in harvesting wild foods, the knowledge of wild foods is believed to be declining, especially with respect to berry picking. The harvesting of fungi and medicinal and aromatic plants seems to be experiencing a rising trend. Hunting and fishing remain popular activities, even if the average age of hunters is increasing (SSB, 2012).

In the past 10 to 20 years, several programmes have been established by the Ministry of Agriculture and Food to enhance the development and production of niche food products, including products based on wild food resources.

Small-scale ice cream production in Western Norway using wild berries.
Photo: Kim-Anh T. Mezzera

[31] The canine tapeworm is spread through fecal contamination by foxes on maturing fruits and berries and can be quite dangerous to human health when ingested.

The interest in using wild food resources available in- and around farmland for commercial small-scale production (i.e. through the production of regional food specialties) has especially grown among women trying to create supplementary farm income (White paper Nr. 9). At the Nordic level, niche products promoting programmes have also been developed, stimulating both the use and the conservation of underutilized domesticated and wild resources.

6.7 Main drivers of change on the role of women farmers and traditional farming

In the 20th Century, Norwegian agriculture was dominated by family farms. Most farmers ran their family holding on a full-time basis, generating the largest part of their income from mixed farming (i.e. combining livestock -mainly dairy cattle and/or sheep- with food and feed crop production). Forestry or fisheries along the coast also played an important part in the total farm income. In these family farms the women of the household actively participated in running the farm, carrying out many diverse tasks, including tending animals.

Over the last 50-60 years, larger family holdings have had the tendency to ”masculinize”, with the man of the family running the farm at an increasingly higher level of mechanization and the women of the household seeking salaried employment outside the farm. In smaller holdings, on the contrary, with rising education levels, particularly men farmers seem to have increased the share of time allocated to off-farm work (i.e. in forestry, fisheries, industry - including oil rigs) (Bjørnsen & Johansen, 2006), more and more transferring the management of the daily farm activities to women.

Today, family farms of modest size are still the backbone of Norwegian agriculture. Family farming is more than a simple profession; it's a way of life where both women and men are involved in decision making, as well as in undertaking practical tasks, including in relation to the maintenance and use of genetic resources.

Even if the number of small-holder farms has dramatically reduced over the years quite a number of them have managed to stay in business thanks to a combination of Norway’s natural conditions that inhibit farm growth, concentrated farm ownership and various support schemes (e.g. agricultural policies promoting the maintenance of rural areas).

Family farming and distributed ownership has significantly contributed to promote the maintenance and use of traditional farming practices,32 including the preservation of knowledge of the use of herbs, fruits and vegetables. Women tend to play a prominent role in up keeping traditional farming practices, which in turn contribute to the maintenance of soil fertility and of structural habitat complexity, species richness and the stable delivery of ecosystem services. Examples of traditional farming include, inter alia, the maintenance of coastal heathlands, species-

[32] Traditional farming is not based on traditional knowledge as described in Article 8(j) of the CBD. It relates to less intensive and often small-scale (family) farms that promote the maintenance and use of traditional farming practices.

rich meadows and a range of other semi-natural nature types that depends on traditional forms of harvesting and management.

Since the "Odelsrett"33 has become gender neutral for children born in and after 1965, the number of women farmers has marginally increased. In 1999, women owned 26% of all agriculture holdings with their share being larger in smaller holdings than in larger ones (Steen Jensen, 2005).

The rising interest of women in nature, the environment, animal welfare and life in the village is also believed to have contributed to the slight increase of women running farms and in particular organic farms; only half of the women organic farmers in Norway actually grew up on a farm. This trend is believed to be beneficial to the use and conservation of biodiversity for food and agriculture. At farmer markets (Bondens Marked), for example, where the primary purpose is to promote and support the production of local food products, research has shown that approximately 20% of the farmers are organic farmers (Flaten et al., 2007), half of which are women (Bjørkhaug, 2009).

The government aims to increase the involvement of women in farming and is making provisions to reach this goal. Until very recently, special funds were allotted through the reindeer agreement to secure and increase the participation of women in reindeer farming activities and to ensure they have the opportunity to preserve and maintain traditional knowledge related to Sámi reindeer herding. Photo: Ragnar Våga Pedersen/NIBIO

[33] Through this ancient inheritance right the eldest child (whether a son or daughter) inherits the farm after his or her parents with the obligation to pay the other siblings their share of the estate. For children born before 1965, the eldest son would inherit the farm; only if there were no sons, the eldest surviving daughter would be the farm's heir. With the "Odelsrett" having become gender neutral, the number of women farmers slightly increased.

6.8 Main drivers of change on Sámi traditional knowledge

The Sámi are an indigenous people that are present in Norway, Sweden, Finland and the Kola Peninsula in the north-western part of Russia. The Sámi settlement in Norway stretches from Finnmark to Hedmark with a total estimated population of around 50,000 to 65,000 (Nordisk ekspertgruppe, 2005). The Sámi constitute a significant part of the total population in Finnmark and are in majority in Inner-Finnmark.

The establishment of the Sámi Parliament in 1989 has significantly contributed to the maintenance and use of Sámi traditions. The Sámi Act (stipulating the responsibilities and powers of the Sámi Parliament), Article 110a of the Norwegian Constitution (1988) and the Finnmark Act (2005)34 are all contributing to the protection of the cultural heritage and cultural environment of the Sámi and to strengthen and continue the Sámi culture.

In 1990, the Sámi were formally recognized as an indigenous people in Norway (ILO Convention 169). Hence, according to international law, they are entitled special protection and rights. In addition, through the adoption of Article 110a of the Norwegian Constitution in 1988, the Norwegian authorities took on the responsibility to create the conditions enabling the Sámi people to preserve and develop their language, culture and way of life. In accordance with this Article, Norwegian Nomadic Sámi are, for example, exempt from the requirement to pay a fishing fee as per Section 14 of Act No.14 of 9 June 1978 relating to reindeer husbandry.

White paper nr.42 (2000-2001) specifically addresses matters pertaining to biological diversity and it includes a specific section on biological diversity and Sámi. In section 8.3 of the paper, the government recognizes the importance to preserve and document traditional knowledge to maintain and provide the opportunity to develop Sámi culture. This knowledge, which is essentially held by older people and traditionally passed on to the next generation orally and through "learning by doing", can easily be lost during the rapid modernization that Sámi society is undergoing. Examples of such knowledge include the use of resources such as berries and plants in the outlying fields, as well as the use of fish resources. Municipal and regional authorities consider the preservation of traditional knowledge a priority. They closely follow the work that is being undertaken by several projects to document and preserve traditional Sámi knowledge.

Furthermore, as a Contracting Party to the Convention on Biological Diversity (CBD), Norway has taken on the responsibility to facilitate, as far as possible and as appropriate, the implementation of Article 8(j), pertaining to the preservation and maintenance of knowledge, innovations and practices of indigenous communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity, including biodiversity for food and agriculture.

The adoption of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity

[34] Finnmark Act: In 2005, Norway adopted the Finnmark Act, transferring about 95% of the area in Finnmark county to the inhabitants of Finnmark. The Act attempts to strengthen the Sámi rights by giving the entire population of Finnmark greater influence on the property in the county. While the Act does not cover fishing rights in saltwater, mining or oil rights, it has contributed to maintaining certain Sámi traditions, including reindeer herding.

(Nagoya Protocol) in October 2010, its ratification by Norway on October 1, 2013 and its entry into force on 12 October 2014 have been important developments for the Norwegian Sámi. The Nagoya Protocol represents a significant step to mainstream indigenous rights as a cross-cutting issue in international negotiations; next to Article 12 of the Protocol that specifically relates to traditional knowledge associated with genetic resources, Article 11 on transboundary cooperation is also highly relevant to the Sámi, whose population lives across four adjacent states.

6.9 Positive drivers on biodiversity for food and agriculture

Policies and programmes have been a key driver in terms of promoting and safeguarding biodiversity for food and agriculture.

Agro-environmental policies and programmes such as the Regional Environment Programme (RMP) have been particularly effective in this respect. Established in 2005 (White Paper Nr.70), the RMP is a central component in the national environmental efforts in agriculture. Through the provision of grants that are managed by the Norwegian Agricultural Authority35 the programme contributes to the sustainable performance of agriculture. Interesting examples in this respect are the provision of agricultural grants for maintaining endangered native livestock breeds (e.g. Telemark cattle, the Norwegian spæl sheep and the Fjord horse) and for the prevention of nutrient runoff from agricultural areas. Regarding the latter, USD 28 million was spent on relevant projects in 2011 (Norwegian Ministry of Climate and Environment, 2014). Support provided through the RMP has also contributed to the conservation and restoration of unique agricultural landscapes, including biodiverse pastures that offer a habitat to a range of valuable species, like for example salamanders. The decisions on the content of the RMP are taken at the county-level. However, national priorities, such as those that have been set by the Ministry of Climate and Environment with respect to the species and habitats to conserve, are also taken into account.

Other examples of positive drivers on biodiversity for food and agriculture include, inter alia, acreage subsidies36 that are being allocated to farmers to up keep, maintain and develop the agricultural landscape, subsidies that support organic farming and farm ponds establishing projects. Environmental subsidy schemes, such as those that promote the conservation of grasslands, of lichen pastures (reindeer farming) and of harvested forests, also contribute to safeguarding biodiversity of for food and agriculture.

The Nature Diversity Act includes a number of provisions that are of importance when it comes to reducing adverse impacts on biological, geological and landscape diversity. Among others, the Act

[35] The Norwegian Agriculture Authority is the agency of the Norwegian Ministry of Agriculture and Food that is responsible of ensuring that all subsidy schemes and regulations are administered uniformly across the country and throughout the value chain. At present, Norway has about 100 different subsidy arrangements related to agriculture, including subsidies that are favorable to traditional farming and rural settlements (i.e. grazing related subsidies, livestock subsidies per farm and per head, including for farmers with small livestock populations). To receive subsidy payments, farmers have to meet well-defined requirements set forth by the government (i.e. fencing criteria, quality prerequisites for the area under their ownership, as well as obligations regarding their own contribution).

[36] Acreage subsidies are in line with Norway's agricultural policy objective to stimulate active farming throughout the country.

contains a series of principles for official decision-making, such as the precautionary principle[37] and the user-pays principle.[38] The Act also includes a principle for species management, whereby harvesting and other removal of terrestrial invertebrates, plants and fungi occurring in the wild are permitted to the extent that they do not jeopardize the survival of the population concerned. A similar principle exists for marine organisms in the Marine Resources Act (Act of 6 June 2008 No. 37) and in the Wildlife Act for the harvesting of wildlife (Act of 29 May 1981 No.38) and of salmonids and freshwater fish (Act of 15 May 1992 No.47).

Recently, the Nature Diversity Act introduced two tools to protect vulnerable habitats and species. Threatened species can be designated a 'priority species', giving them particular protection along with the habitat they live in; and endangered and vulnerable habitats can be designated as 'selected', to safeguard them through protection and sustainable use. The tools enable the central government, the local authorities and the private sector to prioritize, regulate and coordinate what can and what cannot be done within these selected habitat types. In each municipality, surveys are being carried out to establish the areas that are of most importance for preserving natural diversity.

In Norwegian forests, a significant number of measures are in place to reduce possible adverse effects on associated biodiversity, ecosystem services and wild foods. About 34% of the country's total forest area and 22% of its productive forest area are classified as protective forest under the Forestry Act. Protective forests are selected forest areas that are treated with special care due to their location and characteristics. They may serve as protection against avalanches and landslides, flooding rivers, flood damage, sand drift or as special protection for other forests, cultivated land or settlement. The term protective forest can also apply to forests that due to their location near the mountains, near the ocean or far up north have such difficult regeneration conditions or such slow growth that they could be destroyed by mismanagement or wrong harvesting procedures. In protective forest areas, timber harvesting is allowed, although with some restrictions.

Protected forest areas have been established as national parks, nature reserves and landscape protected areas. Approximately 6.1% of Norway's total forest area, or 4.3% of its productive forest area, is classified as protected forest with forestry activities being more limited in landscape protected areas. When excluding landscape protected areas, these percentages are 4.1% and 2.8%, respectively (Tomter & Dalen, 2014; Miljødirektoratet, 2014; Skjeggedal et al., 2010). Under the so-called voluntary protection scheme (frivillig vern) a share of the 4.3% of Norway's productive forest area that is classified as protected forest area is voluntarily proposed for protection by forest owners as a contribution to the conservation of biodiversity in Norwegian forests.

Environmental considerations have been part of Norwegian forest policies for many years through rules and regulations in the Forestry Act, subsidy programmes, environmental registration schemes and capacity building measures to build up environmental knowledge in the forestry sector.

[37] If there is a risk of serious damage to biological, geological or landscape diversity, lack of knowledge shall not be used as a reason for postponing or not introducing management measures.

[38] The costs associated with preventing or limiting any damage caused by a project to biological, geological and landscape diversity shall be borne by the project owner.

Norway also uses a national standard for sustainable forest management. This so-called Living Forests Standard provides specific environmental requirements and actions that are of importance for sustainable forest management. It is part of the country's Programme for the Endorsement of Forest Certification scheme (PEFC).

In 2008, the Norwegian government opened the Svalbard Global Seed Vault. The Seed Vault aims to safeguard crops that are vital to global food security. There are many national, regional and international plant seed collections and gene banks around the world whose primary function is to ensure genetic diversity in the agriculture sector. The Svalbard Seed Vault is a safety stock for these local deposits, which can be used to recreate valuable plant varieties whose seed collections in a local gene bank are lost.

The Vault also aims to secure the long term conservation of forest trees. In February 2015, the first forest tree seeds of Norway spruce (Picea abies) and Scots pine (Pinus sylvestris) were officially deposited and stored in the Seed Vault.

6.10 Key findings and remaining challenges

Key findings

a. Over the past fifty years land use changes have been the most significant threat to associated biodiversity in agricultural landscapes. Both the abandonment of farming and farming intensification has led to alterations that have been of particular negative influence on biodiversity associated to farming.

b. Felling and the removal of trees change the structure and composition of forests and the local climatic conditions, thereby affecting the habitat of forest-associated biodiversity. Norway's sustainable forest management approach aims to keep such effects localized and limited. Other factors with an impact on forest associated biodiversity include, changing grazing patterns, the building of roads and pollution.

c. Bottom trawling and dredging, as well as the construction of marinas, roads and leisure facilities in shore zones are known to affect the habitat of marine associated species, with some of these species being essential food sources for demersal fish.

Remaining challenges

a. Land use changes continue to affect agricultural landscapes negatively. Despite Norway's overall soil conservation strategy, buildings, roads, etc. are increasingly replacing arable land.

b. In agricultural landscapes and forests, still little is known on the extent of the risks caused by climate change, as well as by non-native species, with respect to associated biodiversity.

c. Great uncertainty is attached to the scale and extent of the effects of climate change on marine associated species. The possible impact of the expansion of aquaculture on wild fish resources also needs to be more precisely determined.

7 THE STATUS AND TRENDS OF BIODIVERSITY FOR FOOD AND AGRICULTURE

7.1 Commonalities, differences and synergies between sectors

In 2006, the Ministry of Agriculture and Food established the Norwegian Genetic Resource Centre to ensure the conservation and monitor the development of all national genetic resources for food and agriculture, increase their use in a sustainable manner, raise awareness of their importance and strengthen relevant knowledge. In 2013, the Centre published its strategic plan (Sæther, et al., 2013) laying out the main outputs it aims to achieve. With the support of national genetic resource committees on respectively animal, forest and plant genetic resources, the Centre develops sector action plans to implement its activities. Every four years, these plans are reviewed and updated. The committee on animal genetic resources was established in 1986. Up until the foundation of the national genetic resource committees for respectively plant and forest genetic resources in 2001, Norway's work in these two areas was included in the Nordic network.

7.1.1 Characteristics shared by all sectors

Following the outcomes of the Norwegian country reports on the state of respectively animal (2002 and 2014), plant (1995 and 2008) and forest genetic resources (2012), the three sectors seem to share quite a number of features.

As in many other countries, commercial production in agriculture and forestry is based on relatively few species, varieties and breeds. Commercial breeding and breed improvement is essentially dominated by a single or a small number of mostly Norwegian, partly private, companies. In the case of Graminor (Norway's sole commercial plant breeder), Norwegian and Nordic farmers' cooperatives own 66% of the company and the Norwegian government owns the remaining 34%. The breeding programmes of the main crops (i.e. barley and oat) are commercially based, while the minor crops (e.g. potato, fruit and berries) are predominantly government-funded. The breeding programmes for wheat and forage crops are only partly government-funded.

In the livestock sector, the national breeding companies for dairy and beef cattle, slaughtering pigs, sheep and dairy goats and honey bees are all farmer-owned cooperatives. Norwegian livestock breeding programmes focus on broad breeding goals, including both production and functional traits. To minimize inbreeding breed diversity within different livestock species has been upheld, thanks to which production figures and animal health39 also improved. With the national breeding programmes being to a large extent based on Norwegian livestock breeds, Norway does not depend

[39] The outbreaks of diseases in livestock production systems have been few and the use of antibiotics and other medication is restrictive (3.7 mg veterinary antimicrobial agents/Populations Correction Unit in 2011) and controlled by the veterinarian authorities (Third ESVAC report, p.26: http://www.bondelaget.no/getfile.php/Bilder%20NB/Mat/Mat-%20og%20landbrukspolitikk/Husdyrproduksjon/Antibiotika%2CEMArapport1401.pdf).

on external sources for the viability of its livestock sector, putting the country in quite favorable position in terms of food security, sustainability and resilience. Only in commercial poultry breeding is the breeding material supplied by international breeding companies. In critical situations (e.g. disease outbreaks) the country has no local commercial poultry breeds/lines to fall back on. However, the Norwegian poultry genebank stores five of the commercial egg layer lines that were used in Norway until 1955, before the European Economic Agreement lifted the ban on importing live animals.

The common objectives in the breed improvement work of animals, plants and forests are to obtain genetic improvement through advanced trait selection and to conserve genetic variation so as to secure future breeding work. To achieve these goals, the three sectors inevitably follow different strategies.

7.1.2 Major differences between sector specific monitoring and registration tools

The different sectors work with different databases. For the livestock sector there are quite a few sector-specific databases, including the Husdyrregistret (a national registration system for all production animals, except llama and domesticated deer, that is managed by the Norwegian Food Safety Authority), Kukontrollen and Geitkontrollen (dairy recording systems for cows and goats managed by Norway's main dairy company Tine). Animalia oversees the Storfekjøttkontrollen (beef cattle recording system), Sauekontrollen (sheep recording systems), Ingris (pig recording system) and Ammegeitkontrollen (meat goat recording system). The pedigree and performance data that are collected through the different livestock recording systems are subsequently used in breeding programmes. Norway also has a cow registration system called Kuregisteret. This is a pedigree database for the country's endangered native cattle breeds and is managed by the Norwegian Genetic Resource Centre. The participation rate in the different livestock recording systems varies between 30 to 95%.

National Forest Inventory (landsskogtakseringen) assesses forest resources across the country. It monitors the growing tree stock and the distribution of tree species.

Photo: Lars Sandved Dalen /Skog og Landskap

Other databases include the fruit species database (fruktsortsdatabasen) and the database for protected areas in forests (http://www.skogoglandskap.no/seksjoner/skogverndatabase). The latter includes information from the database "Naturbase" and from other background material. It is the only database to provide an overview of all the main and associated tree species that are present in protected areas in forests.

Some databases have been developed as such that their information can be integrated. This is for example the case for the cow registration system of the Norwegian Genetic Resource Centre and the vegetation geographic information system (GIS) of the NIBIO, or the Institute's land type maps (AR5) and its protected areas GIS.

The National List of Varieties shows the types of agricultural and ornamental plants which are protected and/or have been approved for certified production in Norway, http://www.plantesortsnemnda.no/national-list-of-varieties.

7.1.3 Synergies between sectors

The Norwegian Genetic Resource Centre is responsible for coordinating the conservation and sustainable use of the country's animal, forest and plant genetic resources for food and agriculture. Having such a common centre in place, Norway is in a privileged position to identify and take advantage of the synergies between the different sectors and to weigh the trade-offs. Regular meetings between the different "sectoral experts" have contributed, inter alia, to the development of the Centre's strategic plan, to joint inputs on national policies of relevance to genetic resources for food and agriculture (e.g. environmental related policies) and to interesting exchanges of knowledge and expertise on issues such as the characterization of genetic resources, *in situ* and *ex situ* conservation and the development of indicators.

7.2 Status and trends of associated biodiversity and ecosystem services

Since 2005, the Norwegian Biodiversity Information Centre (NBIC) has been assessing the status as well as the changes and trends in diversity of different species in the agricultural landscape, forests and marine environments. NBIC has recorded the species following the categories and criteria used by the International Union for Conservation of Nature (IUCN) to list species on the Red List. Norway's first Red List was published in 1999 by the Norwegian Directorate for Nature Management and was updated in 2006 and 2010. NBIC aims to revise the Red List for Species and perform new evaluations of individual species at regular intervals.

7.2.1 Associated biodiversity in agricultural systems and in semi-natural forests

Partial drainage of wetlands and overgrowth resulting from reduced grazing have led to the disappearance of many species from well-known habitats in both agricultural landscapes and forests. For endangered species to survive and spread more lands must be kept open through grazing and more wetlands reinstated.

While approximately half of the threatened and near threatened red-listed species in Norway live in forests, there is no indication that the status of these species has deteriorated between 2006 and 2010.

As part of the country's sustainable forest management approach, many initiatives with a positive effect on the diversity of associated biodiversity components in forests have been undertaken. Among others, the increasing volume of standing and lying dead wood has contributed to securing the habitat for a number of forest associated biodiversity species, including for microorganisms such as saprophytes). Photos: Michael Angeloff / NIBIO and Lars Sandved Dalen / NIBIO

Some activities have a negative effect on biodiversity associated with forests, such as clear-felling for example that is believed to be particularly harmful to mycorrhizae.

There are also examples of species that are associated with managed forests. For example, several bird species depend on spruce plantations in areas that were not naturally colonized by spruce.

7.2.2 Associated biodiversity in fisheries and aquaculture

Regarding the state of vertebrates that are associated to marine capture fisheries most fish species seem in good or even excellent state. The status of several sea birds, however, shows a severe negative trend. The state of associated invertebrates seems on the contrary not to have changed that much over the last ten years, even if some species are known to have suffered from overfishing in certain regions of the country (e.g. lobster, deep-water shrimp). With respect to associated plant species, large areas of seaweed and kelp forests are suffering from down-grazing by sea urchins or from pollution in the southern North Sea.

Biodiversity species in- and around aquaculture facilities have been exposed to the negative effects of the industry, such as parasites, (locally) excessive nutrients, as well as the reduction in quantity and quality of coastal habitats due to the expansion of aquaculture related facilities.

7.2.3 Regulating and supporting ecosystem services within production systems

To date, the status and trends of regulating and supporting services have not been systematically monitored or evaluated in Norway's different production systems. However, the importance of these services to food production and the need to monitor their status and trends is recognized.

There are indications that the number and species diversity of pollinators in Norway is declining. This is believed to be caused by factors such as habitat loss, climate change, the use of pesticides and the introduction of species, as well as by other environmental changes that threaten the

biodiversity of insect pollinators and the plants they collect food from. Over the past decade, the reduction in the number of managed honey bee colonies has been particularly drastic (B. Dahle, personal comments).21 This could strengthen the negative effect on seeding and gene flow that is already being caused by the reduction in number and species diversity of wild pollinators.

Knowledge about the complex interactions between insects and plants and how these are affected by changes in species composition is still lacking (Horg, 2013). Monitoring activities have recently been initiated to reduce this knowledge gap.

Climate change also seems to be having a negative effect on pest and disease regulation in all production systems. In aquaculture, this effect can be further strengthened by the industry. The rapid growth of the salmon farming industry has for example triggered the emergence of salmon louse (Lepeoptheirus salmonis) infestations in salmon farming challenging both aquaculture productivity and the conservation of wild salmon.

Nutrient cycling is assumed to have been negatively affected over the past ten years, in all production systems. At present, few details are available on the factors that have been causing this trend.

7.2.4 Linkages between biodiversity for food and agriculture and ecosystem services

Information on the impact of changes in biodiversity for food and agriculture on ecosystem services is not systematically being monitored or evaluated for the different production systems in Norway. However, there are quite a few examples that illustrate the intrinsic relationship that exists between biodiversity and the continued delivery of ecosystem services.

The seasonal movement of livestock to outlying land in the mountainous areas of the country is part of traditional livestock keeping in Norway (Kvamme et al., 1992; Norderhaug et al., 1999). This form of low-intensive animal husbandry has created some extremely species rich semi-natural grasslands. With the transition to modern livestock production systems since the middle of the 20th century, the utilization of outlying land has significantly decreased (Norderhaug & Ihse, 2003; Bryn et al., 2001). Consequently, much of the characteristic vegetation types associated with semi-natural grasslands have been invaded by large herbs succeeded by shrubs and forests and is today considered under severe threat (Emanuelsson & Johansson, 1987, Direktoratet for naturforvaltning, 1994; Austrheim, 1998; Ihse & Blom, 2000; Ekstam & Forshed, 2000; Fremstad & Moen, 2001). With approximately 30% of the red listed plant species known to depend on grassland habitats (Direktoratet for naturforvaltning, 1999), special management measures are required to ensure semi-natural vegetation types and the species connected to them are safeguarded (Norderhaug et al. 1999).

The habitat and thereby the existence of open landscape-dependent species such as Sorbus and wild apple trees, coastal heathlands and a range of grasses, plants and other associated species are also under threat of reduced grazing of livestock on outlying semi-natural pastures.

The presence and possibly even the diversity of oilseed rape, red clover, fruit trees, strawberries and raspberries on cultivated land and orchards is believed to be of positive influence on the pollination of plants outside tilled land.

There are also cases where the involuntary introduction of alien invasive species has affected pest and disease regulation in Norwegian production systems. In 2008, for example, the invasive

Hymenoscyphus fraxineus fungus, lead to the spread of ash dieback to large areas in the southern part of Norway, affecting forests, nurseries, roadside trees and also trees in gardens and parks. In 2009, the disease spread even further to the southwestern and southeastern parts of the country (Solheim et al., 2012).

On Norway's western coastline, from the1950s onwards, the large-scale plantation and replantation of spruce (in particular Sitka Spruce) in areas that were previously covered by coastal heathlands, is believed to have a positive effect on today's carbon sequestration and oxygen production. Generally speaking, the continuously increasing forest area in Norway is having such effects. However, at the same time, tree planting in areas along the coast has been of negative influence on semi-natural habitats of high biodiversity value.

Changes in the composition and status of fish genetic resources have shown to affect the survival of certain sea bird species. Alterations in migration patterns of fish species such as herring, for example, are threatening the survival of several species of auks, such as the puffin bird, for which these fish species are the main source of food.

Kelp forests represent some of the most diverse and productive habitats on earth. They are important biodiversity repositories and contribute to nutrient cycling, energy capture and flow and coastal defense. During the 1970s, large kelp forest areas, predominantly Laminaria hyperborea, suffered destructive grazing by sea urchins (Strongylocentrotus droebachiensis). Since the late 1980s, kelp forests in the southernmost part of a 2000 km2 area along the coastline of mid-Norway that was overgrazed by sea urchins seem to be recovering. This large-scale ecological shift appears to be related to the collapse of sea urchin populations. The Norwegian coast has experienced such population collapses before, even if on a far smaller scale (Christie et al. 1995; Skadsheim et al. 1995). In the northern part of the barren ground (North Norway), no kelp forest recovery has been reported and the dominance of sea urchins persists (Fagerli et al., 2013).

7.2.5 Managing associated biodiversity in support of the delivery of ecosystem services

In Norway, quite a few species of associated biodiversity are actively managed to strengthen the delivery of regulatory and supporting ecosystem services. In some cases this management practice is part of a research programme, while in others, it forms an integral part of the farmer's production method. Table 1 provides a description on how some associated biodiversity species are managed to improve the delivery of ecosystem services.

Table 1 Associated biodiversity species that are actively managed to help provide regulating or supporting ecosystem services

Ecosystem service provided	Actively managed species	Production system40	Additional description	Information source
Pollination	Semi-domesticated honey bees are rented out for the pollination of agricultural crops. Wild bumble bee (Bombus terrestris) queens are collected and their colonies used for the production of greenhouse vegetables and berries.	Rainfed crops	Growers can rent semi-domesticated honey bee colonies for about USD 75 per colony and crop. This service is mainly used for the production of cherries, apples, pears, plums, raspberries, strawberries, black currant and rapeseed.	Norwegian Beekeepers Association / NIBIO
Pest and disease regulation	Companion planting, usually of non-native crop plants to repel or confuse pests and/or provide key resources to beneficial organisms. Placement of nesting boxes in orchards to stimulate the presence of insect-eating birds, such as caterpillars. Wrasses species (Labridae) are used to reduce the burden of sea lice in aquaculture.	Rainfed crops Fed aquaculture	Companion planting is used in organic farming and in private gardens. Onions and carrots are co-planted to, for example, repel carrot flies. Nesting boxes are particularly used in organic farming.	NIBIO / the Norwegian Institute for Nature Research (NINA)
Water purification and waste treatment	Using food, timber and fish processing waste and animal manure for the production of bioenergy.	Rainfed crops Livestock grassland-based systems Semi-natural forests Self-recruiting capture fisheries Fed aquaculture	An integrated policy exists to handle food waste and animal manure for the production of biogas. The production of second-generation biofuel using waste and timber is also ongoing. Fish processing wastes could become a significant source for the production of bioenergy.	White paper nr.39 (2008-2009) (Ward & Løes, 2014)
Natural hazard regulation	Management of vegetation bordering	Rainfed crops	Vegetation bordering rivers such as bushes and trees	Regional plans for water

[40] The different production systems are described in more detail in the chapter *Norway's main food and agricultural production systems* in this report.

	rivers to increase the resilience of production systems to natural hazards.	Semi-natural forests	bind soil particles and contribute to reducing surface runoff41 and soil erosion.	management
Nutrient cycling	Management of vegetation bordering rivers Plantation of clovers in organic farming fields to stimulate nitrogen binding by food crops.	Semi-natural forests Rainfed crops	(Re-) establishment and maintenance of buffer zones is an effective tool to enhance denitrification and to protect against nutrient runoff.	Regional plans for water management (Henrikson, L., 2000) NIBIO
Soil formation and protection	At present, soil associated species are not actively managed. Management of vegetation bordering rivers	Rainfed crops Semi-natural forests	NORSØK (former Bioforsk Økologisk) is undertaking experiments on soil quality and soil resources (including the monitoring of earth worms that are useful soil health indicators). There is no systematic overview of the extent and diversity of soil organisms in the studied areas. By binding soil particles, roots of river bordering bushes and trees help to reduce surface runoff and soil erosion.	NORSØK Regional plans for water management
Water cycling	Sustainable forest management aims at having healthy forests with, inter alia, healthy soils that contribute to water cycling.	Semi-natural forests	Healthy forest soils provide natural water filtration resulting in high-quality source water that requires minimal treatment.	(Henrikson, L., 2000)
Habitat provisioning	Management of buffer zones	Semi-natural forests	Buffer zones (e.g. between cultivated land and forests and river bordering vegetation) provide unique habitats for a range of living organisms, including micro-organisms, invertebrates, vertebrates and plants.	Regional plans for water management (Henrikson, L., 2000)
Production of oxygen/gas regulation	Increased planting of forests in new areas	Semi-natural forests	Increased planting of forests enhances carbon sequestration and the production of oxygen, both of which positively contribute to the mitigation of climate change.	(Haugland et al., 2013)

[41] Vegetation on the edge of rivers intercepts nutrient runoff from agriculture, blocking nutrients such as phosphorus and nitrogen from polluting waterways.

7.2.6 Risk status of the different components of associated biodiversity

The Norwegian Red List for Species is the list of species that have a risk of going extinct in Norway. Each species in the Red List is assigned to one of six categories42 depending on its risk of extinction.

With the help of NBIC, the species that are associated with biodiversity for food and agriculture were extracted from the Red List for Species and linked to the production systems in which they occur (i.e. livestock grassland-based systems, rainfed crop systems, semi-natural forests and the marine environment). The result of this exercise is reflected in Table 2 below.

Table 2 Main threats to associated biodiversity identified as at risk by production system.

Production system40	Associated biodiversity species (number)	Degree of threat of going extinct42	Main threat
Livestock grassland-based	Arthropods (552), including: insects (516), spiders (35) and crustaceans (1) Vertebrates (24), including: birds (18), amphibians and reptiles (4), mammals (2) Molluscs (2) Fungi (156) Vascular plants (83) Mosses (47) Lichen (35)	Arthropods (552) -Insects (516) RE (45); CR (23); EN (117); VU (141); NT (131) and DD (59) -Spiders (35) EN=3; VU=25; NT=5; DD=2 -Crustaceans (1) NT=1 Vertebrates (24) RE=1; CR=3; EN=1; VU=6 NT=13 Molluscs (2) EN=1; DD=1 Fungi (156) RE=2; CR=4; EN=23; VU=52; NT=41; DD=34 Vascular plants (83) CR=6; EN=16; VU=25; NT=32; DD=4 Mosses (47) CR=5; EN= 12; VU=13; NT=6; DD=11 Lichen (35) CR=7; EN=10; VU=12; NT=6	Arthropods Habitat loss due to changing land use and pollution Vertebrates: changes in the breeding population in neighbouring countries and habitat loss Molluscs: habitat loss Fungi: habitat loss and pollution Vascular plants: habitat loss

[42] The six categories are Regionally Extinct (RE), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Data Deficient (DD).

Rainfed crops	Arthropods (90), including: Insects (79) and spiders (11) Vertebrates, including: birds (7) and mammals (1) Fungi (1) Vascular plants (29) Mosses (14) Algae (1)	Arthropods (90) - Insects (79) RE=8; CR=1; EN=26; VU=27; NT=13; DD=4 - Spiders (11) VU=8; NT=2; DD=1 Vertebrates (8) CR=1; VU=2; NT=5 Fungi (1) NT=1 Vascular plants (29) RE=2; CR=1; EN=8; VU=8; NT=9; DD=1 Mosses (14) VU=4; NT=2; DD=8 Algae (1) VU=1	Arthropods Habitat disappearance due to changing land use and pollution Vertebrates Habitat loss Fungi Habitat loss Vascular plants Habitat loss
Semi-natural forests	Arthropods (1049), including: insects (985); spiders (45); springtails (10); myriapoda (7); crustaceans (2) Vertebrates (29), including: birds (17) and mammals (12) Molluscs (8) Fungi (742) Vascular plants (89) Lichen (154) Mosses (61)	Arthropods (1049) - Insects (985) RE=27; CR=43; EN=205; VU=288; NT=312; DD=110 - Spiders (45) EN=3; VU=23; NT=17; DD=2 - Springtails (10) RE=8; CR=1; EN=26; VU=27; NT=13; DD=4 - Myriapoda (7) VU=5; DD=5 - Crustaceans (2) NT=2 Vertebrates (29) CR=3; EN=5; VU=12; NT=8; DD=1 Molluscs (8) EN=2; NT=2; DD=44 Fungi (742) CR=35; EN=109; VU=196; NT=273; DD=129 Vascular plants (89) RE=2; CR=6; EN=10; VU=27; NT=42; DD=2 Lichen (154) CR=23; EN=42; VU=53; NT=36 Mosses (61) CR=6; EN=15; VU=22; NT=12; DD=6	Arthropods habitat disappearance due to changing land use Vertebrates habitat loss both for birds and mammals and human disturbance for mammals Molluscs habitat loss Fungi Habitat loss and pollution Vascular plants Habitat loss

Marine environment	Molluscs: 133 Crustaceans: 90 Sponges/polypus: 47 Vertebrates (38), including: fish (17); birds (13); and mammals (8) Ringworms (19) Algae (18) Vascular plants (5) Insects (1)	Molluscs (133) CR=2; EN=3; VU=3; NT=16; DD=109 Crustaceans (90) EN=1; VU=2; NT=5; DD=82 Sponges/polypus (47) NT=5; DD=42 Vertebrates (38) RE=1; CR=5; EN=6; VU=9; NT=11; DD=6 Ringworms (19) EN=1; VU=1; NT=1; DD=16 Algae (18) CR=1; EN=8; NT=3; DD=6 Vascular plants (5) EN=3; NT=2 Insects (1) DD=1	All associated species in the marine environment Land-use changes, excessive input of nutrients (eutrophication) and harvesting The majority of the threatened and near threatened fish are cartilaginous fish (sharks and skates). The commercially exploited and common fish species like European eel (Anguilla anguilla) (CR), blue ling (Molva dypterygia) (EN) and red fish (Sebastes marinus) (EN) are red listed because their stocks have been declining in recent years. Among the algae, it is especially the stoneworts (charophytic algae) that have many red listed species. All the brackish water stoneworts (10 species) are red listed. Two of the other three threatened or near threatened algae are found in the littoral zone.

7.3 Monitoring associated biodiversity

There are several monitoring systems in place that contribute to assessing the status and trends of associated biodiversity in Norwegian production systems. Most of these systems, the majority of which are listed below, were however not developed for this purpose.

The Norwegian Biodiversity Information Centre, Norway's national knowledge bank for natural biodiversity, makes risk assessments and provides updated information on species and different types of habitats and ecosystems present in the country. The Centre's main deliverables in this respect include:

- The Species Observation System (Artsobservasjoner): In 2008, in cooperation with the Norwegian Biodiversity Network (SABIMA), the Norwegian Biodiversity Information Centre launched a reporting system called the Species Observation System, giving those with relevant knowledge the opportunity to contribute to the documentation of the country's species diversity. Selected parts of the provided data are submitted to a quality check. Since its establishment, the system has registered over 10 million observations, which were reported on by more than 8,500 people. The system has a national coverage, but information is also provided at county level (19 in total). Reference: http://www.artsdatabanken.no/Article/Article/133693
- The Species Map Service (Artskart) provides digital information on the presence of species in Norway, using the database of the Species Observation System. While the Species Map

Service is being used as a tool in natural resource management by research and industry, it could become more important in the future if standardized approaches of habitat classification were used (similar to the approach followed in the Nature types in Norway (NiN)-system). This would improve the knowledge of species and their habitats and facilitate the identification of habitats that could be selected for the conservation of biodiversity. However, it is not advisable to exclusively use species mapping data for direct site selection and prioritisation. Reference: http://artskart.artsdatabanken.no/default.aspx

- Red lists for both species and habitat types: the Norwegian Biodiversity Information Centre also manages Norway's Red lists for both species and habitat types. In 2010, 4600 species were red-listed for Norway's mainland and 70 for Svalbard. In 2011, half of the 80 habitat types covered by the Red List for Ecosystems and Habitat types were regarded as being threatened.
- Both red lists have a national coverage. Information on the red-listed species and habitat types can be found at county level, and is also put into perspective with relevant information provided at the European and at the global level. The most important factors of influence and the preferred habitats of the species are also provided.
- Alien species in Norway – with the Norwegian Black List 2012: in total, 2320 alien species have been identified on Norwegian territory. 1180 of these have been assessed by the Norwegian Biodiversity Information Centre on whether they pose an ecological risk to native species and habitats or not. The Norwegian Black List 2012 indicates that 217 alien species either have a severe or high ecological impact.

The NIBIO also manages quite a few monitoring systems of relevance to associated biodiversity. Among others, the institute runs the:

- 3Q programme that monitors land cover and land use in agricultural landscapes in Norway. This includes a number of landscape elements important to biodiversity (e.g. solitary trees, hedge rows, rocky outcrops, etc.). One element of particular interest is farm ponds, as many associated biodiversity species, including a variety of insects, amphibians and birds are associated with them. Maintaining and/or establishing farm ponds directly contribute to the conservation of associated biodiversity. Farm ponds also provide support in the prevention of soil erosion, protect water quality by collecting and storing runoff water, provide water for livestock, fish, wildlife, and recreational activities, and add aesthetic value to the agricultural landscape. Through the so-called 3Q programme, approximately 1400 plots of 1km2 spread across the country are monitored. Hedmark, Oppland, Østfold, Akershus and South Trøndelag are among the counties with the greatest incidence of farm ponds recorded in the 3Q system. Analyses have shown that over the past five years, the number of farm ponds significantly increased in the Hedmark and Oppland counties. There is however a decline in the number of farm ponds in Østfold and Akershus (Norwegian Forest and Landscape Institute, 2011). The 3Q programme also monitors vascular plant species and farmland birds; and
- Norwegian National Forest Inventory (NNFI) provides estimates of forest parameters on national and regional scales by means of a systematic network of permanent sample plots.

The Inventory covers several variables relevant for associated biodiversity in forests (e.g. coverage of bilberries and of areas that provide important habitats for red-listed species) and also includes Environmental Inventories in Forests (MiS). MiS has two interdependent objectives: i) to improve knowledge of environmental values in forests, in terms of biodiversity and cultural heritage; and ii) to develop methods for recording and monitoring these values.

At present, there are no systematic monitoring activities related to soil associated biodiversity. However, through the "Living topsoil" project,43 soil health, including the occurrence of associated soil biodiversity, is being assessed on agricultural land of both conventional and organic farmers. Following such assessments, farmers are given advice on possible ways to bring back "life" into the soil. Farmers participating in this project are from the counties of Buskerud, Østfold, Vestfold and Rogaland. Both organic and conventional farmers, as well as decision makers at county (Fylkesmannen) and national (Norsk Landbruksrådgiving) levels have shown great interest in this project. In the context of this project, Bioforsk Økologisk (now NORSØK)[44] made a series of thematic sheets on life in soils (http://www.agropub.no/id/10808.0).

The Terrestrial Ecosystems Monitoring Programme/Program for terrestrisk naturovervåking (TOV) that is mainly managed by NINA45 aims to detect both short- and long-term effects of climate change, long-range pollutants and other natural and anthropogenic impact factors on vegetation and fauna in common boreal and low alpine ecosystems. In addition to climatic variations, snow cover, storms, changes in rodent populations and the amount of birch-defoliating moths are important causes of changes in these ecosystems (Framstad (red.), 2013).

The Norwegian Environment Agency oversees a number of wild foods related databases, including:

- Naturbase, a database that provides spatial data on biodiversity. It gives an overview of the protected areas and the state-funded outdoor recreational areas and provides maps indicating selected habitats and ecologically functional areas for priority species (http://www.miljodirektoratet.no/no/Tjenester-og-verktoy/Database/Naturbase/);
- the Wild reindeer database (villreinbasen), that contains information on the habitats of wild reindeer by municipality and on wild reindeer committees and relevant decision making at county level. It also offers a map service to facilitate the management of the habitat of wild reindeer (http://www.miljodirektoratet.no/no/Tjenester-og-verktoy/Database/Villreinbase/);

[43] This project came about through a partnership between county representatives of Buskerud, Lindum AS, VitalAnalyse and former Bioforsk Økologisk

[44] Norwegian Centre for Organic Agriculture (NORSØK). At the establishment of the Norwegian Institute of Bioeconomy Research (NIBIO) from 1 July 2015, it was decided that NIBIO should not promote a certain farming system, like organic farming. NORSØK has therefor been given the task from the Norwegian ministry of agriculture and food to take over personnel and tasks from NIBIO in this field

[45] The University of Oslo is responsible for monitoring vegetation in Solhomfjell.

- the Wild salmon registry (Lakseregisteret) that keeps track of salmon, trout and char populations in 1300 rivers across the country (http://www.miljodirektoratet.no/no/Tjenester-og-verktoy/Database/Lakseregisteret1/); and
- Sea environment (havmiljø), an analytical system that undertakes environmental valuations and measures the vulnerability of marine species and habitats to oil pollution during different periods of the year (http://havmiljø.no/).

The Norwegian Nature Index documents overall trends for biodiversity in different ecosystems in Norway relative to a state of reference. At present, a large share of the Nature Index work is based on assessments conducted by experts. The Nature Index uses 309 indicators split between nine major ecosystems, excluding agricultural areas, Arctic ecosystems and green urban spaces. The state of reference being defined differently for different indicators and ecosystems, one must be cautious when comparing the state of the various ecosystems based on the index number. The methodology and indicators of the Nature Index are continuously being improved and the Index' next version is expected to be based on more factual data and it will also include a proposal on the development of future measures.

The Norwegian Marine Data Centre (Norsk marint datasenter-NMD) is a national data center for the management of Norway's marine environment and fish data. The Center maintains the country's largest collection of marine environmental and fish data and is managed by the Norwegian Institute of Marine Research (Havforskningsinstituttet) (http://www.imr.no/forskning/faggrupper/norsk_marint_datasenter_nmd/nb-no).

Under guidance of the Directorate of Fisheries, the Institute of Marine Research, the Geological Survey of Norway and the Norwegian Mapping Authority carry out field sampling and other scientific activities within the framework if the MAREANO programme. MAREANO maps depth and topography, sediment composition, biodiversity, habitats and biotopes as well as pollution in the seabed in Norwegian offshore areas.

In line with the EU Water Framework Directive, assessments of the ecological status of inland waters (fresh waters) and coastal waters are being undertaken within the framework of Norway's Water Management Regulations. For these assessments, Norway has been divided into 11 river basin districts that are managed by river basin district authorities. By the end of 2015, all water bodies should have been assessed based on biological indicators and chemical parameters and given an environmental status (good, moderate, poor) in accordance with the EU Water Framework Directive criteria.

7.4 Conservation of associated biodiversity

7.4.1 *Ex situ* conservation of associated biodiversity

7.4.1.1 Wild plants

The Nordic Genetic Resource Center (NordGen) aims to safeguard plant genetic resources to enable future generations to breed crop varieties and face new challenges. The accessions kept by

the Center include accessions of forage plant species that have been collected from cultivated fields and wild habitats. NordGen also conserves seed samples of other wild flora species, like medicinal and aromatic plants, crop wild relatives, etc. The Center's publicly accessible genetic database contains information on the characteristics and provenance of the conserved plant varieties. NordGen's SeedStore Management System tool (SESTO) and the two databases for grasses of the European Cooperative Programme for Plant Genetic Resources (ECPGR)[46] provide additional information on the size of the collections that are being kept.[47]
The botanical garden of the University of Oslo manages a collection for endangered wild plant species, thereby also contributing to the conservation and documentation of Norway's red-listed plant species.

7.4.1.2 Invertebrates

Recently, a honey bee project within the framework of which endangered honey bee sub-species were conserved through cryoconservation was discontinued, as it turned out not to be successful (Bjørn Dahle, personal comments).[21]

7.4.1.3 Micro-organisms

At present, there is no complete inventory of the microbial collections that are housed in Norway. Public institutions and private companies that store micro-organisms manage their microbial collections and relevant data differently and for different uses. Most food processing companies, like dairy companies for example, have their own storage facilities to keep the microbial strains they use for their produce. Contrary to the collections held in public institutions (e.g. in universities), the information on the nature and size of the collections managed by the food processing industry tend not to be made publically available.

None of the yeast strains used in Norwegian breweries are stored in Norway. Yeast strains owned by the major Norwegian breweries and the commercial strains they use, are kept in the largest yeast strain collections in Denmark (Alfred Jørgensen and Carlsberg) and in Germany (Hefebank Weihenstephan and VLB Berlin). It is assumed that most Norwegian craft breweries use dried yeast, provided by yeast producers in the United Kingdom and the United States of America.

The Norwegian Institute for Water Research (NIVA), Norway's leading institute for basic and applied research on marine and fresh waters, manages a culture collection of algae including more than 900 strains of different algae. This collection serves as the national reference collection for algae and is mainly used for algal experiments.

The Botanical Museum in Oslo houses a mycological herbarium with about 230,000 Nordic48 and approximately 45,000 foreign fungi specimens of both the Ascomycota and the Micromyceta

---

[46] The European Cooperative Programme for Plant Genetic Resources (ECPGR) is a collaborative programme among most European countries aimed at ensuring the long-term conservation and facilitating the increased utilization of plant genetic resources in Europe.

[47] See http://www.nordgen.org/index.php/en/content/view/full/2607I.pdf?epslanguage=no

[48] Most of the fungi have their origin in Norway and the Arctic.

phylum. The database of the herbarium contains almost 30,000 records of observations, notes and literature accounts, as well as nearly 15,000 field notes. So far, more than 106,000 Norwegian specimens have been recorded in a publically available electronic database.

The museum's collection serves as a national reference collection for fungi for comparison and identification with unknown samples and for documenting species distribution and variation within species. It does not preserve specimens to propagate new individuals.

7.4.2 *In situ* conservation of associated biodiversity

Across Norway, the generalized Sustainable Forest Management approach contributes to the *in situ* conservation of biodiversity associated with forests. Specific actions in this respect include: increasing the volume of standing and lying dead wood that provide a habitat for numerous invertebrates, micro-organisms (e.g. fungi and bacteria), plants and lichens; Reduced impact logging (a general policy in Norway); the establishment of protected and protective forest areas; and the management of buffer zones bordering waterways and marshland.

A wide network of protected areas provides home range and habitat for different associated biodiversity species and functional ecosystems. This particularly applies to protected areas in forests, traditionally managed agricultural landscapes and marine protected areas.

Conservation programmes for native and endangered cattle breeds also promote grazing in outlying fields. This practice is favorable to maintain and enhance the diversity of grasses, wild plants, invertebrates and micro-organisms in open landscapes.

7.5 Status and trends of wild resources used for food

Besides the rich diversity of forage plants, the genetic resources of wild berry plants are considered to be the richest with respect to plant genetic resources in the Norwegian flora. Several species of the Fragaria, Rubus, and Ribes genera are distributed in the wild flora, some genuinely wild, but some escaped from cultivated fields. In addition a broad range of wild growing berry species is distributed throughout the country with representatives from the following genera: Vaccinium, Empetrum, Oxycoccus, Sambucus and Hippophae. About 20 rare blackberry (Rubus fruticosus) species have been collected and a long term collection was established in the first phase of the national plant genetic resources programme (2001-2005). The collection of specimens and establishment of a national variety collection for berries has however not yet been completed (Asdal, 2008).

The aquatic related wild food species include the most common fish species that are being caught through recreational fishing (angling and touristic fishing).

Monitoring activities have shown that the status of the country's wild food species has remained relatively stable over the past years.49 There is no evidence of a significant threat of extinction or

[49] Between 2006 and 2010, while some wild food species on Norway's Red List were downgraded, others were upgraded in terms of "threat category".

loss of important wild food populations. While some factors are considered to be of threat to some wild food species, these tend to be fairly under control. Harvest data for hunting and fishing are documented and monitored by Statistics Norway (SSB), while population size figures of important game and fish species are essentially monitored by the National monitoring program for wild cervids and the Institute of Marine Research, respectively.

7.5.1 Wild plants, berries and edible fungi

Between 2006 and 2010 there have been few actual changes in the populations of threatened and near threatened wild plant, berry and edible fungi species according to the Norwegian Red List for Species.50 The main risk factors to the status of wild plant, berry and edible fungi varieties include land-use changes, such as discontinued grazing, discontinued haymaking and discontinued burning of heather, as well as land-use associated changes, such as housing construction, infrastructure, felling special trees, business development, sand and gravel extraction/dumping. Other risk factors include terrestrial and aquatic pollution (e.g. artificial fertilization, biocides, organic and inorganic pollutants and acid precipitation); climate change; harvesting; and invasive alien species (e.g. raccoon dogs (Nyctereutes procyonoides)51 and wild boar (Sus scrofa)). Forestry related activities, such as selective felling, changing tree species, the building of forestry roads and the extinction of forest fires tend to have a negative effect on the diversity of wild food species. Some forestry practices can have both negative and positive effects. Clear felling, for example, has been of positive influence on the status of certain berry varieties, such as raspberry, bilberry and lingonberry.

In terms of wild berries, a national variety collection for berries is under establishment (Asdal, 2008).

[50] As there are few population data to rely upon for many groups of species, the 2010 Red List may not give a representative picture of the actual changes over this 4-year time period.

[51] More information on the impact of raccoon dogs on Norway's flora and fauna is available at: http://www.miljodirektoratet.no/old/dirnat/attachment/502/M%C3%A5rhund-hefte.pdf

In recent years, the harvesting and use of some wild resources that were traditionally used for food (e.g. sorbus for the production of jam and other preserves) significantly decreased, as did the knowledge on the potential uses of these resources. The declining trend in the use and knowledge of wild edible resources is one of the main constraints to the conservation of these resources. Photo: Per H. Salvesen

More financial and human resources need to be allocated to monitor and gain knowledge about wild plant and fungi species, many of which lack population size and resource data. More knowledge is needed on the potential use of these species as a source of food, as well as on the role(s) they play in the delivery of ecosystem services (e.g. certain fungi species facilitate the provision of nitrogen and phosphorus to trees, thereby contributing to the productivity of forests; other wild food species may be of particular cultural value).

7.5.2 Wild mammals and birds

Wild mammal and bird populations are facing a few threats, all of which are considered to be relatively minor and stable. Hunting is highly regulated and closely monitored activity; and while illegal hunting does occur, its effects on the diversity of wild food resources has so far remained limited. Information on the number of traffic killed individuals is available for only a few species. Between 2007 and 2009, traffic killed moose and deer is estimated to have increased. In 2009, almost 7,500 animals, with the total number of individuals being close to 450,000, were killed on Norwegian roads (Solberg et al., 2009; SSB; National monitoring program for wild cervids (NINA)).

7.5.3 Marine species

According to the Norwegian Red List for Species, the degree of threat to marine species seems to be relatively stable. Between 2006 and 2010, there seems to have been few actual changes in the populations of threatened and near threatened species in Norwegian waters.49 Destruction of habitats, changing sea temperature, commercial exploitation and the use of environmental pollutants are considered to be among the main factors of threat to marine species. Fresh water species are also under the influence of the filling in, draining and overgrowing of small lakes, ponds and streams.

7.6 Conservation, management activities and programmes for wild food species

7.6.1 *Ex situ* conservation

The conservation conditions of wild fruit shrubs and trees, as well as of herbs and medicinal and aromatic plants that are conserved ex situ are generally good. However, the level of safety duplication could still be improved.

Overall, the wild food species that are being conserved ex situ are not systematically characterized and evaluated. Nevertheless, some wild food species, like rowan (Sorbus spp.) for example, have been investigated quite thoroughly by the institutions that keep them.

Table 3 provides information on a number of wild food species that are known to be conserved ex situ.

Table 3 *Ex situ* collections for wild food species in Norway

Wild food species conserved	Size of collection (number of accessions)52	Conservation conditions	Objective(s)	Characterization and evaluation status
Onion/leek (Allium sp.)	40 (approx.)	Seed and field genebank	Conservation and use	Few data
Angelica, Holy Ghost (Angelica archangelica ssp. archangelica)	8	Seed and field genebank	Conservation and use	Few data
Common Caraway (Carum carvi)	62	Seed genebank	Conservation and use	Some data
Blackberry (Rubus fructicosus)	21	Field genebank	Conservation and use	Botanical data available
Red currants (Ribes spicatum and Ribes rubrum)	18	Field genebank	Conservation and use	Some data
Plums (Prunus sp.)	40 (approx.)	Field genebank	Conservation and use	Characterization and evaluation project ongoing
Rowan (Sorbus spp.)53	231 accessions54 (2014)	Mostly conserved as seeds, some as plants at the Arboretum and Botanical Garden in Milde	Research (species delimitation, phylogeny and evolution), *ex situ* conservation and evaluation for use in horticulture	Phenotypically and phylo-genetically characterized
HERBS AND MEDICINAL PLANTS				
Oregano (Origanum vulgare)	36 clones	Field genebank	Conservation and use	Some data
Common hop (Humulus lupulus)	39	Field genebank	Conservation and use	Some data
Common tansy (Tanacetum vulgare)	44	Field genebank	Conservation and use	Some data
Ostrich fern (Matteuccia struthiopteris)	19	Field genebank	Conservation and use	Some data
Rose root (Rodiola rosea)	97 clones		Conservation and use	
Blackberry (Rubus fruticosus)	30 varieties	Field genebank (NIBIO Landvik, Grimstad)	Future plant breeding / back-up for threatened wild blackberry varieties	

[52] These collections are spread over several institutions across Norway. These institutions have agreements with the Norwegian Genetic Resource Centre on conservation and maintenance.

[53] The most relevant species traditionally used as sources of food, include: *Sorbus aucuparia*, *Sorbus hybrida*, *S. subarranensis*, *S. sognensis* and *S. meinichii*. A particular form of *S. meinichii* called "Faegriana" is being promoted for the production of jam and other preserves.

[54] Two to three trees are planted per accession. This number is low because the Sorbus is mainly reproduced by apomixis.

The The European crab apple (Malus sylvestris) or wild apple is a relatively rare apple species in Norway. Hybridization with cultivars threatens the diversity and integrity of the wild apple's gene pool. With support of the Norwegian Genetic Resource Centre a research project has been undertaken to develop a conservation strategy for this apple species. The results of this project indicated that a combination of in situ and ex situ conservation activities would be among the preferred options to safeguard the genetic diversity of this apple species. Photo: Per A. Aasen

7.6.2 *In situ* conservation

The "*In situ* conservation of plant genetic resources in protected areas" Project aims to define the optimal number of *in situ* conservation sites to conserve a maximum of the genetic diversity within the most important crop wild relatives (CWR). The Project was initiated in 2013 and will end in 2016. It is managed by the Norwegian Genetic Resource Centre with the support of a reference group, including representatives from the University of Birmingham, GBIF Norway, the University of Oslo, County authorities and NordGen. The project is connected to the European project PGR-Secure (http://www.pgrsecure.org/). The project wishes to know how many *in situ* conservation sites are needed to conserve 99% of the alleles coding for adaptive traits of the country's five most important CWR. Most research activities are carried out in protected areas. By March 2014, 200 crop wild relative species were identified as prioritized species for *in situ* conservation.

7.7 Traditional knowledge to preserve and use associated biodiversity and wild resources

Interesting initiatives have been and are being undertaken to document traditional knowledge of associated biodiversity and wild food species with a view to use this knowledge in today's and tomorrow's food related practices.

7.7.1 Sámi traditional knowledge

Sámi traditional knowledge is essentially held by older people and passed on to the next generation orally and through "learning by doing". It can therefore easily be lost during the rapid modernization that Sámi society is undergoing. Examples of such knowledge include the use of resources that are picked and harvested in outlying fields, such as berries and plants, as well as fish.

Article 110a of the Norwegian Constitution (1988), the establishment of the Sámi Parliament and the Sámi Act stipulating the responsibilities and powers of the Sámi Parliament (1989), as well as White paper Nr.42 (2000-2001)[55] and the Finnmark Act (2005) have all significantly contributed to protect Sámi culture and strengthen the maintenance and use of Sámi traditions, including with respect to the use of wild foods.

The Árbediehtu (inherited knowledge) project is of particular importance when it comes to supporting Sámi communities to develop sustainable livelihoods using traditional knowledge. Through this project, that is being carried out by the Sámi University College since 2010, traditional knowledge and methods Sámi have been utilizing to manage natural resources, including wild foods, and that had so far mainly been transferred through verbal communication and by practice, are being collected, documented and systematized.

For the documentation of Sámi traditional knowledge in the context of the Árbediehtu project ethical guidelines were prepared (Nordin Jonsson, 2011). These guidelines include a section on "male and female traditional knowledge", acknowledging the fact that men and women have and had different responsibilities, tasks and roles in Sámi life (i.e. the traditional knowledge of Sámi women is usually linked to family life, such as the preparation of food, taking care of the family home, etc.). Female traditional knowledge has generally been documented to a lesser extent than male traditional knowledge (Grenier, 1998).

The long-term goals of the Árbediehtu project are (i) the preservation of traditional knowledge; (ii) the inclusion of traditional knowledge in educational programmes; and (iii) the use of traditional knowledge in decision making processes on the conservation and sustainable use of biological

[55] In section 8.3 of the paper of White paper nr.42 (2000-2001) the government recognizes the importance to preserve and document traditional knowledge to maintain and provide the opportunity to develop Sámi culture.

diversity. The Project's work is aligned with the conventions and declarations that were ratified by Norway and are of relevance to Indigenous Peoples and Local Communities.56

Finally and very importantly, municipal and regional authorities consider the preservation of Sámi traditional knowledge a priority. They closely follow the work that is being undertaken by several projects, like Árbediehtu, to document and preserve this knowledge.

7.7.2 Traditional farming

During the 20th century, a series of ethnological registration projects documenting knowledge of traditional practices were carried out on national government supported programmes. Among others, the history of plants used in traditional Norwegian cuisine and medicine were mapped for some of the approximately 107 plant species in the Norwegian wild flora (e.g. the history of Garden Angelica (Angelica archangelica) was documented dating back to the 11th century).The results of these projects are reflected in monographs and short publications and are stored in museum- and archive-collections.

More recently, similar type of registration and collection activities have been carried out at a more local level by interested individuals, some of which have put their documented knowledge into use, for example by developing niche products. An interesting case in this respect is the successful commercialization of "tjukkmjølk", a thick sour milk and traditional summer drink from mountain areas in Norway. Tjukkmjølk is believed to have been produced by using butterworth (Pinguicula vulgaris), a plant that grows on the moors. Up until 1995, when Røros dairy (Rørosmeieriet) started to produce tjukkmjølk at a larger scale, the product had never been commercially distributed. Today, six different local and traditional products, including tjukkmjølk, are exclusively processed at and sold by Rørosmeieriet, and in 2004 tjukkmjølk was the first Norwegian food product to be granted a Protected Geographical Indication (PGI)57(Amilien, Torjusen & Vittersø, 2005).

In the 1990s, the Sogn og Fjordane University College initiated a local project studying commonly used pollard trees in the county. This included documenting traditional techniques to use pollard trees as fodder. Restoring and maintaining pollard trees have since become a state supported activity that is part of the environmental measures of the agricultural agreement.

---

[56] For example, as a Contracting Party to the Convention on Biological Diversity (CBD), Norway has taken on the responsibility to facilitate, as far as possible and as appropriate, the implementation of Article 8(j), pertaining to the preservation and maintenance of knowledge, innovations and practices of indigenous communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity, including biodiversity for food and agriculture.

[57] PGI is one of three European Union schemes to promote and protect names of quality agricultural products and foodstuffs. It is based on the legal framework provided by the EU Regulation No 1151/2012 on quality schemes for agricultural products and foodstuffs. This Regulation ensures that only products genuinely originating in that region are allowed to be identified as such in commerce. The PGI scheme protects the reputation of the regional foods, promotes rural and agricultural activity, helps producers obtain a premium price for their authentic products, and eliminates the unfair competition and misleading of consumers by non-genuine products, which may be of inferior quality or of different flavour.

In Lindås municipality (Nordhordland), the Lyngheisenter, a living museum, explores and teaches old management techniques for the maintenance of coastal heathlands. Through the Regional Environment Programme (RMP), the Norwegian Ministry for Agriculture and Food supports the maintenance of coastal heathlands through the use of environmental friendly techniques like these.

There are also examples whereby knowledge of traditional practices has been translated into practical measures in the area of landscape management. In the preparation of field guides for the maintenance of cultural landscapes, such as «Bondens kulturmarksflora», for example, Bioforsk Midt-Norge (now NIBIO) uses information from historical literature (Bele & Norderhaug, 2008).58

Similar to other farming systems, herding and range management also involve traditional practices. The knowledge of such practices has been steadily declining, partially because more and more agricultural land is being rented out.59 The government has implemented economic and political measures, including grant systems to maintain and enhance traditional farming methods, such as, for example, small-scale transhumance. The main objective of such measures is to preserve certain fields, farmland and landscapes and conserve their rich diversity in grasses and legume species (Asdal, 2008).

The "Man and natural heritage" project (Mennesket og naturarven) is another example whereby traditional knowledge on the use of natural resources is translated into practical action. The project aims to improve the management of protected areas and threatened species, as well as of selected nature types and cultural landscapes by collecting and using knowledge on how natural resources were used by Norwegians in the past, at the time when fishermen, farmers and forest-dwellers were living closer to nature. The project is led by the Norwegian Environment Agency and the Norwegian Nature Inspectorate in close cooperation with relevant institutes and organisations, including the Sámi University College that is responsible for the Árbediehtu project.

7.7.3 Role of women in the sustainable use of wild resources

Norway's active hunting and fishermen's associations play a significant role in terms of the maintenance and dissemination of traditional hunting and fishing practices.

In the 2012/2013 hunting season there were slightly less than 138,000 registered hunters in Norway, nearly 6% of which were women. These figures have shown a rising trend for five consecutive years between 2008 and 2013 (SSB) and slightly decreased in the 2013/2014 hunting season.

Hobby fishing is also quite a male-dominated outdoor activity. In 2008, barely 5% of the Norwegian salmon anglers were women (Tangeland et al., 2008).

---

[58] Additional knowledge about the maintenance of traditionally managed agricultural landscapes can be found in Norderhaug, A., Austad, I., Hauge, L. and Kvamme, M. (1999). Skjøtselshåndboka for kulturlandskap og gamle norske kulturmarker. Landbruksforlaget.
[59] More than 50% of Norway's agricultural land is rented out.

Together with horseback riding, berry and mushroom picking are the only outdoor activities where women are more active than men (http://www.hegnar.no/kvinner/artikkel15985.ece). In 2012, Statistics Norway estimated that there were about 1,6 million annual berry pickers in Norway,[60] most of which were women; men in the age group 16 to 24 were the least involved. In Northern Norway, about 51% of the population is estimated to pick berries on an annual basis, followed by 50% in Trønderlag, 39% in Østlandet (excluding the inhabitants of Oslo and Akershus), 29% in Vestlandet and 28% in Agder and Rogaland. In the northern part of the country, cloudberry is the most harvested berry species, in other regions, billberry, lingonberry and raspberry are the most commonly picked species (http://www.nationen.no/tunmedia/helt-hekta-pa-baerplukking/).

Berry and mushroom picking is also especially popular among the older share of the population. In 2012, 36% of adults aged 67 and above were engaged in either of the two activities at least once over a twelve months period. State supported mushroom checkpoints existed across the country to assist mushroom pickers, free of charge, to identify edible mushrooms. The state support for this service was suspended in 2015.

The eider tradition on the Vega archipelago is an example whereby the role of women has been particularly important in bringing back a lucrative traditional practice in favor of the conservation and use of a wild duck species. For more than 1000 years, the inhabitants of the Vega archipelago made nests for hundreds of eider ducks during spring. The women of the households were responsible to look after the eiders once they were nesting. Half of the eggs produced were used for consumption, while the eider down was collected, cleaned, processed and sold. As a valuable export commodity eider duck down provided about half of the islanders' annual income. From the 1960s onwards, when the inhabitants started abandoning the islands, the eider population also significantly declined.

However, the eider tradition was revived when the Vega Archipelago was awarded the World Heritage status in 2004 and five years later, around 3000 bird houses and nests were made and nearly 1300 birds nested. Today, the down-collecting tradition is upheld by 18, mostly women, bird tenders, as opposed to 6 or 7 in 2000. The annual global production of cleaned eider down is approximately 2000 kg.[61] [62]

---

[60] 3% less than in 2002 (http://www.ringblad.no/kultur/article6827286.ece).

[61] The people of Vega and the surrounding district, particularly women, still manually clean the down. It takes a couple of weeks to clean one kilogram of down, as the down needs to be dried, shaken, rough-cleaned and then fine-cleaned.

[62] See http://www.verdensarvvega.no/index.php/no/ for more information.

7.8 Natural or human-made disasters affecting biodiversity for food and agriculture

In the course of its history, Norway has hardly been affected by major natural or human-made disasters, even if the number of severe floods has steadily increased over the past years. The country also suffered from the effects of the Chernobyl accident that took place at the Chernobyl nuclear power plant in Ukraine in 1986.

7.8.1 Chernobyl nuclear power plant disaster

The 1986 Chernobyl disaster has had a significant impact on different components of biodiversity for food and agriculture in Norway. As a result of the accident and unfavorable rain patterns, radioactive cesium permeated freshwater lakes, inland forests and grazing areas, contaminating fish, sheep, reindeer, wild game, berries and other plants (Stephens, 1995).

Trout fishing and sheep and reindeer herding in the central part of the country (south of Saltfjellet, Nordland) were hit particularly hard. With the contamination of grazing pastures, including lichen (the main winter staple of reindeer) large amounts of airborne cesium passed straight onto sheep and reindeer that could no longer be used for human consumption. Consequently, major quantities of meat had to be destroyed in the years following Chernobyl.

To safeguard the livelihood of herders the government took a series of arduous measures: up until 1990 subsidies were granted to compensate for contaminated animals;[63] artificial fodder was introduced; lichen was imported to ensure herders could continue to feed their reindeer; and scientists pioneered with radionuclide-bonding pellets to mix with fodder. In 1987, a method for measuring radioactive cesium in living reindeer was developed and special feeding schemes and early slaughter were introduced to avoid having to dispose of large quantities of meat. The government also introduced becquerel safety levels to regulate the meat industry.

Encouraged by the government, many Sámi herders continued to herd and slaughter as normal following Chernobyl, even if many of the reindeer they raised were disposed of due to their radioactivity levels. To a certain extent, the destruction of herds did interrupt the sharing of traditional herding (Stephens, 1995).

While there is no clear evidence of significant health or reproductive problems in post-Chernobyl Sámi areas (Stephens, 1995), it would be a fallacy to say that health damage has not occurred simply because of lack of conclusive proof.

Three decades onwards, Norway still feels the effects of Chernobyl. Mushroom and grazing animals are being measured on a regular basis for radioactivity. If necessary, sheep and reindeer are treated using the “foddering down” method. The "foddering down" process involves feeding the animals a

[63] The first year after the nuclear accident, the reindeer industry received USD 3.7 million in compensation for the reindeer meat it had not been able to sell.

controlled cesium-free diet six weeks prior to slaughtering. In 2014, several places in the central areas of Valdres and Gudbrandsdalen have seen measurements as high as 4,500 becquerel per kilo of sheep meat, which is seven times higher than the 600 Becquerel allowed for sheep by the Norwegian Radiation Protection Authority (NRPA). The exceptionally good summer and autumn mushroom seasons are believed to be the main cause behind these exceptionally high measurements. Sheep are particularly fond of mushrooms, which are known to accumulate cesium.

To date, combatting the effects of Chernobyl has cost Norway over 650 million kroner (in average USD 430,000 per year). In parallel with the effects of Chernobyl, the investments in the radioactivity schemes are however gradually reducing.

7.8.2 Local pollution

While human caused pollution of several fjords, rivers and harbor areas may not be considered a disaster its effects are significant and long term. In certain areas, local waterway pollution has already led to eating restrictions of sea- and river food.[64]

7.9 Invasive alien species and biodiversity for food and agriculture

There are quite a few examples whereby invasive alien species have had a significant effect on biodiversity for food and agriculture and on the delivery of ecosystem services. Many of these examples are recorded in "Alien species in Norway-with the Norwegian Black List 2012", or “The Norwegian Black List” (Gederaas et al., 2012). This publication provides an overview of a large number of alien species that are found in Norway and assesses their possible ecological impact.65 Species with the greatest ecological impact form the Norwegian Black List 2012. Some information on the (possible) effects of individual alien species on ecosystems is also provided. This type of information is however not systematically documented in relation to the different components of biodiversity for food and agriculture or the delivery of relevant ecosystem services.

The Nature Diversity Act includes the provisions to deter the introduction of invasive alien species to Norway (Chapter IV Alien organisms, sections 28-32). The operational and financial responsibilities for the implementation of this national strategy are divided between the different ministries (Norwegian Ministry of the Environment, 2007). Mid 2015, these provisions were expanded by the adoption of a new regulation on alien organisms (Forskrift om fremmede organismer). The regulation includes a list of forbidden alien plant species and puts restrictions on the importation and spread of alien species. The regulation is an important step forward in the conservation of species and ecosystems in Norway.

[64] The Foreigner (Norwegian news in English), 17 September 2009, 21 February 2012, 20 October 2014.

[65] To estimate the ecological impact of an alien species, the likelihood of the species to become established and spread in Norwegian territories and its potential to affect biodiversity are assessed.

In view of the increased entrance of alien species into Norway, due to several factors, including climate change and unfavorable trade regulations, the diminishing role of the Norwegian Food Safety Authority (Mattilsynet) may have to be reevaluated. With respect to imported foodstuff, for example, the responsibility for ensuring that the product is safe for human consumption and that the labelling and the content comply with Norwegian food regulations has shifted from Mattilsynet to the importer. Perhaps a study could indicate whether changes like these have positively contributed, or not, to the introduction of invasive alien species.

7.9.1 Invasive alien species with an effect on biodiversity for food and agriculture

This section includes examples of invasive alien species that have negatively affected Norway's biodiversity for food and agriculture over the past ten years.

The blacklisted multicolored Asian Ladybeetle (Harmonia axyridis) is a Coccinellidae species that originates from Asia and entered Norway as a stowaway with imported plants (Staverløkk, 2006). The species has established itself (eggs, larvae and pupae) in Oslo and Tvedestrand. It is an aggressive and highly effective predator that eats almost all insect larvae and other Coccinellidae species, irreversibly affecting ecological processes and becoming the dominating species. In a number of countries it has been deliberately introduced for biological control of animal and pests.

There are quite a few examples of invasive alien species affecting native pollinators and pollination. The honey bee (Apis mellifera), for example, competes with native pollinators including with the endangered wild bee Andrena hattorfiana; the Varroa destructor mite is a serious pest of honey bee colonies (Dahle, 2009); and the Buff-tailed bumblebee (Bombus terrestris) competes for resources with native bumblebees possibly leading to a decline in the populations of the latter.

There are also more than 70 alien vascular plant species in Norway which attract pollinators that would otherwise have pollinated native plant species. Sometimes, the native pollinators also transport pollen grains from the alien vascular plants to stigmas in native plants species, which can block the stigmas for the right pollen. Many studies have shown that this competition may have negative effects on the reproductive success of native plants (Bjerknes et al., 2007). At times, alien plant species may also provide a new source of nectar in replacement of native plants that may have declined in number (e.g. due to changing farming practices).

Norwegian forest trees are also exposed to quite a few invasive alien species, including the Ash dieback fungus (*Hymenoscyphus fraxineus*), various Phytophthora species and the Red elderberry (Ambucus racemosa). While the latter is not systematically being monitored, research is ongoing to study how this berry is affecting the regeneration of forest trees.

Biodiversity in Norwegian waters is also subject to a number of invasive alien species.

Along the Norwegian coats, kelp forests create unique three dimensional structures together with associated macroalgae, providing a habitat to a range of invertebrates, fish, marine mammals and birds.

After having recovered from extensive overgrazing by green sea urchins (Strongylocentrotus droebachiensis), kelp forests (Laminaria hyperborean) are now exposed to red sea urchins (Echinus esculentus). The latter have recently been observed grazing on algae and recovered kelp forests along the Norwegian coast (Bekkby et al., 2014). Sea urchins graze kelp in "herds" and can reach population densities large enough to destroy kelp forests at the rate of nearly 10 meters per month. In countries like the United States of America, Sea otters play a critical role in containing the kelp grazing urchin populations (http://sanctuaries.noaa.gov/about/ecosystems/kelpdesc.html). Photo: Yngve Ask/Innovation Norway

During the latest resource mission to the Barents Sea in 2013 and 2014, scientists found large amounts of young snow crabs (Chionoecetes opilio), which implies that the recruitment in the population is good. The snow crab population in the Barents Sea exploded in 2012 and is thereby becoming an important part of the Sea's ecosystem. The snow crab prefers much colder waters than the king crab (see chapter Marine and fresh water environment) and has therefore not spread to the southern parts of the Barents Sea, where the king crabs have settled. However, following the experience with the king crab, one could expect the snow crab to also affect the bottom fauna of the Barents Sea. http://barentsobserver.com/en/nature/2014/03/snow-crabs-have-found-niche-barents-sea-ecosystem-12-03

7.9.2 Controlling the effects of invasive alien species[66]

Still little is known on the unintentional introduction, the colonization and the risks associated with invasive alien species and "door knockers".67 If Norway intends to continue to develop and expand its assessments of the ecological impact(s) posed by alien species, efforts to strengthen the knowledge base are needed.

The unintentional introduction of invasive alien species is regulated through the Nature Diversity Act.68 The enforcement of the Act seems to be quite challenging, partly because the philosophies pertaining to alien species in nature conservation policies and those applying to agriculture and forestry tend to differ. The former are very restrictive with respect to aliens, whereas the latter are open to test and use different species, varieties and breeds, including new ones, to enhance production system development across the different sectors.

With respect to controlling the introduction of invasive alien species into Norway, there are still relatively few measures in place. Areas like these could be strengthened through the allocation of more financial and human resources to responsible authorities like the Norwegian Food Safety Authority (Mattilsynet), that controls the importation of alien plants, parts of plants and other regulated articles into Norway, some of which may carry pests.

To enhance public awareness on the impact of invasive species, control measures and the unintentional introduction of invasive species, more targeted awareness raising activities focusing on hobby gardeners or travelers should also be considered.

Given the global threat of invasive alien species on biodiversity, there is an increasing need for the development of an international methodology that can be used across national boundaries to assess the impacts posed by alien species. In view of its experience in preparing the Black List, Norway is in a good position to promote and participate in the development of such a methodology.

7.10 Linkages between associated biodiversity, wild food resources and genetic resources for food and agriculture

In situ conservation of animal and plant genetic resources for food and agriculture, as well as of forest genetic resources tends to positively contribute to the conservation of associated biodiversity and wild food diversity. Forest conservation programmes,69 for example, have enhanced the conservation of fungi and wild berry varieties.

---

[66] The information provided in this section was extracted from: Gederaas et al., 2012

[67] Door knockers are alien species with the potential to establish in Norway.

[68] Chapter IV Alien organisms, Section 28-32.

[69] Conservation is one of the main pillars of the sustainable forest management approach.

In contrast to most of the different components of associated biodiversity, the status and trends of both wild foods and genetic resources for food and agriculture are well documented. This is true for many countries and is not surprising in view of the countless number of associated biodiversity components.

The conservation of the complex and crucial interactions between associated biodiversity and sector genetic resources are usually not given priority in the management of food production systems. This is of no benefit to the status of associated biodiversity and does also not contribute to the sustainability of the production systems.

In general, there is inadequate capacity and knowledge about most aspects of associated biodiversity. In addition, with the declining number of taxonomists, field knowledge related to these biodiversity species is rapidly weakening. The interest from the general public for associated biodiversity is also very limited.

Regarding ecosystem services, research activities have been modest so far and Norway's knowledge on the whole is limited and fragmentary. Extrapolating knowledge from studies undertaken in other countries is often of limited use due to Norway's unique climatic and geographical conditions.

With respect to pollination, in particular, too little is known about how dependent plant species are on pollination for their seed production; the distribution and density of important groups of pollinators, the plant species they depend upon and those they pollinate; how honey bees interact with wild pollinators; how pollinator communities have changed over time and why; and how climate change affects pollinators and pollination.

Most of the main capacity and resources limitations that are of relevance to pollinators and pollination also apply to other components of associated biodiversity and ecosystem services. These limitations occur in the areas of:

1. Mapping and research (e.g. which species of flowers the various insects visit is not being mapped). Mapping must take place in a systematic and scientifically rigid manner, which requires expertise in insect taxonomy;
2. Taxonomy;
3. Human capacity. Collecting data on the insect fauna that pollinate the more than 1000 native insect-pollinated plant species in Norway is a time consuming and costly exercise.70
4. Higher education. Norwegian universities currently have no regular offer of education specifically directed at pollination ecology.

Norway has few good taxonomists making it difficult to identify collected insect specimens (e.g. for the identification of the most important groups of pollinators consisting of hoverflies, solitary bees, bumblebees, and butterflies and moths). Photo: Ragnar Våga Pedersen/NIBIO

[70] At present, such information is available for no more than 50 plant species.

To fill the existing knowledge gaps, one should start by defining and gathering information on the main challenges with respect to the management of ecosystem services in Norway. In terms of pollination, for example, in view of the decline of many wild bee populations and their significance as pollinators, relevant mapping activities could be strengthened; knowledge about bees and which species of plants they visit could be compiled;[71] ongoing mapping projects could be extended to include new groups of pollinators (especially flies and flower-visiting beetles); depending upon the distribution pattern of the groups being investigated mapping activities could be initiated on national, regional (counties) and local levels; the mapping of specialist plants and pollinators[72]will be a valuable tool in the vulnerability analysis and preservation of such species; and Norwegian universities and experts may wish to cooperate to set up courses on pollination ecology and to initiate joint research projects.

To determine the associated biodiversity species that should be prioritized in terms of monitoring and safeguarding one could start by identifying a selection criterion (e.g. food production, environmental, cultural,...) and the key functional groups[73] within it. Where functional groups have similar ecological roles, those with a single or only a few species (low or no redundancy) should be prioritized for conservation.

Limited knowledge of biological processes, such as the complex interactions that exist between the different components of associated biodiversity in and around production systems, can lead to decisions with unforeseen and often irreversible consequences. An example in this respect is the decision to remove topsoil from agricultural land to safeguard the fertile soil before the land is used for other purposes (e.g. building projects). Topsoil works in harmony with subsoil and bedrock to produce fertile soils and its removal seriously affects their complex relationship; it can take thousands of years for this relationship to rebuild (between 30 to 1,000 years are needed for the bedrock and subsoil to generate 25mm of fertile topsoil).[74]

7.11 Key findings and remaining challenges

Key findings

a. Commercial breeding and production in agriculture and forestry is based on few species, varieties and breeds.

b. Half of Norway's threatened and near threatened red-listed species are associated to forests. Contrary to the status of biodiversity species associated to agricultural landscapes, the status of these species does not seem to have deteriorated between 2006 and 2010.

[71] Such knowledge already exists in Sweden (Pettersson, Cederberg & Nilsson, 2004).

[72] Plants and pollinators that are particularly vulnerable to changes in the availability of partners.

[73] Set of species co-existing in a given community with similar functional characteristics related to an ecosystem service.

[74] Most of the information provided in this section was extracted from: Totland et al., 2013.

c. Most fish and invertebrate species in marine ecosystems seem to be in good to excellent state. The status of marine plant and sea bird species show a negative trend, as does the status of species in- and around aquaculture facilities.

d. Some associated biodiversity species are actively managed to strengthen the delivery of ecosystem services in food and forest production systems (e.g. pollination management for fruit production).

e. Several monitoring systems exist to assess the status and trends of associated biodiversity in food and forest production systems.

f. The status of wild food species has remained relatively stable over the past years. There is no significant threat of extinction or loss of important wild food species. Some wild food species, such as wild fruit shrubs and trees, herbs and medicinal and aromatic plants are conserved *ex situ*. A national variety collection for berries is being established.

g. Several initiatives are being undertaken to document and use traditional knowledge and traditional farming practices involving biodiversity for food and agriculture.

h. Quite a few alien species, including pests and diseases have made their way into Norway and their number is increasing. Some alien species are known to affect native species of relevance to food and agriculture.

i. Genetic resources for food and agriculture, associated biodiversity and wild food resources are intrinsically linked. The complex and crucial interactions between them are neither conserved nor actively managed in food production systems.

Remaining challenges

a. Old traditional plant varieties and endangered native livestock breeds have the potential to contribute to Norway's food production and to the delivery of ecosystem services. At present, these varieties and breeds are underutilized.

b. Relatively little attention is given to the conservation and use of biodiversity associated to food and forest production systems, despite its many roles and functions.

c. Large areas of seaweed and kelp forests are exposed to down-grazing by sea urchins and/or pollution. Biodiversity in- and around aquaculture facilities is under pressure of the expanding aquaculture industry that affects the quantity and quality of coastal habitats of a range of species.

d. The potential effect of changes in the status of biodiversity for food and agriculture on the delivery of ecosystem services in production systems is not being monitored or evaluated.

e. There are no systematic monitoring activities in place related to soil-associated biodiversity. Norway does also not have a complete overview of the microbial collections it houses.

f. Quite a number of wild plant and fungi species are still short of population size and resource data. With respect to wild food species that are conserved *ex situ*, systematic characterization and evaluation is lacking, while the level of safety duplication could also be improved.

g. Initiatives to document traditional knowledge and traditional farming practices involving biodiversity for food and agriculture tend to only focus on how to conserve such knowledge and practices. More emphasis could be put on conserving them through use.

h. Still little is known on the risks associated with invasive alien species and “door knockers” (i.e. alien species with the potential to establish in Norway). With respect to controlling the introduction of invasive alien species into the country, there are still relatively few measures in place.

i. Limited knowledge of the interaction between the different components of biodiversity in and around production systems can lead to decisions with unforeseen and irreversible consequences.

8 THE STATE OF USE OF BIODIVERSITY FOR FOOD AND AGRICULTURE

8.1 Management practices that favour the sustainable use of biodiversity for food and agriculture

Several management practices favour the maintenance and use of biodiversity for food and agriculture. These practices vary in nature and scope, ranging from small-scale projects seeking for practical solutions to long term national programmes.

8.1.1 Regional Environment Programme for Agriculture

The Regional Environment Programme for Agriculture (RMP) promotes sustainable agricultural management practices to achieve a number of environmental goals in agriculture. These management practices include elements of Integrated Plant Nutrient Management (IPNM), Integrated Pest Management (IPM), Pollination management, Landscape management, Sustainable soil management practices, Conservation agriculture, Water management practices and water harvesting. The area covered by these practices has not been calculated, but figures show that approximately 50%, or 22,000 Norwegian farm entities, participated in the RMP in 2013 (Miljøstatus i landbruket for 2013, Norwegian Agricultural Authority).

8.1.2 Managing livestock grazing to maintain biodiversity within landscapes

Across Norway, livestock grazing has contributed in many ways to develop, maintain and restore landscape complexity. When adequately managed grazing enables the landscape to benefit from improved nutrient cycling, fewer undesirable weed species, better water absorption, and increased biological diversity (e.g. grazing contributes to maintain and use native grass and legume species). Grazing also contributes to the recovery of riparian areas (http://www.wildfarmalliance.org/resources/wfagrazebrief.pdf).

8.1.3 Sustainable soil management practices

Globally and nationally the awareness on the importance of soils as a fundament of sustainable food production and a sustainable society is steadily increasing. At present, even if there is no systematic approach to promote sustainable soil management and maintain soil health and soil fertility, some interesting small scale activities, such as improving soil coverage with vegetation, are being undertaken.

8.1.4 Application of Integrated Pest Management principles

Integrated Pest Management (IPM) is somewhat loosely defined in Norway. There is no IPM label and its application is not being monitored. Even so, all Norwegian growers learn about IPM when they take the course to either obtain or renew their license to buy and use pesticides.

In a 2008 survey, 29 % of Norwegian growers indicated they had been applying the Integrated Pest Management (IPM) principles since 2003.[75]

In the near future, Norway is expected to start with the implementation of the European Union's directive on sustainable use of pesticides, making the application of IPM compulsory across the country (http://www.bioforsk.no/ikbViewer/page/prosjekt/tema?p_dimension_id=23995&p_menu_id=24011&p_sub_id=23996&p_dim2=23999).

8.1.5 Genetic base broadening of barley, rye grass and apple

In 2011, the Nordic Council of Ministers established the Public Private Partnership for Pre-breeding to support Nordic plant breeding programmes for barley, rye grass and apple to meet long-term needs of the agricultural and horticultural industries, specifically regarding adaptation to climate change, setting targets for environmental policies, and responding to demands from consumers, markets, etc. The Partnership has been the driving force behind the broadening of the genetic base of barley, rye grass and apple production through the development of new varieties.

8.1.6 Strengthening niche food markets to increase the use of biodiversity for food and agriculture

Niche production based on a variety of traditional plant and livestock related products is increasing (e.g. jams, cheese, meat products, etc.). This provides new opportunities for farmers to broaden their product range, enter into new markets and increase their income. It would be interesting to further explore the significant diversity in plants and livestock and its possible contribution to the development of innovative niche products.

8.1.7 Conservation hatcheries

Several hatcheries in Norway release Atlantic salmon in an effort to compensate for loss of spawning and juvenile rearing areas (due to hydropower development, for example). Relative to other countries in the region the production and release of salmon reared in conservation or fishery enhancement hatcheries is small (Jonsson et al., 1993; Naish, et al., 2008).
According to scientists, hatcheries have been of little impact on the wild fish population structure, despite 40 years of stocking (Heggenes et al., 2002). While hatchery fish does hybridize with wild fish, the survival of hybrids is lower than that of wild fish (Skaala et al., 1996).

8.1.8 Polyculture/aquaponics for sustainable aquaculture

In Evje (Aust-Agder), a pilot-scale aquaponics project has been initiated. In aquaponics, conventional aquaculture is combined with hydroponics (cultivation of plants). Water from the aquaculture system is fed to the hydroponic system. The water's by-products are broken down by

[75] Despite representing only a small part of Norwegian agriculture, most greenhouse vegetable growers use biological control to reduce the number of pest populations. This practice is entirely based on IPM principles.

nitrification bacteria into nitrates and nitrites, which are utilized by the plants as nutrients. The water is then recirculated back to the aquaculture system. In practice, a mini-ecosystem without emissions is created. The project in Evje aims to provide an economic and practical analysis for cold water aquaponics, providing technological solutions and business models for sustainable aquaculture (Liltved et al., 2012).

The project Aquaponics NOMA promotes aquaponics at the Nordic level, involving Norway, Iceland and Denmark. Each of these countries explores the aquaponics system differently, using the options that fit their needs and possibilities. Under this umbrella, NIBIO Landvik in Grimstad (Norway), in collaboration with NIVA (Norsk Institutt for Vannforskning), initiated an aquaponics project in March 2014 using brown trout in a closed system, whereby 100% of the water used is recirculated. It is the first time this fish species is used in an aquaponics system (http://www.nibio.no/nyheter/fiskeoppdrett-og-planter-i-samme-system).

Closed aquaponics systems that recycle water present a new opportunity for sustainable food production in areas where the possibilities for food production are limited due to water scarcity.

8.2 Ecosystem approaches for the sustainable use of biodiversity for food and agriculture

Production systems in most sectors of relevance to food and agriculture are adopting an ecosystem approach. In Norway's forests, crop fields and large areas of marine and coastal waters, ecosystem approaches are generalized management practices that favour the conservation and sustainable use of biodiversity for food and agriculture.

8.2.1 Sustainable forest management in support of forest and forest-associated biodiversity

Norway's forests are governed by the Forestry Act. The Act applies to all categories of forest ownership. It includes a wide range of measures (i.e. legislation, taxation, financial support schemes and research and advisory bodies) and incorporates the country's obligations under international agreements. One of the main objectives of the Forestry Act aims is to promote Sustainable Forest management, the criteria of which are incorporated in Norwegian law.[76]

Sustainable forest management is Norway's general approach in forestry. Many tools and instruments are being used to ensure the successful implementation of this management approach, including certification schemes (i.e. the Norwegian Programme for the Endorsement of Forest Certification and the Forest Stewardship Council) and subsidies enhancing sustainable forestry activities (Tomter & Dalen, 2014). A regulation under the Forestry Act also requires forest owners to reinvest part of their revenue into a government administered fund called the Forest Trust Fund. The Fund is used to secure long term investments in forest management and to facilitate

[76] The criteria of Sustainable Forest Management were negotiated in the framework of forest policy cooperation in Europe.

sustainable silviculture, forest management planning and the development and implementation of environmental measures. Forest owners are also required to deposit between 4 to 40% of the gross revenue from the sale of timber and fire wood to a trust fund that remains with the forest holding. Support schemes for forestry, including financial support is also granted for developing forest management plans, including environmental inventories (Det norske Skogselskap, 2011). Schemes like these significantly contribute to safeguard forest and forest associated biodiversity and to maintain and restore landscape complexity.

Within Norway's sustainable forest management strategy, forest enrichment is an important diversity based practice. It consists of keeping at least 10% of the country's broadleaved trees in coniferous stands.

Approximately 25% of Norway's productive forest area is managed with a focus on protection and environmental considerations rather than on wood production (2.3% of this share is protected under the Nature Diversity Act). In the remaining 75%, even if production is the main objective, environmental and cultural interests are also taken into account (Søgaard et al., 2012) and some kind of measure is applied to reduce the impact of forestry on the environment.[77] Such measures can consist of leaving strips of forest towards ponds, lakes, mires and rivers; leaving single selected trees, snags and logs on clear cuts; small set-aside areas called forest key habitats with restrictions on the use of tree species; areas with selective cutting of trees only; etc. Most of these retention measures were introduced in the late 1990s and have been applied on an increasingly larger area over the last decade. While they are expected to mitigate negative effects of forestry, their actual impact on the long-term remains to be measured. In this context, it is also important to note that harvesting in Norwegian forests has been less than 50% of the increment of trees for several decades. This has resulted in an increasing volume of forest trees and has also enhanced the aging of forests, as well as the accumulation of dead wood and other structures associated with old forests. In view of these trends, the environmental conditions and development opportunities for forest associated biodiversity are likely to improve.

8.2.2 Organic farming and the sustainability of agricultural systems

Similar to integrated pest management (IPM), organic agriculture is an agricultural practice that is based on biological processes. Through an integrated ecosystem approach, ecosystem services are managed to improve productivity and reduce environmental impact.

Over the past 20 years, the number of organic farms and the total area under organic cultivation, as well as the production and consumption of organic products have steadily increased in Norway. Organic food sales augmented by more than 140% between 2006 and 2012, generating a revenue of USD 244 million (or 1% of the total food expenditure in grocery stores) in 2013. Quite surprisingly however, the total area under organic farming decreased from 5.6 to 5.3% between 2012 and 2013 (Oikos, 2014).

[77] This is also being referred to as reduced-impact logging.

The Norwegian government aims to increase the production and consumption of organic food to 15% by 2020. To achieve this ambitious goal, the Ministry for Agriculture and Food developed an action plan entitled "Økonomisk, agronomisk-økologisk!" that was published in 2009.[78] The action plan aims to create the conditions that are needed to ensure that an as large as possible share of the nationally consumed organic food products are Norwegian; increase the consumption of organic food products, both in the private and public sector, through market development; and to ensure work related to the development of organic food production becomes an integral part of activities undertaken in sectors other than agriculture. Incentives, including in the form of subsidies, have been developed to enhance both the number of organic farmers and the area under organic cultivation. White Paper Nr.9 (2011-2012) Agricultural and food policy "Welcome to the table" (Velkommen til bords) reports on the development of organic farming in Norway and discusses the challenges linked to the implementation of the action plan.

Oikos (Økologisk Norge) plays a crucial role in the promotion of organic farming in Norway. This non-governmental organisation was established in 2000 following the merger of Norsk Økologisk Landbrukslag (NØLL), Norsk Økologisk Urtelag (NØU) and Økoprodusentane. It actively serves Norway's organic community by strengthening communication among the different stakeholders and undertaking both practical and political work in favour of organic food production.

Norwegian Centre for Organic Agriculture (NORSØK)[79] also strongly promote organic agriculture. It manages Agropub, a website on organic farming that includes articles on cultivation, farm animals, soils, climate and the envionment (http://www.agropub.no/id/1).

Even if the organic farming community considers organic agriculture to be more beneficial to biodiversity than conventional agriculture, there is quite some debate on this issue both at the global and national level.[80]

8.2.3 The ecosystem approach applied to fisheries

In 1997, ministers and EU commissioners responsible for North Sea fisheries and environment agreed to develop and apply an ecosystem approach in order to integrate fisheries and environmental protection, conservation and management measures. This culminated in the Bergen Declaration from the 5th North Sea Conference in 2002, where a political commitment was made to implement an ecosystem approach applied to fisheries. The ministers agreed to a conceptual framework for the ecosystem approach including an integrated set of Ecological Quality Objectives.

Following the Bergen Declaration, Norway's Institute of Marine Research, which provides most of the scientific advice for fisheries management, strengthened its ecosystem focus in its research and advisory work.

---

[78] http://www.regjeringen.no/upload/LMD/Vedlegg/Brosjyrer_veiledere_rapporter/Handlingsplan_o-kologisk_200109.pdf

[79] Previously called Bioforsk Økologisk.

[80] The scientific committee for food safety contests organic farming is more beneficial to biodiversity for food and agriculture than conventional farming in its 2014 assessment of organic farming: http://www.vkm.no/dav/7852b1a164.pdf.

The Government of Norway adopted the ecosystem approach to ocean management in 2002. For the practical implementation of the approach, Norway developed, among others, the management plan for the Barents Sea. The plan reconciles the different uses that are made of the various resources from the Barents Sea by providing a framework that allows their exploitation while maintaining the ecosystem structure and function.

In May 2009, through White Paper Nr.37 (2008-2009), the Norwegian government launched the Integrated management plan of the Marine Environment of the Norwegian Sea. Following international guidelines for ecosystem-based management, the plan provides an overall framework for managing all human activities (mainly oil and gas industry, fishing, and shipping) in the area to ensure the continued production and function of the ecosystem. Areas of particular value in terms of biodiversity or biological production were identified. In each of these areas, any access for substantial human activity is to be carefully managed. To monitor the overall development of the Norwegian Sea, a set of indicators with associated environmental quality objectives have been selected. The approach used builds upon experience gained from the first integrated Norwegian management plan for the Barents Sea-Lofoten region, developed in 2002-2006. This plan was updated through White paper Nr.10 (2010-2011) Oppdatering av forvaltningsplanen for det marine miljø I Barentshavet og havområdene utenfor Lofoten. Work towards a Norwegian management plan for the North Sea, including Skagerrak, was initiated in 2009. (Ottersen et al., 2011; http://www.imr.no/cliffima/meetings_activites/conferences/240090/2nd_conference/time_table_and_presentations/gi_van_der_meeren_risor_2012.pdf/en.)

8.3 Management practices with an impact on the use of associated biodiversity and wild food resources

8.3.1 Industrial side effects

Industrial side effects, such as acid rain caused by sulphur and nitrogen emissions, can be of threat to many components of biodiversity for food and agriculture. Even if a lot has been done to reduce emissions like these, the deposition of sulfur and nitrogen is the major cause of declining water quality in lakes and rivers in the southern half of the country.
Over the years, many aquatic animals and plants have also severely been affected by acidification. In all, more than 9000 fish stocks were lost and over 5000 were severely depleted due to acidification in 1990. Similar calculations have not been performed since, but a study that was published in 2008 estimated that the area with damaged fish stocks in Norway had reduced from around 20.000 km² in 1990 to 13.000 km² in 2006 (State of the Environment in Norway: http://www.environment.no/Topics/Air-pollution/Acid-rain/.)

8.3.2 Over-use of chemicals in agriculture

The application of artificial fertilizers and other external inputs, such as pesticides, herbicides, veterinary drugs, etc. is highly regulated in Norway, among others through the EU Framework

Directive for Sustainable Use Pesticides. Even so, the loss and over-use of artificial fertilizers (particularly nitrogen) do occur, leading to soil and water degradation (interviews with Bioforsk[81] and VitalAnalyse).

The STRAPP-project (2013-2015) is an interesting example of an initiative that has been taken to minimize the loss of artificial fertilizers. This project aims to develop strategies for the implementation of sound cereal production methods with low loss of pesticides and phosphorus (interview with Bioforsk[78]).

8.3.3 Intensive farming

In some areas, intensive cultivation of land has also negatively affected the health status of Norwegian soils, causing erosion, as well as the depletion of soil organic carbon and soil microbiota.

8.3.4 Associated biodiversity not always a priority in food and agriculture

In Norwegian food and forest production systems, the conservation and sustainable use of associated biodiversity and wild food resources is often not considered a priority, even if the awareness on the importance of these components of biodiversity and the need to maintain them is increasing. For example, in the country's sustainable forest management approach and in the ecosystem approach applied to fisheries, safeguarding biodiversity has become an important pillar.

In the case of plant genetic resources, only a very low number of crop plant varieties are available on the market. This is known to affect the diversity of plant genetic resources and could also have a negative impact on the status of plant associated biodiversity (Åsmund Asdal, personal comments).[82]

8.3.5 Over-grazing

In West-Finnmark, where the number of reindeer is still higher than the maximum allowed number set by the Ministry for Agriculture and Food (see Annex 4 for reindeer population figures for West-Finnmark), over-grazing and increased trampling of animals is believed to cause an imbalance and destruction of the natural resources base. Among others, overgrazing is thought to affect the growth rate and the number of types of lichens, the main and favourite food of reindeer.

Different conclusions were drawn by researchers on whether the reduction of lichen biomass is worse in areas like West-Finnmark where the density of reindeer is high. While some researchers support this theory (Tømmervik et al., 2013), others published results showing increases in lichen biomass instead (Kvakkestad & Aalerud, 2012).

---

[81] Bioforsk became part of NIBIO in July 2015 following the merger of Bioforsk, the Norwegian Forest and Landscape Institute and the Norwegian Agricultural Economics Research Institute.

[82] Åsmund Asdal is a former senior advisor on plant genetic resources at the Norwegian Genetic Resource Centre.

Over-grazing is also believed to contribute to reindeer losses both in Finnmark and in the other "reindeer" counties, and to have a negative impact on the slaughter weight of the animals (White paper Nr.12 (2002-2003)). There is indeed a decreasing trend in the live weight of adult reindeer, even if this figure varies between years and districts.

8.4 Uses of wild resources for food

8.4.1 Hunting and fishing

The most significant contribution of wild foods to the population's food supply comes from commercial fishing (self-recruiting capture fisheries). Recreational fishing and hunting is generally speaking of marginal importance to the population's food supply and nutrition security.

In Norway, hobby fishing is one of the most popular outdoor activities. Approximately half of the country's adult population is considered to be a recreational fisherman, even if the majority, or 56%, is categorized as "an occasional angler". Coast and sea are the most common fishing sites (56%), followed by lakes (26%) and rivers (18%). Annually, USD 271 million is spent on transportation and licenses linked to recreational fishing in lakes and rivers. Recreational fishery is a male dominated hobby with only 36 % of the 1,161 recreational fishermen being a woman. The average age of fishermen is 40 (Toivonen et al., 2000).

Sea angling is an increasingly popular activity both among Norwegian and foreign tourists. As the sea angling tourism industry is growing, so are the involved fishing tourism enterprises that arrange lodging, boat rental and equipment for both foreign and Norwegian tourists. Recent estimates indicate that this industry generates more than USD 73 million annually (Borch et al., 2011).

Hunting is a popular autumn activity of many Norwegians. In 2014, more than 450,000 individuals were subscribed to Norway's hunter register, nearly 19,000 of which come from Akershus county. While the number of women hunters has steadily increased over the past years, nearly 93% of the 195,000 hunters that participated in the 2013/2014 hunting season were men. Among these hunters, 40% exclusively hunted wild deer, 35% hunted small wild animals and about 25% hunted both (SSB, 2014).

8.4.2 Cloudberries and Arctic raspberries

The cloudberry (molter) is an important wild berry variety in Norway. It grows in swamp areas on mountains, plains and even by the sea. Cloudberries are part of Norwegian traditional cuisine. They are used as an ingredient in pies (bløtkaker), cream ("multekrem"), yoghurt, ice-cream, sauces and jams. Photo: John Y. Larsson

In both Norwegian and Sámi cultures, picking and eating cloudberries is a strong tradition. The Sámi traditionally preserved the berries in reindeer milk, which contains high levels of fat (the cloudberry cream is likely to have derived from this practice).

Cloudberries are of high economic value, both because it takes an average of seven years for female plants to give fruit and because the berries can only be handpicked. The general rule is that cloudberries can be freely picked in outlying fields/unfenced areas. However, this rule can slightly differ across regions. In the northern counties of Nordland and Troms landowners have the right to forbid cloudberry picking on their property, while in the northernmost county of Finnmark, anyone can pick cloudberries, but their consumption should be on site or else a special permit is needed. According to paragraph 400 of the penal code (Straffeloven), one could be fined and even put in jail for up to three months if found guilty of unlawful cloudberry picking.

In search of enhancing the economic activities around the production and processing of cloudberries, Inger Martinussen from NIBIO (Tromsø) suggests distributing new and better varieties in swamp areas. She does indicate that improving the selection and development of new cloudberry varieties requires more research on the heredity traits and environmental conditions

that affect the main characteristics of the berry (i.e berry size, the number of flowers and the taste and content of health-promoting substances) (Forskning.no, 2011).

Next to the cloudberry, the Sámi and the local population in the northern parts of the country also used the vitamin C-rich arctic raspberry (Åkerbær (Rubus arcticus)) for jams and deserts. Arctic raspberries are also known to have been used as medicine against scurvy, a vitamin C deficiency disease. At present, the arctic raspberry is still quite commonly found in the inner parts of Troms and Finnmark, but little is known about its consumption. More eastwards, in Finland, this berry variety is being used for the production of Mesimarja liquor.

At times, the Sámi also supplement western-style medical care with traditional more natural medical techniques, using earth, turf, as well as specific herbs and plants (Sexton & Stabbursvik, 2010).

8.5 Gaps and priorities for the sustainable use of biodiversity for food and agriculture

8.5.1 Developing targeted management practices that favour the use of biodiversity for food and agriculture

As a result of political priorities, consistent management actions in favour of biodiversity are more common in the environmental than in the agricultural community. In the agricultural sector, most of the management practices or actions that are of benefit to the use of biodiversity for food and agriculture are not necessarily put in place with that objective. Particularly the conservation and use of associated species does not tend to be prioritized in the management strategies of the various production systems, even if the awareness on their importance to food production and food security is increasing.

More resources need to be allocated to strengthen research on and promote the use of management practices or actions that favour the use of biodiversity for and agriculture.

8.5.2 Strengthening the implementation of ecosystem approaches

Ecosystem approaches are being adopted in several production systems (e.g. in the forestry and fishery sectors). Even so, there are still quite a few major information and knowledge gaps that might hinder the implementation of such approaches.

In the various production systems, particularly little is known about regulating and supporting ecosystem services and the extent to which the delivery of these services is exposed to risk.

To address this relatively complex issue, a first step could be to map the main ecosystem services of relevance to the production system, as well as of the organisms involved, followed by a risk assessment to identify their threats, if any. Such information is of crucial importance to the development and implementation of holistic policies and management strategies, such as the ecosystem approach.

To increase the number of organic farmers and the area under organic cultivation a subsidy scheme has been put into place. The subsidies that have been granted so far have mainly been linked to the size of the area under organic cultivation. To further promote the values of organic agriculture it might be useful to also link these subsidies to, inter alia, the extent to which the farmer contributed to improve the soil structure and health of the land under cultivation, or to whether initiatives have been undertaken to (pro)-actively manage the delivery of ecosystem services, for example by adopting pollinator friendly landscape practices.

Finally, the more practical aspects of organic farming could be strengthened in the trainings that are being given to organic farmers; these seem to have received too little attention so far.

8.5.3 Strengthening the characterization of traditional plant varieties and endangered native livestock breeds

In general, the use of diverse animal, plant, forest and aquatic genetic resources is recognized as important for sustainable and healthy food production and knowledge about these resources is well documented. In Norway's animal breeding program, for example, the focus lies both on yield improvement and on the maintenance of genetic diversity within breeding populations. The breeding work is carried out by cooperative companies that focus on a single productive breed per livestock species. This approach enables farmers to share the breeding programme costs and to maintain genetic variation within the breed. Still, maintaining genetic variation is costly and time consuming and the contribution of traditional plant varieties and endangered native livestock breeds to food security tends to be undervalued. Characterizing these varieties and breeds should be prioritized to gain a better understanding of their potential values and use.

8.5.4 Enhancing knowledge about associated biodiversity for food and agriculture

Safeguarding associated biodiversity in and around production systems needs to move higher up on the political agenda. In order to do so decision-makers, farmers and consumers should firstly and foremost recognize the importance of these components of biodiversity to sustainable food production. This will require the acquisition of knowledge and the development of targeted awareness raising activities.

Overall, knowledge about associated biodiversity for food and agriculture is lacking. Very little is known about the distribution and functions of the different components of associated biodiversity in and around production systems. Moreover, the limited research that is undertaken with respect to associated biodiversity tends to focus on its conservation and not on its sustainable use.

The existing knowledge gaps with respect to most aspects of associated biodiversity are partly the result of the limited resources that are spent on research in this field. More human and financial resources need to be allocated to gain knowledge on how associated biodiversity can be conserved and used for sustainable and healthy food and forest production.

8.6 Key findings and remaining challenges

Key finding

a. A series of initiatives are in place to strengthen the maintenance and use of biodiversity for food and agriculture, with the Regional Environment Programme being among the most important ones.

b. In Norway's forests, certain crop fields and large areas of marine and coastal waters, the ecosystem approach is general practice.

c. The use of diverse animal, plant, forest and aquatic genetic resources is recognized as important for sustainable and healthy food production.

d. The most significant contribution of wild foods to the population's food supply comes from commercial fishing.

e.

Remaining challenges

a. In the management strategies of food and forest production systems, the conservation and use of associated species does not tend to be prioritized, even if the awareness on their importance to these systems is increasing.

b. A few major information and knowledge gaps are hindering the implementation of ecosystem approaches. Particularly little is known about regulating and supporting ecosystem services and the extent to which these services are exposed to risk in the various production systems.

c. Maintaining genetic variation is costly and time consuming. The contribution of traditional plant varieties and endangered native livestock breeds to food security still tends to be undervalued.

d. To ensure commercial fishing is sustainable, it is managed through an integrated marine environment plan. The implementation of this plan continues to be challenging in view of the complexity of marine ecosystems and the absence of data on several marine organisms and their interactions.

9 INSTITUTIONAL SETTING IN SUPPORT OF THE CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY FOR FOOD AND AGRICULTURE AND THE PROVISION OF ECOSYSTEM SERVICES

9.1 National policies, programmes and enabling frameworks

There are a number of national policies, programmes and enabling frameworks that support the conservation and sustainable use of biodiversity for food and agriculture and the provision of ecosystem services. Some of these policies and programmes were intentionally developed with the aim to support biodiversity for food and agriculture, while others are broader in scope and address concerns of relevance to biodiversity for food and agriculture.

9.1.1 Policies and programmes targeting the conservation and sustainable use of biodiversity for food and agriculture

Regional Environment Programme

The Regional Environment Programme (RMP) has been particularly effective to improve the maintenance and use of biodiversity for food and agriculture across different sectors. As previously described, the RMP has contributed, among others, to the conservation and use of biodiverse pastures and of endangered native livestock breeds, and to maintain associated biodiversity species, like salamanders, for example.

Svalbard Global Seed Vault

The long term safety deposit of seeds in the Svalbard Global Seed Vault directly contributes to food security and nutrition in Norway and beyond by conserving crop seeds that are vital to humanity. The Seed Vault encompasses samples of about one third of the unique seeds that according to FAO are stored in genebanks worldwide. From 2012 to 2013, the number of stored seeds increased by 4%.

Norway's national policy for the conservation of cultivated land and soils

This policy was developed to ensure sustainable food production and safeguard food security and nutrition. With Norway's increasingly urban population and thereby the rising need for building and road development projects, implementing this policy has become quite challenging.

9.1.2 Broader policies addressing concerns of relevance to biodiversity for food and agriculture

Regarding the resilience and sustainability of production systems, Norway has a number of policies in place that include references to biodiversity for food and agriculture.

The cross-sectoral strategy on invasive alien species is deeply concerned with the conservation of Norwegian biodiversity, including biodiversity for food and agriculture. The Nature Diversity Act includes the provisions to deter the introduction of invasive alien species to Norway (Chapter IV Alien organisms, sections 28-32). Mid 2015, these provisions were expanded by the adoption of a new regulation on alien organisms (Forskrift om fremmede organismer). The regulation includes a list of forbidden alien plant species, some of which used to be sold by garden centers. It also puts restrictions on the importation and spread of alien species such as of foreign bumblebees that are being used for pollination in greenhouses. The regulation is an important step forward in the conservation of species and ecosystems in Norway. The operational and financial responsibilities for the implementation of this national strategy are divided between the different ministries (Norwegian Ministry of the Environment, 2007).

In the context of climate change and the sustainability of production systems, research on reducing the emission of methane produced by livestock is increasingly gaining interest. In the same line, biomass and timber from Norwegian forests continue to play an important role as renewable sources that can help meet the challenges of climate change.

The national policy of limiting the use of pesticides and antibiotics contributes to the sustainability and resilience of agricultural production systems in Norway, including by being restrictive about imports of breeding animals and other possible sources that could introduce pests and diseases.

Important policies and programmes to support farmers, pastoralists, forest dwellers and fisher folk to adopt and maintain practices that strengthen the conservation and use of biodiversity for food and agriculture, include: the Forestry Act; subsidy schemes managed by the Norwegian Agricultural Authority; agricultural policies in favour of small scale farming; Norway's policy to increase Norway's share of organic agricultural production and consumption to 15% by 2020; the Nature Diversity Act; The Norwegian Water and Wetlands Initiative, as it ensures the maintenance and enhancement of wetland biodiversity and environmental goods and services for improved local livelihoods; the Finnmark Act and the Arbediehtu project.

Policies that embed the use of biodiversity into disaster management and response

The Forest Act includes a paragraph requiring regulations for the maintenance of protective forest, for instance in mountains towards the timber line (the edge of the habitat at which trees are capable of growing). This is to limit the risk of landslides, avalanches, floods and erosion, as well as for general protection of forest, cultivated land or settlement.

At present, there are no explicit policies or programmes in place to preserve and enhance the delivery of ecosystem services. Following a report published by an expert commission in 2013 describing the natural benefits-on the value of ecosystem services (NOU, 2013), the Norwegian government is aware of the need for the development of such policies and programmes. The ecosystem approaches applied in agriculture, forestry and fisheries could serve as frameworks to safeguard the delivery of ecosystem services within the relevant production systems.

9.1.3 Policies and programmes promoting the application of ecosystem and landscape approaches

Organic food production and consumption policy

Organic agriculture maintains healthy soils, sustainable ecosystems and human health, by building on biological processes, biodiversity and nutrient cycles. Parliament has set the goal to increase Norway's organic food production and consumption from approximately 5% today to 15% by 2020.

The Norwegian Genetic Resource Centre recently developed indicators to monitor the country's animal, forest and plant genetic resources in, inter alia, cultural landscapes and protected areas. These indicators will contribute to monitor and evaluate the effectiveness with which the different ecosystem and landscape approaches are being implemented.

The Forestry Act promotes sustainable forest management based on criteria that were negotiated within the framework of forest policy cooperation in Europe (Forest Europe). The fourth criterion of this ecosystem approach has 9 quantitative indicators to monitor the maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems. These indicators are used to assess the diversity of tree species and of forest tree genetic resources, as well as the volume of both standing and lying deadwood and the area of protected forests.

The Living Forest standard was agreed upon in 1998 with the aim to develop criteria for sustainable forestry in Norway, as well as to document and control the environmental conditions in forests. Despite the Standard's formal suspension mid-2012, it has been maintained as part of Norway's Programme for the Endorsement of Forest Certification scheme (PEFC).

The ecosystem approach applied to fisheries, as well as sustainable forest management and (agricultural) landscape management practices, all contribute to the conservation and sustainable use of associated biodiversity. Within the sustainable forest management approach, for example, micro-organism and invertebrate species are safeguarded through the promotion of standing and lying dead wood and by protecting forest areas and other wooded land known for their biological diversity, landscapes and specific natural elements. With respect to the ecosystem approach applied to fisheries, the management plan for the Barents Sea significantly contributes to its implementation.

The Selected Agricultural Landscapes Project (Utvalgte kulturlandskap i jordbruket) was established in 2006 by the Ministry of Agriculture and Food and the Ministry of Environment. It was led and coordinated by the Norwegian Agricultural Authority in close cooperation with the Regional Agricultural Authorities, Nature Management, and Cultural Heritage administrations. The Project's mandate was based on the Ministry of Agriculture and Food's White paper Nr.1 (2005-2006), which

Stated "Cultural landscapes of special historical and biological value are to be registered, and a plan for their management effected before the end of 2010"; and White paper Nr.21 (2004-2005) on Norway's Environmental Policy/State of the Nation's environment that stipulated that "the historical agricultural landscapes are to be managed in such a way that the historical features, aesthetic values, biodiversity and accessibility are maintained". For this Project, 20 agricultural landscapes were selected based on their richness in biodiversity and historical/cultural assets and

on their viability in the long-term. Regional administrators and councils cooperated with the landowners by managing and maintaining the natural- and cultural treasures in the areas.

The Directorate for Cultural Heritage (Riksantikvaren) is responsible for the implementation of the Norwegian Cultural Heritage Act and its objectives that are provided by the Norwegian Parliament and the Ministry of Environment. The Directorate contributes to the maintenance of landscapes by ensuring that a representative selection of monuments and sites from all periods is preserved for present and future generations. The selection of monuments and sites must provide an overview of historical developments, the way of life and the range of works of art and craftsmanship of each period.

9.1.4 National planning in support of biodiversity for food and agriculture by sectors other than agriculture

Norway's current *National Biodiversity Strategy and Action Plan (NBSAP)* was adopted in the form of White paper Nr. 42 (2000-2001)-"Norwegian biodiversity policy and action plan – cross-sectoral responsibilities and coordination". The NBSAP has since been revised by White papers Nr. 21 (2004–2005) and Nr. 26 (2006–2007), both of which are entitled "The Government's Environmental Policy and the State of the Environment in Norway". Since the adoption of the NBSAP, Norway has strengthened its knowledge base on all components of biodiversity and it has improved the coordination of relevant legislative instruments (e.g. the Nature Diversity Act and the Planning and Building Act both have provisions in place to protect biodiversity that are compatible and apply across sectors). To protect the environment, the NBSAP also encourages the coordinated use of legislative and other instruments of the management plans for Norway's sea areas and those of the river basin management plans. So far, particularly the economic instruments of these two management plans are inadequately coordinated.
The Government is currently in the process of drawing up an action plan to halt the loss of biodiversity and implement national goals and the Aichi targets (Norwegian Ministry of Climate and Environment, 2014).

The Nature Diversity Act aims to protect biological, geological and landscape diversity and ecological processes through conservation and sustainable use. The Act applies to Norwegian land territory, including river systems, and to Norwegian territorial waters. The Act includes chapters focusing on species management, alien organisms and access to genetic material, all of which are highly relevant to food and agriculture.

Policies to avoid major disturbances to biodiversity are implemented across sectors (e.g. infrastructure development is for example to be avoided in endangered and vulnerable habitats to maintain important ecological functions) (White Paper Nr.26 (2006-2007)).

Through White paper Nr.21 (2011-2012) and Nr.34 (2007), the Norwegian climate policy embeds the use of biodiversity for food and agriculture, including its different components, into climate change adaptation and mitigation strategies.

9.1.5 Policies, programmes and enabling frameworks governing exchange, access and benefits

9.1.5.1 Access to different components of associated biodiversity

Access to vascular plants, mosses, algae, parts of plants (including berries and fruit), fungi, lichens, terrestrial invertebrates and microorganisms is governed by the Nature Diversity Act. According to this Act, the King may make regulations or individual decisions regarding harvesting and other removal of plants and fungi that are not regulated by provisions laid down in or under another statute. The public right of access (Allemannsretten) gives the right to pick berries, fungi and flowers for personal consumption in most outlying areas, with the exception of some rare species (special rules exist for protected species). Under the Nature Diversity Act the King has the competence to make regulations for Prior Informed Consent (PIC) and Benefit-sharing. While there is no PIC requirement at present the government is working on the development PIC regulations.

Access to wildlife (e.g. terrestrial mamals, birds, reptiles and amphibians that occur naturally in the wild and their eggs, nests and lairs) is governed by the Wildlife Act. According to this Act, the King decides which species of wildlife may be hunted (game species) and during which periods of time hunting may take place. At present there is no PIC requirement.

Access to wild living marine resources and genetic material derived from them (including plant varieties, fungus species and invertebrates) is governed by the Marine Resources Act. At present there are no PIC or benefit-sharing requirements even if these could be applied by law.

Access to natural stocks of anadromous salmonids, fresh water fish, their habitats and other fresh-water organisms (plants and animals) is governed by Act No.47 of 15 May 1992 relating to salmonids and fresh-water fish etc. Under this Act it is prohibited both to release salmonids, fresh-water fish, live eggs or fry of such species and other organisms in water courses, fjords or the sea without permission from the Ministry and to initiate stock enhancement measures for salmonids and fresh-water fish without permission from the Ministry.
The Ministry may grant permission to catch broodstock or juvenile fish or to carry out scientific investigations, practical trials, or stock enhancement measures.
For statistical purposes, any person who sells, processes or uses salmonids or fresh-water fish for commercial purposes is required to report the weight and value of each fish species separately, as well as the name and address of the seller. At present there are no PIC or benefit-sharing requirements even if these could be applied by law.

9.1.5.2 Access and benefit-sharing of traditional knowledge associated with biodiversity for food and agriculture

The Nature Diversity Act provides the legal framework for the protection of Sámi culture, with Chapter VII focusing on access to genetic material in particular. In June 2013, an amendment to the Nature Diversity Act was adopted by Parliament in order to be able to ratify the Nagoya Protocol. This amendment involved the expansion of Section 61 of the Act to include paragraph a. covering access to and utilization of traditional knowledge associated with genetic material. According to this new paragraph, indigenous peoples and local communities (IPLCs) have the right

to protect their interests when knowledge related to genetic material they developed, transmitted and preserved is being accessed and utilized. The King may issue regulations that access to and use of traditional knowledge requires the prior informed consent of IPLCs, which could also include sanctions in the case of illegitimate accession or utilization. The King may decide that the issued regulations also apply to traditional knowledge developed, transferred and conserved by IPLCs in another State, provided that access to or use of the knowledge also requires the prior informed consent of IPLC's under the law of that State.

Other relevant sections of the Nature Diversity Act include:
- Section 8 (knowledge base), which states that the authorities shall attach importance to knowledge that is based on many generations of experience acquired through the use of and interaction with the natural environment, including traditional Sámi use, and that can promote the conservation and sustainable use of biological, geological and landscape diversity;
- Section 14 (other important public interests and Sámi interests), which mentions that measures under this Act shall be weighed against other important public interests. When decisions are made under the Act that directly affect Sámi interests, due importance shall be attached, within the framework that applies for the individual provision, to the natural resource base for Sámi culture; and

- Section 57 (management of genetic material), which refers to the fact that genetic material obtained from the natural environment is a common resource belonging to Norwegian society as a whole and managed by the state and that it shall be utilized to the greatest possible benefit of the environment and human beings in both a national and an international context, also attaching importance to appropriate measures for sharing the benefits arising out of the utilisation of genetic material and in such a way as to safeguard the interests of indigenous peoples and local communities.

As a Contracting Party to the CBD, Norway has committed itself to implementing Articles 8(j) and 10(c) of the Convention, which entails the preservation of the traditional knowledge relating to biological diversity of Sámi. According to Article 8 (j), each contracting party shall respect, as far as possible and as appropriate, preserve and maintain knowledge, innovation and practices of indigenous peoples and local communities and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from their utilization. Prior informed consent is currently seen as critical to securing these rights.

On 1 October 2013, Norway ratified the Nagoya Protocol[83] that was adopted in 2010 and entered into force on 12 October 2014. The Protocol, as well as the process of its development have been significant steps in mainstreaming indigenous rights as a cross-cutting issue in international

[83] The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the CBD

negotiations. Articles 5,[84] 7,[85] 11[86] and 12[87] of the Protocol are of particular relevance to the Sámi people. Work to bring national legislation relevant to access and benefit-sharing of genetic resources, as laid out in the Nature Diversity Act, in line with the Nagoya Protocol is still ongoing and a proposal is expected to be presented soon.

9.1.6 Incentives and benefits to support the conservation and sustainable use of biodiversity for food and agriculture

9.1.6.1 Current incentives

Norway's agricultural sector benefits from supportive policies, including fiscal policies and subsidies. The agriculture related subsidies, of which there were approximately 100 in 2014, are set by the Agricultural Agreement (Jordbruksavtalen). Some of the subsidies included in the Agricultural Environment programme (Miljøprogram i jordbruket), also aim to support the conservation and sustainable use of biodiversity for food and agriculture and/or associated biodiversity (e.g. subsidies supporting the maintenance of pasture fields, those promoting the conservation of native livestock breeds and subsidies promoting outfield grazing). Subsidies directed at organic production are also important for the sustainable use of biodiversity/associated biodiversity with other subsidies being of negative influence (e.g. subsidies related to development projects).

Norway's agricultural quality system (Kvalitetssystem i landbruket-KSL) has developed a series of tools to help farmers record, plan and document their agricultural operation from an environmental perspective. With this set of tools, farmers can assess the environmental impact of their production system and comply with the basic requirements that are needed to apply for production related subsidies.

The Regional Environment Programme is a central component in the national environmental efforts in agriculture. Through the provision of grants that are managed by the Norwegian Agricultural Authority88 the programme contributes to the sustainable performance of agriculture.

[84] According to this article, each Party shall take legislative, administrative or policy measures, as appropriate, in order that the benefits arising from the utilization of traditional knowledge associated with genetic resources are shared in a fair and equitable way with IPLCs holding such knowledge, and that such sharing shall be upon mutually agreed terms.

[85] In accordance with domestic law, each Party shall take measures, as appropriate, with the aim of ensuring that traditional knowledge associated with genetic resources that is held by IPLCs is accessed with the prior and informed consent or approval and involvement of these IPLCs, and that mutually agreed terms have been established.

[86] This article refers to instances where the same genetic resources are found *in situ* within the territory of more than one Party. This is highly relevant to Sámi who are living across four adjacent states.

[87] This article is also of importance, as it specifically binds Parties to ensure the participation of the IPLCs when establishing mechanisms to inform potential users of traditional knowledge associated with genetic resources about their obligations.

[88] The Norwegian Agriculture Authority is the agency of the Norwegian Ministry of Agriculture and Food that is responsible of ensuring that all subsidy schemes and regulations are administered uniformly across the country and throughout the value chain. At present, Norway has about 100 different subsidy arrangements related to agriculture, including subsidies that are favorable to traditional farming and rural settlements (i.e. grazing related subsidies,

The Regional Environment Programme (RMP), that is included in the Agricultural Environment programme and is managed by the Norwegian Agricultural Authority, is a central component in the national environmental efforts in agriculture. Through the provision of grants, the programme contributes to increasing the sustainable performance of agriculture. Interesting provisions in this respect include agricultural grants to maintain summer livestock farming in the mountains. This promotes extensive grazing, which prevents regrowth of outlying pastures and grasslands, thereby protecting the associated biodiversity that depends on open landscapes.

RMP grants provide support to farmers who let their animals graze in outlying fields. This practice contributes to the maintenance and use of native threatened livestock breeds, such as Telemark cattle. Photo: Anna Rehnberg / NIBIO.

livestock subsidies per farm and per head, including for farmers with small livestock populations). To receive subsidy payments, farmers have to meet well-defined requirements set forth by the government (i.e. fencing criteria, quality prerequisites for the area under their ownership, as well as obligations regarding their own contribution).

The Forest Certification scheme (PEFC) promotes sustainable forest management through certification of forest properties and forest products. It is considered to be the certification system of choice for small forest owners (http://www.pefc.org/about-pefc/membership/national-members/16-Norway).

9.1.6.2 Possible incentives

In 2013, the Ministry of Environment published Norway's first review on the state of its ecosystem services (NOU 2013.10). Using the Millennium Ecosystem Assessment as a reference, this study assessed, described and made an attempt to give a value to the ecosystem services that are of most relevance to the country. The document addresses and makes recommendations as to the possible payment/remuneration in support of activities that are perceived to favour the delivery of ecosystem services.

9.2 Stakeholder participation for the maintenance of biodiversity for food and agriculture

9.2.1 Stakeholder groups that actively conserve biodiversity for food and agriculture

Farmers, fishermen and forest[89] owners actively contribute to the conservation of biodiversity for food and agriculture as individuals and as members of for example plant clubs, breeding societies or cooperatively-run associations and companies.

9.2.1.1 Farm animals

The cooperative owned breeding company GENO aims to secure the long-term storage of genetic material of all bulls used in artificial insemination and bull mothers for Norwegian Red (NRF) cattle. In cooperation with the Norwegian Genetic Resource Centre, GENO also actively supports the conservation of the native and endangered cattle breeds.

For each endangered native breed there is a breed society or a breeding association. These are important for connecting the different stakeholders that are interested in these breeds, such as the farmers, the Norwegian Genetic Resource Centre and the specific breed associations. For the endangered cattle breeds there is an umbrella organization (Norsk Bufe).

The Norwegian Sheep and Goat association (Norsk sau og geit-NSG) works to safeguard the interests of sheep and goat holders. Activities include the development of sheep and goat breeding programmes and the maintenance of outlying fields and grazing land. NSG works closely with agricultural research institutes, other farm organizations, government agencies and policy makers. The organization has about 11,000 members across Norway. NSG has a large storage of semen from the Norwegian goat- and sheep breeds, which is expanding every year.

[89] Forest related information is given in 2.1.4.

The pig breeding company Norsvin sells live animals and semen to both Norwegian and international customers. The pig producer owned company actively participates in debates relevant to the pig industry, including at the political level. Norsvin has an *ex situ* gene bank of native boar semen that was stored during the period 1990-2000.

In cooperation with the Norwegian Genetic Resource Centre, Hvam Agricultural College runs a genebank for egg laying hens. This genebank was established in 1973.

In cooperation with the Norwegian Genetic Resource Centre, the Norwegian Kennel Club and the different dog breed societies established a national genebank during the 1990s. This genebank includes semen from the six native endangered hunting and herding dog breeds. Discussions on the establishment of a national genebank to store horse semen, following this model, are ongoing.

The Norwegian Beekeepers Association (Norges Birøkterlag) runs a breeding program and supports conservation activities in assigned protected areas for the European dark bee or Nordic brown bee (Apis mellifera mellifera). . The brown bee being among the most threatened subspecies of honeybees in the Nordic region, NordGen established and is coordinating a project to map and support the conservation of the bee in the Nordic countries. With approximately 1500 colonies, the Norwegian brown bee population is regarded as the largest in the Nordic region. [90]

9.2.1.2 Plant genetic resources

Graminor, the Norwegian plant-breeding company is responsible for providing Norwegian farming and horticulture with a diversity of varieties of disease resistant field crops and horticultural species that are suitable for Norwegian growing conditions. Near the city of Hamar, Graminor undertakes research, breeding and testing of new varieties of cereals, potatoes, strawberries and forage grasses in greenhouses and through field pilots. Testing of grass varieties for the northern regions of Norway takes place at NIBIO in Tromsø, and breeding and testing of fruit and raspberries at Njøs Research Station in Sogn og Fjordane. Multiplication of seeds and plantlets for production is carried out mainly through the Norwegian farmers' cooperatives.

Cultivars, landraces and other genotypes of vegetative propagated plant species are conserved as living plants in so-called "clonal archives" in different parts of Norway. These collections are hosted by local museums, botanical gardens, research stations, universities, etc.

In 2006, the Norwegian Genetic Resource Centre and the Norwegian Garden Society (Hageselskapet) established five Norwegian Heritage Seed Saver clubs as non-profit organizations that aim to conserve old heritage vegetables by active cultivation and use through a group of amateur gardeners throughout Norway. In 2012, the Norwegian Seed Saver clubs had 170 members.

There are also individuals who have cared for certain crop varieties for many years either as private persons or in their research work. The national programme on plant genetic resources for food and agriculture has in some cases supported some of these dedicated enthusiasts in establishing

[90] http://www.nordgen.org/index.php/en/Farm-Animals/Innehaall/Nordic-conservation-work/Nordic-farm-animal-breeds/The-Nordic-brown-bee-the-old-native-bee-of-the-Nordic-countries

networks within different crop groups on project basis. The custodians of these varieties produce seeds or propagate plant parts for distribution and prepare annual reports about the conservation of each maintained variety as long as project collaboration is ongoing.

9.2.1.3 Fish breeding

Nofima is one of the largest institutes for applied research within the fields of fisheries, aquaculture and food research in Europe. Their scientists have pioneered work in fish breeding since the beginning of the 1970s, and have contributed to the ability of the Norwegian aquaculture industry to produce salmon with better health and in half the time previously required, using less feed. Aqua Gen AS develops, produces and provides genetic material to the global fish farming industry. The fish breeding company is a leading supplier of Atlantic salmon and rainbow trout fertilized eggs.

9.2.1.4 Wild foods

The Norwegian Association of Hunters and Anglers (Norges Jeger- og Fiskerforbund - NJFF) is the national organization for hunters and anglers in Norway. NJFF has approximately 120,000 members belonging to 570 local hunting and fishing clubs dispersed across the country. NJFF works to secure and maintain viable game and fish stocks in order to (i) ensure future hunting and fishing opportunities; (ii.) enable all motivated hunters and anglers to hunt and fish at a reasonable price; and (iii.) promote hunting and fishing as legitimate forms of harvesting natural resources now and in the future. NJFF is also interested in maintaining and improving the hunting skills of Norwegian dog breeds.

9.2.2 Stakeholder groups that support the conservation of biodiversity for food and agriculture

This section provides a list of major institutes and organizations that support the conservation of the biodiversity for food and agriculture in Norway, including associated biodiversity species and species of wild food resources.

9.2.2.1 Agriculture, forestry and fisheries

The Norwegian institute of bioeconomy research (NIBIO) conducts applied research linked to multifunctional agriculture and rural development, plant sciences, environmental protection and natural resource management. The institute's objective is to provide industries, governments and consumers with new knowledge, services and solutions within these scientific fields. NIBIO also gives high priority to International collaboration with respect to the conservation of biodiversity for food and agriculture.

NIBIO conducts research and provides information about forests, soils, outlying fields and landscapes. It also manages a range of national mapping programs and resource inventories related to land cover, forestry, agriculture, landscape and the environment. The institute shares its knowledge with the authorities, the private sector and the general public to contribute to the sustainable management of and value creation based on land resources.

Within NIBIO, *the Norwegian Genetic Resource Centre* coordinates expertise and activities regarding the conservation and utilization of national genetic resources. The centre has been commissioned to contribute to the effective management of genetic resources in farm animals, crops and forest trees. It also acts as an advisory body to the Norwegian Ministry of Food and Agriculture.

The Norwegian Farmers and Smallholders Union (Norsk Bonde- og Småbrukarlag) is a politically independent organization that works to improve the economic and social conditions in agriculture, including by participating in the annual agricultural agreement negotiations. The organization's areas of focus include increased food production, economic development, local breeding, animal welfare and dynamic cultural landscapes. The Union has about 7,000 members.

The Norwegian Farmers' Union (Norges Bondelag) is Norway's largest trade union for farmers. It aims to improve conditions for agriculture (e.g. it negotiates with the State on farmer income opportunities on an annual basis) and to enhance agriculture's importance to society. The Union is financially and politically independent and counts 60,500 members.

Oikos - Økologisk Norge is a non-governmental organization that was founded to establish a national movement of organic producers and consumers in Norway and strengthen its voice in Norwegian politics, economics and social life. Next to promoting the production and consumption of organic food, the organization also contributes to raising awareness on the importance of associated biodiversity in food production systems, such as of soil biodiversity.

The Biodynamic Association (Biologisk-dynamisk Forening) works to spread knowledge on bio-dynamic farming and to increase the number of farmers that produce bio-dynamic foods. In bio-dynamic farming, great importance is attached to biodiversity within the agricultural landscape and a minimum of 10% of the total farm acreage is set-aside to preserve biodiversity.

The Norwegian Garden Association (Norske Hageselskap) is an independent environmental organization that aims to promote gardening, sustainable horticulture and green surroundings through the dissemination of information. The association has approximately 25,000 members.

The Norwegian Fishermen's Association (Norges Fiskarlag) is the professional fishermen's union and business organization. It was founded in 1926. The association is politically independent and is based on the voluntary membership of fishermen. It has approximately 5700 members.

Through the Ark of Taste initiative, *the Slow Food Foundation* globally collects small-scale quality productions that belong to the cultures, history and traditions. This initiative was created to point out the existence of special products, draw attention to the risk of their extinction and invite everyone to take action to help protect them. In 2014, 10 of the 2020 products that were admitted to the international Slow Food Foundation's Ark of Taste were Norwegian, including 3 edible plants/crops (Angelica 'Vossakvann', Garden pea 'Jærert' and Turnip 'Målselvnepe'), 2 livestock breeds (Telemark cattle and and Villsau sheep), two cheese products (Artisan Sognefjord Geitost and Hedmark and Oppland Counties Pultost) and three fish related products (Baccala from Møre

og Romsdal, Cured and Smoked Herring from Sunnmøre and Stockfish from the Isle of Sørøya). For more information on these products see: http://www.slowfoodfoundation.com/ark#risultati

9.2.2.2 Associated biodiversity and wild foods

Founded in 1914, *the Nature Conservation Association* (Naturvernforbundet) is the oldest environmental protection organization in Norway. The association focuses on environmental issues related to area conservation, climate change, energy and transport. It has about 20,000 members.

The Norwegian Biodiversity Network (SABIMA) is an umbrella NGO working to strengthen the protection of biodiversity in Norway. It influences political and other processes to improve the conditions for biodiversity in Norway. SABIMA focuses on better legislation, more sustainable use of resources, and more robust and comprehensive management systems.

The in 1988 established *Norwegian Institute for Nature Research* (NINA) is responsible for long-term strategic research and commissioned applied research to facilitate the implementation of international conventions, decision-support systems and management tools, as well as to enhance public awareness and promote conflict resolution. NINA offers broad-based ecological expertise covering the genetic, population, species, ecosystem and landscape level, in terrestrial, freshwater, and coastal marine environments. NINA is, among others, experienced in dealing with natural and human aspects of resource and biodiversity management.

The State of the Environment in Norway (Miljøstatus i Norge) provides regularly updated information on the state of the environment in Norway, including on relevant laws and agreements. It also keeps an overview of the national environmental objectives and is administered by the Norwegian Environment Agency.

The Norwegian Association of Fungi and Useful Plants (Norges sopp-og nyttevekstforbund) is the umbrella organization for the country's various fungal associations and crop associations. At present, the organization has about 3800 members. The association aims to (i.) increase the use and knowledge of mushrooms and herbs; (ii.) facilitate the collection of mushrooms and herbs; (iii.) participate in efforts to conserve biodiversity in nature and to advise on species interactions with other organisms and their beneficial and harmful effects; and (iv.) work for both public and scientific interest in the fields of mushrooms and herbs.

World Wide Fund for Nature (WWF) Norway aims to protect and preserve the values of nature and its biodiversity in marine and coastal areas, in fresh water and on land. The organization also continuously works to improving Norway's climate and energy related policies and laws.

The in 1957 founded *Norwegian Ornithological Society* (NOF) aims to protect birds and their habitats in Norway and to influence any related developments through research and documentation.

9.2.3 Cooperation between different stakeholders to implement national programmes and policies

9.2.3.1 The Norwegian Genetic Resource Centre and its Genetic resource committees

The Norwegian Genetic Resource Centre is responsible for monitoring, ensuring access to and increasing the use, knowledge and awareness on the conservation and sustainable use of animal, plant and forest genetic resources for food and agriculture. Having a single centre working on a large share of the country's genetic resources for food and agriculture, Norway is in a privileged position to both identify and take advantage of the synergies between the different sectors and to weigh the trade-offs, of which there are few. The sectoral committees on animal, plant and forest genetic resources both jointly and separately discuss and provide advice on the Centre's strategic and action plans and on national policies of relevance to genetic resources for food and agriculture. Joint meetings of the three genetic resource committees have led to interesting exchanges of knowledge and expertise across sectors on issues such as the characterization of genetic resources, *in situ* and *ex situ* conservation and the development of indicators.

9.2.3.2 Collaboration to implement the Convention on Biological Diversity (CBD)

All Norwegian authorities, industrial sectors and other relevant actors are required to play their part in efforts to ensure the conservation and sustainable use of biodiversity. Since the adoption of its first National Biodiversity Strategy and Action Plan in 2001, Norway has taken a series of measures to strengthen its commitment to the implementation of the Convention on Biological Diversity and its Strategic Plan (2011-2020). The country strengthened its knowledge base, including through the development of monitoring programmes,[91] and it improved existing and developed new legislative instruments. In addition, the Nature Diversity Act was developed to protect biological diversity and ecological processes through conservation and sustainable use. The Act also includes provisions on alien species and access to genetic material. Applying to multiple sectors, the Nature Diversity Act significantly facilitates multi-sectoral coordination. Other cross-sectoral measures of relevance to the conservation and sustainable use of biodiversity, include the Planning and Building Act, the management plans for Norway's sea areas and the river basin management plans. In addition, the Ministry reports on the status and trends of biodiversity in Norway through the submission of national reports to the CBD. For the preparation of such reports, the Ministry coordinates and consolidates inputs provided by the Norwegian Environmental Agency, other relevant ministries, including the Ministry of Agriculture and Food, and the Sámi parliament. For the most recently submitted Fifth National Report to the CBD, inputs from other relevant stakeholders, gathered through an open consultation, were also included. Between 1998 and 2014, five national reports have been submitted to the CBD. The Fifth National Report is the first report prepared by KLD since the adoption of the Strategic Plan for Biodiversity

[91] Some of Norway's major ecosystems, including agricultural habitats, forests and marine and freshwater environments are monitored through biodiversity monitoring programmes; and monitoring systems are in place for the regular assessment of certain animal populations (e.g. wild salmon, marine fish stocks and large ungulates).

2011-2020.[92] In this report, KLD reported on the implementation of the 20 Aichi Biodiversity Targets with support from the Ministry of Agriculture and Food, particularly with respect to Aichi Target 13.[93] Since 2001, Norway has systematically developed actions plans for the conservation of animal, forest and plant genetic resources. The country has also undertaken assessments of the status of characterization in the different sectors. Each of these activities contributes to achieve Aichi Target 13.

9.2.3.3 Collaboration between sectors to implement White papers and laws

The following White papers are of relevance to the conservation and sustainable use of biodiversity for food and agriculture. Each of them requires the involvement of stakeholders from different sectors for their implementation: White paper Nr.58 (1996-97) - Environmental policy for sustainable development; White paper Nr.42 (2000-2001) – Norwegian biodiversity policy and action plan - cross-sectoral responsibilities and coordination; White paper Nr.9 (2011–2012) Agriculture and food policy "Welcome to the table"; White paper Nr.21 (2011-2012) Norwegian climate policy; and the Nature Diversity Act of 19 June 2009 Nr.100 Relating to the management of biological, geological and landscape diversity.

Concrete actions undertaken to implement the mentioned White papers and the Nature Diversity Act, include the:

- Development of a national programme to map and monitor biological diversity;
- Establishment of protected areas (i.e. national parks, protected forests and protected marine areas);
- General provisions on sustainable use in the Nature Diversity Act;
- Establishment of the Norwegian Biodiversity Information Centre;
- Development of action plans for endangered and prioritized species and for selected nature types;
- Establishment of the Norwegian Genetic Resource Centre and of its genetic resource committees for animal, plant and forest genetic resources;
- Engagement in the establishment of the Nordic Genetic Resource Center (NordGen) in 2008;
- Establishment of the Svalbard Global Seed Vault (2008).

[92] http://www.cbd.int/reports/nr5/

[93] By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity).

9.2.4 Projects in support of the conservation and sustainable use of biodiversity for food and agriculture

There are a series of projects being undertaken in support of the conservation and sustainable use of biodiversity for food and agriculture, associated biodiversity and wild food resources. Of the projects listed, none were included in Norway's national reports on animal, plant and/or forest genetic resources (Sæther, 2002; Asdal, 2008; Skrøppa, 2012).[94]

9.2.4.1 Establishment of *in situ* reserves for plant genetic resources in protected areas

This ongoing project, that is being carried out in accordance with the Norwegian Nature Diversity Act and its regulations, aims at the national implementation of the plant genetic resources *in situ* conservation provisions reflected in the International Treaty on Plant Genetic Resources for Food and Agriculture and in the Global Plan of Action for Plant Genetic Resources for Food and Agriculture. The project is being carried out by the University of Birmingham, GBIF Norway, Oslo's Natural History Museum, NordGen, County authorities responsible for the management of protected areas and the Norwegian Environment Agency (observer). The County authorities and the Norwegian Environment Agency provide support in determining how genetic resources of certain crop wild relatives (CWR) species could be protected, while respecting the existing protected areas regulatory framework of the Nature Management Act. At present, the research area consists of protected areas where important CWR occur; field work is currently being carried out in 5 to 10 hot-spots. This project is expected to contribute to sustained genetic diversity within crops and their wild growing relatives by 2020 (Aichi target 13). At the same time it will also contribute to safeguard their associated biodiversity.

9.2.4.2 Better pollination of red clover with help of bumble and honey bees (PolliClover)

This five year project was initiated by Bioforsk95 in 2013. It aims to reverse the continuous decline in red clover seedlings through the active use of pollinators and to evaluate the effects of habitat management with a view to increase bumble bee density. Red clover is Norway's main pasture legume crop. It fixes nitrogen directly from the air and adds extra protein and minerals to animal fodder.

9.2.4.3 Wild apple in Norway

This Project aimed to analyse the status of wild apple trees in Norway with respect to hybridisation with cultivated apples and their genetic variation to define how to best protect them. The main outcomes of this recently ended project can be found at http://www.genressurser.no.

---

[94] The projects are not listed in order of priority.

[95] Bioforsk became part of NIBIO in July 2015 following the merger of Bioforsk, the Norwegian Forest and Landscape Institute and the Norwegian Agricultural Economics Research Institute.

9.2.4.4 Living topsoil project (Levende matjord)

The "Living topsoil" project was established in 2009 by county representatives of Buskerud, Lindum AS, VitalAnalyse and Bioforsk Økologisk (now NORSØK). Through this Project, farmers are encouraged approach their soils from a biological perspective and to take into account the soil food web dynamics. The project includes soil health assessments on agricultural land of both conventional and organic farmers, whereby the occurrence of associated soil biodiversity is an important indicator. Based on these assessments farmers are given advice on possible ways to bring back "life" into the soil. Farmers participating in this project are from the counties of Buskerud, Østfold, Vestfold and Rogaland. Farmers (in particular the conventional ones) and decision makers at county (Fylkesmannen) and national (Norsk Landbruksrådgiving) levels have shown great interest in this project. This project is closely linked to the "Soil knowledge and soil culture" project (Jordkunnskap og jordkultur) which aims to stimulate biological diversity and improve the amount of humus in topsoils. The latter project was initiated and is funded by the Norwegian Agricultural Authority (Landbruksdirektoratet).

9.2.4.5 Vermicomposting for vegetable production in Vestfold county

Vestfold county runs a ten-year project involving companies and researchers that are working together to increase innovation and value creation in businesses, VRI Vestfold . The project focuses on food, micro-technology, water purification and energy and marine engineering. It is mainly funded by Norway's Research Council and Vestfold Value Creation (Verdiskaping Vestfold), with the latter being the owner of the project.

One of the project's interesting research areas relates to vermicomposting for vegetable production. In vermicomposting various earthworms are used to break down a mixture of horse manure, cow dung and vegetable waste, resulting into worm castings or worm manure. These nutrient-rich castings are subsequently tested as organic fertilizers and soil conditioners to produce healthier and more resistant food crops. Through this research, which is being carried out by Stenersens Gardening, the project ultimately aims to reduce the use of chemical fertilizers in crop production and to enhance sustainable crop intensification (http://vri-vestfold.no/delprosjekter/gronn-forskning-landbruk/meitemarkens-fode-blir-markens-grode/).

9.2.4.6 Living forest

The Living Forest Standard was agreed upon in 1998 with the aim to develop criteria for sustainable forestry in Norway, as well as to document and control the environmental conditions in forests. The Standard also intended to strengthen Norwegian and international confidence in products from Norwegian forestry and forest industry. The standard was developed with the participation of forest owner organizations, the forest industry, trade unions and environmental and outdoor organizations. Government officials participated as observers (Det norske Skogselskap, 2011). Despite the Standard's formal suspension mid-2012, it is maintained as part of Norway's Programme for the Endorsement of Forest Certification scheme (PEFC).

9.2.4.7 Environmental recording in forests (Miljøregistrering i skog-MiS)

This project is being implemented by NIBIO is funded by the Ministry of Agriculture and Food. The two interrelated objectives of MiS are to i) improve the knowledge of the environmental benefits of biodiversity in forests; and ii) develop methods to detect and monitor this biodiversity. The project

involves the use of a registration tool that provides information to forest owners on areas that are particularly important to conserve from an environmental perspective.

9.2.4.8 Development projects on animal, plant and forest genetic resources

Projects for the development of the national animal, plant and forest genetic resources sectors are described in more detail in Norway's sectoral reports on animal, plant and forest genetic resources, as well as in the strategic plan of the Norwegian Genetic Resource Centre and its rolling plans of action for the conservation and use of farm animals, forest trees and plants (www.genressurser.no).

9.2.5 Landscape based initiatives to protect or recognize areas of land and water rich in biodiversity

There are a number of landscape based initiatives that are being undertaken to protect or recognize areas of land and water that are particularly rich in biodiversity, including in biodiversity of relevance to food and agriculture (see Table 4).

Table 4 Landscape based initiatives in Norway to protect biodiversity rich areas

Landscape based initiatives	Area covered in km2 (when available)	Description
National Parks (Asdal,2008)	26,756 km2 or 8.3% of Norway's total land area (2008)	Total number: 29
Protected landscapes	15,093 km2 or 4.7% of Norway's total land area	Total number: 174
Nature reserves	4,299 km2 or 1.3% of Norway's total land area (this are increased by 94.5% between 1996 and 2008)	Total number: 1,822
Nature monuments	2 km2	Total number: 101
Other protected areas	126 km2	Number: 122 - 0%
Selected Agricultural Landscapes **https://www.slf.dep.no/no/miljo-og-okologisk/kulturlandskap/utvalgte-kulturlandskap#english**	The selected landscapes vary greatly in size (i.e. from 9 to 16,500 ha)	See chapter Institutional setting in support of the conservation and sustainable use of biodiversity for food and agriculture and the provision of ecosystem services of this report.
Heritage value project (Arvesølvprosjektet) **http://www.bioforsk.no/ikbViewer/page/prosjekt/hovedtema?p_dim2=23261&p_sub_id=23260&p_dimension_id=23259&p_menu_id=23270**	In autumn 2010 the project was active in 33 different areas in the counties of Aust-Agder, Vest-Agder, Telemark, Rogaland and Hordaland	The project aimed to increase knowledge and conserve biodiversity of nature types and species in old outlying fields that had been pastured or mowed and unploughed. The work of this project is being continued in other forms, including through the Norwegian Environment Agency's Action Plan for mowed fields (Å. Asdal, personal comments).[96]

[96] Åsmund Asdal is a former senior advisor on plant genetic resources at the Norwegian Genetic Resource Centre.

Other landscape based initiatives that are of significance to biodiversity for food and agriculture in Norway include the mapping of valuable nature types (NIBIO), the farm distribution mapping service (NIBIO's Gårdskart - see chapter *National information management relevant to biodiversity for food and agriculture*), the designation of selected nature types/cultural landscapes (NiN, Artsdatabanken), the maintenance of cultural heritage sites (Riksantikvaren - see chapter *National policies, programmes and enabling frameworks*) and subsidies promoting farming in mountainous areas (seterdriftstillskudd).

Protected forest areas and protected areas covering semi-natural ecosystems (e.g. coastal heathlands, traditionally maintained meadows and grazing land) are also recognized as areas with particular significance for biodiversity for food and agriculture.

Finally, some protected areas that were not established to protect or recognize biodiversity hotspots incidentally happen to cover biodiversity for food and agriculture.

9.3 National information management relevant to biodiversity for food and agriculture

9.3.1 Linkages between sector information systems

Statistics Norway (SSB) at times uses information from different sectoral databases for the calculation of its figures. To calculate the country's gross domestic product (GDP), the crop, livestock and forest production related data are for example extracted from different databases.

The Species Map Service (Artskart), provided by the Norwegian Biodiversity Information Centre and the Global Biodiversity Information Facility Norway (http://www.gbif.no), distributes data on species found in Norway. The Service retrieves most information from the Species Observation System, a database that contains most of the available digital information on the presence of species in Norway. More than 30 Norwegian and foreign data providers working in different sectors have processed, adapted and made electronically available spatial species occurrence data from their primary databases. Data providers include NIBIO, the Institute of Marine Research, the Norwegian Association of Fungi and Useful Plants, the Norwegian entomological society, the Norwegian Forest and Landscape Institute, the Norwegian Institute for Nature Research (NINA) and the Norwegian Institute for Water Research (NIVA). A complete list of data providers can be found at: https://artskart.artsdatabanken.no. The Species Map Service is an important tool in natural resource management, and is also used by research and industry.

Naturbase provides information, including maps, on, *inter alia*, protected areas, habitats that are conserved under the Nature Diversity Act, farmlands of high biological value and cultural heritage sites. This database is managed by the Norwegian Environment Agency. It is connected to other databases, such as the environmental inventories in forests, forest management plans and land resource maps from the NIBIO and the threatened and vulnerable species database from the Norwegian Biodiversity Information Centre, allowing its users to combine data from Naturbase with that of other sources.

The database for protected areas in forests (Norsk genressurssenters database over verneområder i skog) includes data from Naturbase, as well as information from other forest-related background material. It is the only database to provide an overview of all the main and associated tree species that are present in protected areas in forests.

Farm distribution mapping (Gårdskart) is a mapping service designed to assist agricultural managers, as well as owners and users of agricultural properties. The service is based on a series of different databases, including Norway's farm register that is managed by the Norwegian Agriculture Agency, Norway's Cadastre and the detailed land resources mapping service AR5 from NIBIO.

9.3.2 Information systems on associated biodiversity and wild food resources

Several information systems provide data on associated biodiversity and wild food resources. The major ones are reflected in Table 5.

Table 5 Information systems in Norway providing data on associated biodiversity and wild food resources.

National information system	Component of associated biodiversity	Description of information system
The 2010 Norwegian Red List	All	The 2010 Norwegian Red List contains extinction risk assessments. 21,000 of the 40,000 known multi-cellular species on mainland Norway and in adjacent waters have been evaluated, resulting in 4599 red listed species. This list has been prepared in accordance with the IUCN criteria and the information provided is based on knowledge on distribution, population size and development for each species.97
Norwegian Red List for Ecosystems and Habitat Types 2011	All	National risk assessment of ecosystems and habitat types, covering all terrestrial, freshwater and marine systems.76
Alien species in Norway-with the Norwegian Black List 2012	All (including bacteria, algae, fungi, insects, fish)	Provides an overview of a large number of alien species that are found in Norway and assesses the ecological impact of those alien species that reproduce in Norwegian territories. Species with the greatest ecological impact form the 2012 Black List.76
Norwegian Nature Index	Key species, including algae, lichens, fungi, plants, invertebrates, fish, amphibians, birds and mammals in major habitat types (excluding cultivated agricultural land)	The Nature Index shows trends in biodiversity in major ecosystems, excluding agricultural land. It is based on 309 indicators representing different aspects of biodiversity. The overall objective is to measure whether Norway is succeeding in halting the loss of biodiversity, as pledged under several international agreements. The first edition of the Nature Index was published in September 2010 (http://www.miljodirektoratet.no/old/dirnat/attachment/2246/DN-Report-1-2011.pdf).

[97] This List is supported by searchable databases containing more detailed information, such as the Species Map System (Artskart), Species Observation System (Artsobservasjoner) and Information system for Norwegian Habitat types (Naturtyper i Norge).

National monitoring programme for wild cervids	Moose, red deer, wild reindeer	The programme was established in 1991. It is run by the Norwegian institute for nature research (NINA). The data collected during the 21 years of monitoring enables NINA to follow the development in population condition (carcass mass, fecundity and recruitment rates), population density and population structure of representative populations of moose, red deer and wild reindeer. The monitoring is carried out in 17 areas distributed across Norway (moose: 7, red deer: 3, reindeer: 7) (Solberg et al., 2012).
Naturbase	Selection of natural and recreational areas	Database managed by the Norwegian Environment Agency.[98] It provides information, including maps, on Norway's major habitats across Norway (www.naturbase.no).
Algaeinfo	Algae in Norwegian waters	This database provides information on the algal situation in Norwegian waters. It is managed by the Institute of Marine Research in cooperation with Oceanor, the Norwegian Ministry of Trade, Industry and Fisheries and the Norwegian Institute for Water Research (http://algeinfo.imr.no/eng/).
State of the environment in agriculture (Miljøstatus i landbruket)	Multiple components	Through the yearly report *State of the environment in agriculture*, the Norwegian Agricultural Authority shows how the agricultural sector is following up on the country's environmental goals. The report includes information on subsidies that were granted for measures taken to safeguard biodiversity in agriculture.
Statistics Norway (SSB)	Multiple components, including wild foods (e.g. hunting data)	Founded in 1876, SSB is responsible for the country's official statistics and carries out extensive research and analysis activities. Statistics Norway reports to the Ministry of Finance, but is a professionally autonomous organization.
Norwegian Association of Fungi and Useful Plants (Norges sopp-og nyttevekstforbund-NSNF)	Edible and poisonous fungi	NSNF is an umbrella organization for the country's various fungal and crop associations. It provides, among others, information on edible and poisonous fungi in Norway, it participates in mapping them and it organizes fungi identification courses for anyone interested.
National Forest Inventory (NFI)	Different components of associated biodiversity	The National Forest Inventory (NFI) was established in 1919 to oversee the development of forest resources in Norway based on statistical sampling techniques. It was the world's first national forest inventory. Today, the inventory is based on permanent sample plots which are re-visited every five years. This ongoing evaluation systematically collects information on forest growth, production capability, standing timber volume, species distribution and availability, but also on the environmental status of forests. Statistical information from NFI has significantly contributed to the sustainable management of forest resources and has in recent years also gained importance with respect to the sustainable management of biodiversity.
Terrestrial Ecosystems Monitoring Programme (TOV)	Biological components of common boreal and low alpine ecosystems	TOV aimss to detect both short- and long-term effects of climate change, long-range pollutants and other natural and anthropogenic impact factors on vegetation and fauna in the natural environment of common boreal and low alpine ecosystems.

[98] The Norwegian Environment Agency was established on 1 July 2013 as a result of the merger of the Norwegian Climate and Pollution Agency and the Norwegian Directorate for Nature Management.

9.3.3 Information systems to support the maintenance of traditional knowledge

Information on traditional knowledge on biodiversity for food and agriculture is available among informal and more formal networks, such as Norsk Landbruksrådgiving.

The Nordic Genetic Resource Center (NordGen) is exploring possibilities to more systematically document traditional knowledge related to the conservation and use of old and traditional plant varieties.

9.4 Capacity development

9.4.1 Training and extension programmes targeting the conservation and sustainable use of associated biodiversity

Training and extension programmes that target the conservation and sustainable use of associated biodiversity exist in many forms and at different levels, some examples of which are provided in this section of the report.

Some high schools provide practice-oriented education on organic farming. Amongst these schools only the Sogn Jord-og Hagebruksskule (http://sjh.no) is Debio-certified.[99]

Bioforsk[100] initiated the establishment of school gardens to provide children with a unique "learning by doing" programme to learn more about food production, enjoy nature, respect everything that lives (i.e. earthworms, bees, etc.) and gain insight in ecological processes.[101] In this context, Bioforsk[98] produced a series of thematic sheets on, *inter alia*, food production, life in soils and plant varieties[102] while Oikos developed a school project to promote the production and consumption of organic foods.

In 2010, the Environmental Education Network organized a nationwide school project focusing on the importance of earthworms. With the support of scientists from Bioforsk[98], this project resulted in the registration of more earthworm species in more locations in Norway than ever before.[103]

Skoleskogen (forest school) is an educational programme for teachers, school administrators, parents and others interested in interdisciplinary teaching on forests (http://www.skoleskogen.no). Norway's "Learning with the Forests" programme, that is based on

[99] Debio inspects organic products in Norway and certifies them in accordance with the Norwegian "Regulations on the Production and Labelling of Organic Agricultural Products" (see http://www.debio.no/information-in-english#sthash.vy31Qta2.dpuf).

[100] As of 1 July 2015, Bioforsk is part of the Norwegian Institute of Bioeconomy Research or NIBIO (Norsk institutt for bioøkonomi).

[101] http://www.bioforsk.no/ikbViewer/page/prosjekt/hovedtema?p_dimension_id=19960&p_menu_id=19975&p_sub_id=19962&p_dim2=19963

[102] http://www.bioforsk.no/ikbViewer/page/prosjekt/tema/artikkel?p_dimension_id=19960&p_menu_id=19975&p_sub_id=19962&p_document_id=107098&p_dim2=19969

[103] https://www.miljolare.no/kampanjer/forskningskampanjen/2010

the international "Learning About Forests" initiative, encourages school classes and teachers to go to forests, learn from them and in them, and to share experiences with other countries.

The Norwegian Genetic Resource Centre contributes to enhance knowledge and raise awareness on the importance of (associated) biodiversity for food and agriculture, including through the distribution of material to schools (e.g. the tree species diversity posters - skogtreplakatene).[104]

The Norwegian Ministry of Climate and Environment, in cooperation with different actors, developed a range of initiatives to expose school children to environmental issues, such as the need to conserve biodiversity. The "Environmental backpack" initiative (Den naturlige skolesekken), for example, funds school projects that promote sustainable development and involve cooperation with local communities. Since April 2014, schools across the country can invite environmental ambassadors to come and talk about the "Green Generation" (Generasjon Grønn). In this context, students are among others encouraged to discuss the linkages between climate change, biodiversity loss and other environmental challenges.

Norway was also an active partner in the URBACT Thematic Network "Sustainable Food in Urban Communities", a network that enhanced the exchange of knowledge across Europe on urban sustainable food strategies up until April 2015. Examples of initiatives undertaken in Oslo in this context include the establishment of the "Geitmyra School Garden", an area where school children can participate and get insights in gardening and beekeeping, "Bogstad Farm", where the general public can observe farming and the production of vegetables and animal products while enjoying the landscape and the "Hærligheten Wasteland Garden", where wasteland caught in between two streets was transformed into a crop growing area using growing boxes.[105]

9.4.2 Higher education programmes on the conservation and sustainable use of associated biodiversity

In Norway, there are quite a few higher education programmes specifically targeting the conservation and use of associated biodiversity. A number of these programmes are listed in Table 6.

[104] http://www.skogoglandskap.no/nyheter/2013/Nye_plakater_om_skogtrer/newsitem

[105] http://www.sustainable-everyday-project.net/urbact-sustainable-food/category/oslo

Table 6 Higher education programmes in Norway targeting the conservation and use of associated biodiversity

Institution	Programmes	Degree level
The Norwegian University of Life Sciences (NMBU)	- Agroecology - Ecology - Ecology and nature management - Microbiology - Plant sciences - Environment and natural resources - Forestry - Soil fertility and soil management courses - Business development based on outlying fields	Master Master Master Master Bachelor/Master Bachelor/Master Bachelor/Master Master Master
Norwegian College of Fishery Science	Multidisciplinary programmes tailored to the needs of the seafood industry. Research is undertaken on the quality of seafood, ecosystem-based management, vaccines for fish and the development of industry and society.	Professional Study, Bachelor and Master
University of Tromsø - The Arctic University of Norway	Courses on physiology and marine ecology	Bachelor
University of Bergen	Biology programmes including specializations in: aquaculture; fisheries and management; marine biodiversity; evolution and ecology; microbiology; and developmental biology and physiology The University's ecology course focuses, among others, on the processes that influence patterns at specimen, population, community, and ecosystem level. The University's Biology Department includes a Marine biodiversity group that explores marine biological fields and studies the diversity of marine organisms through multidisciplinary projects.	Master

Several other universities, such as the University of Oslo and the Norwegian University of Science and Technology (NTNU), as well as a number of regional colleges of higher education also provide programmes and courses of relevance to biodiversity and ecology.

Through their different faculties and departments, the Norwegian University of Life Sciences (NMBU) and the University of Nordland in Bodø offer a broad range of courses involving the conservation and sustainable use of associated biodiversity. Several regional colleges of higher education (Distriktshøgskoler) propose similar educational programmes at Bachelor level.

9.4.3 Research institutions with programmes on the conservation and sustainable use of associated biodiversity

Among the main institutions that are directly involved in research on the conservation and sustainable use of associated biodiversity, are NIBIO;[106] the Institute of Marine Research (Havforskningsinstituttet);the Norwegian Institute for Nature Research (NINA); the Norwegian Institute for water research (NIVA); the Norwegian University of Life Sciences (NMBU); the Norwegian University of Science and Technology (NTNU); the Sogn og Fjordane University College; the University of Bergen; the University of Oslo; the University of Tromsø-the Arctic University of Norway; and several regional colleges of higher education.

Biodiversity and ecosystem services, as well as effects of land use, climate change and pollution are amongst NINA's key research themes. In relation to the conservation and sustainable use of associated biodiversity and wild foods in particular, relevant initiatives include projects on reindeer husbandry and predators, the organization of a seminar on ecosystem services and retribution of ecosystem services, the mapping of bees, including bumblebees, and the monitoring of hollow oaks.

[106] As of 1 July 2015, Bioforsk, the Norwegian Agricultural Economics Research Institute and the Norwegian Forest and Landscape Institute merged into the Norwegian Institute of Bioeconomy Research or NIBIO (Norsk institutt for bioøkonomi).

Hollow oaks provide a habitat for many different elements of associated biodiversity, including insects, fungi and lichen. Photo: Dan Aamlid / NIBIO

NIBIO does research and provides information on, *inter alia*, forests, soils, outlying fields and landscapes. The Institute generates knowledge that is used by the government, the private sector and the broader public to ensure the sustainable management and development of land resources.

NIVA is an environmental research organisation committed to research, monitoring, assessment and studies on freshwater, coastal and marine environments in addition to environmental technology. Key areas of work include environmental contaminants, biodiversity and climate related issues.

NMBU works towards the sustainable development of natural resources, including their use and conservation.

NTNU is involved in a broad range of research programmes, some of which are of relevance to the conservation and sustainable use of associated biodiversity. NTNU houses the Centre for Biodiversity Dynamics (CBD) that aims to develop into an interdisciplinary centre for research into changes in time and space of biological diversity at different organism levels. The three primary research areas of the Centre include population dynamics, evolution and community dynamics (http://www.ntnu.edu).

The Sogn og Fjordane University College offers programmes and undertakes research on landscape planning, as well as on geohazards and climate change.

The University of Bergen has an extensive marine research programme that focuses, inter alia, on marine and fisheries biology and climate change.

9.4.4 Gaps to fill to develop knowledge and capacity in the longer term

There is quite some expertise in Norway on the management and sustainable use of biodiversity for food and agriculture, especially within the fields of forest, animal and plant genetic resources. However, with respect to the less commercialized species, varieties and breeds and to associated biodiversity species, there are still some major knowledge and information gaps. Some of these gaps are the result of the fact that there still is a general lack of understanding of their importance and value, both outside and within the farming community and among the relevant authorities. This is an overriding limitation that needs to be addressed. The Norwegian Genetic Resource Centre, with its broad competencies within the field of genetic resources for food and agriculture, contributes to close these existing knowledge and information gaps. However, still much can be done to improve the understanding and awareness on the importance and value of the different components of food and agriculture among their users, relevant decision-makers and the broader public.

To increase the knowledge of the management and sustainable use of associated species, thorough survey and identification work is needed. This requires the support of species specialists and taxonomists, of which the country has very few. The recruitment in this field of work is low. Recruiting new taxonomists will require acknowledging the importance of taxonomy.

9.5 Regional and international collaboration for the conservation and sustainable use of biodiversity for food and agriculture

Norway actively contributes to the development and implementation of many regional and international initiatives, including to those of relevance to the conservation and sustainable use of biodiversity for food and agriculture.

9.5.1 Regional initiatives

9.5.1.1 Nordic Council of Ministers

Norway is an active member of the Nordic Council of Ministers, an official cooperation forum of the Nordic governments (Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland and Åland). The Nordic Council of Ministers established, *inter alia*, working groups on respectively microbiology, animal health and welfare and fisheries to ensure effective cooperation between the Nordic authorities in these fields (http://www.norden.org/en). The Council finances the Nordic Genetic Resource Centre, NordGen, that provides significant support to the region's activities related to the conservation and sustainable use of genetic resources for food and agriculture (see chapter *National information management relevant to biodiversity for food and agriculture*).

9.5.1.2 European Landscape Convention

As one of the 38 contracting parties to the European Landscape Convention, Norway supports European co-operation on landscape issues such as landscape protection, management and planning (http://conventions.coe.int/Treaty/en/Treaties/Html/176.htm).

9.5.1.3 Forest Europe

As a member country of Forest Europe, the Ministerial Conference on the Protection of Forests in Europe, Norway participates in the political process for the sustainable management of Europe's forests. Among others, Forest Europe has developed guidelines, criteria and indicators for sustainable forest management. Since the 1990s, collaboration between the ministers responsible for forests in Europe has had a great economic, environmental and social impact at the national and international levels. (http://www.foresteurope.org/about_us/foresteurope).

9.5.1.4 EU Water Framework Directive

The EU Water Framework Directive, a framework for the Community action in the field of water policy, was adopted on 23 October 2000 and entered into force on 22 December of the same year. Twelve Waternotes include issues that need to be addressed to implement the Directive, such as the management of ground water, the reduction of dangerous chemicals in Europe's waters and the importance of integrating water related policies (http://ec.europa.eu/environment/water/water-framework/index_en.html).

9.5.1.5 Convention on the Protection and Use of Transboundary Watercourses and International Lakes

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes, to which Norway is a contracting party, aims to protect and ensure the quantity, quality and sustainable use of transboundary water resources by facilitating cooperation. Countries outside the

European Economic Community are expected to be able to join the Convention as of late 2015 (http://www.unece.org/fileadmin/DAM/env/water/pdf/watercon.pdf).

9.5.1.6 Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)

As one of the 15 Contracting Parties of the OSPAR Convention, Norway strives to protect the marine environment of the North-East Atlantic. Work under the Convention is managed by the OSPAR Commission that is made up of representatives of each of the Parties and the European Commission, representing the European Union (http://www.ospar.org).

9.5.1.7 Bern Convention

The Bern Convention is a binding international legal instrument in the field of nature conservation, covering most of the natural heritage of the European continent, as well as of some African States. This regional Convention promotes European co-operation to conserve wild flora and fauna and their natural habitats. It also takes account the impact other policies may have on natural heritage and recognizes the intrinsic value of wild flora and fauna. The Berne Convention has 50 parties, one of which is Norway (http://www.coe.int).

9.5.1.8 European Environment Agency

As one of the 33 member countries of the European Environment Agency, Norway supports the European Community and other member countries to make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability, and to coordinate the European environment information and observation network (http://www.eea.europa.eu).

9.5.1.9 European Economic Area (EEA) and Norway Grants

From 2009 to 2014, €1.798 billion was set aside under the EEA and Norway Grants to implement a series of projects up until 2016. Among others, The EEA Grants support programmes on biodiversity and ecosystem services in Bulgaria, Cyprus, Czech Republic, Lithuania, Poland, Romania and Slovenia. These programmes particularly aim to contribute to the protection of native ecosystems and to increase the management capacity of protected areas (http://eeagrants.org/).

9.5.2 International initiatives

9.5.2.1 FAO Commission on Genetic Resources for Food and Agriculture (CGRFA)

Norway is one of the 177 member countries of the FAO Commission on Genetic Resources for Food and Agriculture, an intergovernmental forum where issues of relevance to all components of biodiversity for food and agriculture, are discussed and negotiated. Since its establishment in 1983, the Commission has overseen global assessments of the state of the world's forest, plant and animal genetic resources for food and agriculture. The Commission agreed on policy responses in the form of Global Plans of Action to address the main gaps and challenges identified in these assessments. The Norwegian Genetic Resource Centre mirrored both the structure and content of these global action plans in its strategic plan, as well as in the national action plans for animal, forest and plant genetic resources (http://www.fao.org/nr/cgrfa/cgrfa-home/en/).

The Svalbard Global Seed Vault provides secure conservation facilities for safety deposit of samples of seeds of distinct genetic resources of importance to humanity. Photos: Kim-Anh Tempelman

9.5.2.2 International Treaty on Plant Genetic Resources for Food and Agriculture

Norway is one of the 136 Contracting Parties to the International Treaty on Plant Genetic Resources for Food and Agriculture. The Treaty was adopted by the Thirty-First Session of the FAO Conference on 3 November 2001 and entered into force on 29 June 2004. It aims to recognize the contribution of farmers worldwide to the diversity of food crops; to establish a global system to provide farmers, plant breeders and scientists access to plant genetic materials; and to ensure recipients share the benefits they derive from the use of these genetic materials with the countries the materials originate from (http://www.planttreaty.org/content/overview).

9.5.2.3 Svalbard Global Seed Vault

The Svalbard Global Seed Vault holds the seeds of many tens of thousands of varieties of essential food crops such as beans, wheat and rice. These seed samples are duplicates of seed sample stored in national, regional and international gene banks. The Seed Bank was established and is fully funded by the Norwegian government, with the responsibility for operations assigned to the Ministry of Agriculture and Food. The Ministry coordinates daily operation with the Nordic Genetic Resource Center (NordGen) and the Global Crop Diversity Trust, and receives guidance from a dedicated international council established to advise the Seed Bank. The vault was planned

and established in close collaboration with international bodies and it has been an important step to facilitate the implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).
FAO estimates that there are about 2 million unique accessions in the world's 1750 recorded collections - by November 2014, approximately 840,000 accessions from more than 20 international and national institutions were deposited in the Seed Vault. Early 2015, the first forest tree seeds, consisting of accessions of Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*), were officially deposited and stored in the Seed Vault (http://www.seedvault.no).

9.5.2.4 Convention on Biological Diversity (CBD)

Norway has been a contracting party to the Convention on Biological Diversity since 1993. In this context, it contributes to the conservation of biological diversity (including biodiversity for food and agriculture), the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources (http://www.cbd.int/convention/).

9.5.2.5 Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)

As one of the 123 member countries of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), Norway is committed to contribute to assessing the state of the planet's biodiversity, its ecosystems and the essential services they provide to society. IPBES was established in 2012, as an independent intergovernmental body open to all member countries of the United Nations. IPBES provides a mechanism recognized by both the scientific and policy communities to synthesize, review, assess and critically evaluate relevant information and knowledge generated worldwide by governments, academia, scientific organizations, non-governmental organizations and indigenous communities (http://www.ipbes.net).

9.5.2.6 United Nations Environment Programme (UNEP)

Overall, Norway actively contributes to the United Nations Environment Programme. It strongly supports the organization's policies, plans and agenda, which are centered on cross cutting themes such as climate change, ecosystem management, environmental governance, harmful substances and hazardous waste and resource efficiency, including sustainable consumption and production. In support of UNEP's programme of work, Norway established the GRID-Arendal Centre. The Centre generates environmental data, which it organizes and transforms into credible, science-based information products, delivered through innovative communication tools and capacity-building services targeting relevant stakeholders (http://www.unep.org; http://www.grida.no).

9.5.2.7 Convention on the Conservation of Migratory Species (CMS)

Norway is also involved in the Convention on the Conservation of Migratory Species (CMS), an environmental treaty under the aegis of the UNEP that provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range (http://www.cms.int/).

9.5.2.8 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

As one of the 180 contracting parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Norway aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival (http://www.cites.org).

9.5.2.9 OECD's Environmental Performance Reviews (EPRs)

OECD's Environmental Performance Reviews (EPRs) identify good practices and make recommendations to improve the reviewed country's environmental policies and programmes. Norway's latest Environmental Performance Review that was conducted under the management of the OECD Working Party on Environmental Performance (WPEP) dates back to May 2011 (http://www.oecd.org/norway/norway2011.htm).

The International Barcode of Life project (iBOL) has one overarching goal- to assemble the sequence library and technology necessary to identify known and discover new organisms rapidly and inexpensively. iBOL's main mission is to extend the geographic and taxonomic coverage of the barcode reference library (Barcode of Life Data Systems (BOLD)) storing the resulting barcode records, providing community access to the knowledge they represent and creating new devices to ensure global access to this information. That includes a hand-held device that will provide real-time access to identifications by anyone in any setting (http://ibol.org). iBOL invites countries to participate as Nodes[107] of the project. As a regional node, Norway is a significant contributor to the global effort of building a DNA barcode archive for all eukaryotic life on Earth. The country is committed to build a complete reference library of DNA barcodes for all eukaryotic species occurring in Norway and in the Arctic region. It also contributes Norwegian taxonomic expertise to global barcode campaigns within the framework of the iBOL project (http://ibol.org/norway).

As a member of the 1999 Gothenburg Protocol, Norway has agreed to abate acidification, eutrophication and ground-level Ozone sets emission ceilings for four pollutants, namely sulphur, NOx, VOCs and ammonia. Once the Protocol is fully implemented, Europe's sulphur emissions should be cut by at least 63%, its NOx emissions by 41%, its VOC emissions by 40% and its ammonia emissions by 17% compared to 1990. Under the Protocol, farmers are taking specific measures to control ammonia emissions. The Protocol was amended in 2012 to include national emission reduction commitments to be achieved in 2020 and beyond (http://www.unece.org/env/lrtap/multi_h1.html).

Norway complies with the FAO Port State Measures Agreement to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing. The in 2009 adopted agreement aims to prevent, deter and eliminate illegal, unreported and unregulated (IUU) fishing through the implementation of robust port State measures. IUU is a global threat to sustainable fisheries and to the management and conservation of fisheries resources and marine biodiversity (http://www.fao.org/fishery/topic/166283/en).

[107] Nodes are networks of leading researchers and key organizations affiliated to iBOL and engaged in DNA barcoding and/or in funding and advancing biodiversity science in a country or region.

Norway is also a contracting party to the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention). The Ballast Water Management Convention, adopted in 2004, aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments.

Invasive aquatic species present a major threat to the marine ecosystems, and shipping has been identified as a major pathway for introducing species to new environments. The effects of the introduction of new species have in many areas of the world been devastating (http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships%27-Ballast-Water-and-Sediments-%28BWM%29.aspx).

Norway has seven sites on the World Heritage List of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the following two of which are of most relevance to the conservation and sustainable use of biodiversity for food and agriculture:

- Vegøyan-The Vega Archipelago is a cluster of islands centered on Vega, just south of the Arctic Circle, which forms a cultural landscape of 103,710 ha, of which 6,930 ha is land. The islands bear testimony to a distinctive frugal way of life, based on fishing and harvesting down from the eider ducks over the past 1,500 years. Fishing villages, quays, warehouses, eider houses (built for eider ducks to nest in), farming landscapes, lighthouses and beacons are important sites.
- The Geiranger and the Nærøy fjords are part of the west Norwegian fjord landscape. They are among the world's longest and deepest fjords. Their landscape features a range of supporting natural phenomena, both terrestrial and marine, such as submarine moraines and marine mammals. Remnants of old and now mostly abandoned transhumant farms add to the cultural aspects of the dramatic natural landscape that complements and adds human interest to the area. The ministries of Agriculture and Food and of Climate and Environment jointly support the maintenance of cultural landscapes like these by providing annual funding for grazing and mowing (http://unesco.no/eng-child-page/world-heritage-in-norway/).

Overall, Norway has a long history in development cooperation contributing to multiple projects in different regions of the world, including in the field of sustainable forest management. NORAD, the Norwegian Agency for Development Cooperation is responsible for ensuring that Norwegian development aid funds are spent in the best possible way and reports on what works and what does not work (http://www.norad.no).

9.6 Key findings and remaining challenges

Key findings

a. Norway has a broad range of national policies, programmes and enabling frameworks that either directly or indirectly support the conservation and use of biodiversity for food and agriculture.

b. The exchange of and access to the different components of associated biodiversity are governed by the Nature Diversity Act, the Wildlife Act and the Marine Resources Act.

c. Farmers, fishermen and forest owners actively contribute to the conservation of biodiversity for food and agriculture as individuals and as members of clubs, cooperative-run associations, etc.
Several national livestock breeding programmes, most of which are based on native breeding material and are internationally acknowledged for their sustainability, are managed and owned by cooperative associations.
The national crop plant and forest breeding programmes' focus on developing commercial varieties and species that are adapted to the Nordic climate and day lengths.
Many (research) institutes and organizations have programmes and projects in support of the conservation and sustainable use of biodiversity for food and agriculture.

d. Stakeholders from different sectors collaborate to implement policies and programmes of relevance to biodiversity for food and agriculture at national, regional and international levels.

e. There are a series of information systems in place with data on biodiversity for food and agriculture, associated biodiversity and wild food resources.

f. Training and extension programmes targeting the conservation and sustainable use of associated biodiversity exist at all educational levels.

Remaining challenges

a. There are no explicit policies or programmes in place to preserve and enhance the delivery of ecosystem services in the different production systems.

b. As a contracting party to the Nagoya Protocol, Norway is bringing its national legislation of relevance to access and benefit-sharing of genetic resources, as laid out in the Nature Diversity Act, in line with the International Protocol. This is a challenging task to be finalized by 2015.

c. While it is, in general, a challenging task to conserve and use biodiversity in food and forest related production systems, this is even truer for native commercial and non-commercial genetic resources for food and agriculture.

d. Collaboration among stakeholders to implement policies and programmes at national, regional and international levels often requires compromise, as the institutions involved in these processes have different perspectives and competences and come from different sectors.

e. Traditional knowledge related to the conservation and use of old and traditional plant varieties could be more systematically documented.

f. Within the fields of forest, animal and plant genetic resources, there are still some knowledge gaps with respect to the potential of less commercialized species, varieties and breeds.

g. Knowledge on the management and sustainable use of associated biodiversity species is also limited; unfortunately the country has few taxonomists who could enhance work in this field.

10 FUTURE AGENDAS FOR CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY FOR FOOD AND AGRICULTURE

10.1 Norway and the implementation of the Strategic Plan for Biodiversity

Norway's national environmental targets and its corresponding indicators are very much in line with the Strategic Plan for Biodiversity and its 20 Aichi biodiversity targets, https://www.cbd.int/sp/ and http://www.environment.no/Goals-and-indicators/Goals-and-indicators/Biodiversity/ .
This section describes the national environmental targets that are linked to achieving Aichi targets 6, 7 and 13.

10.1.1 National environmental targets linked to Aichi target 6

Norway's national environmental targets of relevance to achieving Aichi target 6 are targets:
1.1. The structure, functioning, productivity and diversity of marine ecosystems will be maintained or restored and they will provide a basis for value creation through the sustainable use of natural resources and ecosystem services.
1.4. Maintain ecosystem functioning in coral reefs and other vulnerable ecosystems (this target is also of relevance to achieving Aichi target 10.).
1.5. and 2.4. Losses of threatened marine species and threatened species in freshwater will be halted and the status of declining species will be improved by 2020.
1.6. Management of all harvested marine species will be ecosystem-based, and they will be harvested sustainably.
2.5. Management of all harvested freshwater animals and plants will be ecosystem-based, and they will be harvested sustainably by 2020.
2.6. Wild stocks of anadromous salmonids (including their genetic diversity) will be viable.

The integrated management plans for the Barents Sea–Lofoten area, the Norwegian Sea, and the North Sea and Skagerrak all include management goals that are of relevance to Aichi target 6. Norway's integrated marine management plans provide a framework for the sustainable use of natural resources and ecosystem services derived from the sea areas and at the same time maintain the structure, functioning, productivity and diversity of the area's ecosystems.

An ecosystem-based approach is fundamental to the legislation governing Norwegian fisheries management. The fisheries authorities must also regularly assess what measures are needed to safeguard individual stocks that are harvested. A great deal of work has been done at both national and international level to reduce illegal, unreported and unregulated fishing (IUU fishing) through port state controls when catches are landed. Nevertheless, single species management is still the dominant approach in fisheries management. Steps are being taken to learn more about interactions between stocks and develop a more integrated ecosystem-based management regime

for marine resources. Thus, some stocks are now being given multi-species based advice for the fishing quotas (e.g. capelin, north-east arctic haddock and north-east arctic cod, as well as herring, mackerel and blue whiting in the Norwegian Sea).

No harvesting of threatened species or stocks of freshwater fish species is permitted. Salmon stocks are managed on the basis of spawning stock management targets, based on the number of female fish needed for the river to produce the maximum sustainable yield of smolt. The goal is for target levels to be reached in three of every four years, and fishing in each salmon river is regulated with the aim of achieving the defined spawning stock level. This management regime has resulted in an increase in salmon stocks (Forseth et al., 2013). Since 1970, wild salmon stocks have shown a negative trend in all parts of the North Atlantic. The aquaculture-related measures, including those described under Aichi target 7. may in the long term reduce pressure on wild salmon and sea trout from this sector.

Assessment of progress in the Barents Sea-Lofoten area

Viable populations have been achieved for cod, haddock, saithe, capelin, herring and marine mammals. Beaked redfish and possibly also Greenland halibut are now under recovery while golden redfish, and coastal cod have been at low levels and did therefore not reach their full reproductive potential. The target has not been achieved for seabird populations. In 2005, there was extensive illegal, unreported and unregulated (IUU) fishing of Northeast Arctic cod. Norway took the initiative to cooperate with other countries to reduce fishing pressure. This was successful, and IUU fishing has been greatly reduced. The target of maintaining populations of threatened species and species for which Norway has a special responsibility or restoring them to viable levels as soon as possible has not been achieved. Populations of many such species are not considered to be viable at present.

Assessment of progress in the Norwegian Sea

An assessment of progress towards the targets for the Norwegian Sea is expected to be completed in summer 2014. It can be said that most species for which Norway has a special responsibility and important large fish stocks are soundly managed. With the exception of the beaked redfish stock, a number of endangered and vulnerable species are still under pressure and show negative trends.

General measures implemented by Norway in marine areas include the further development of systematic monitoring and the management of living marine resources in accordance with the Marine Resources Act. The country also continues to develop ecosystem-based management regimes for living marine resources. Finally, Norway supplies data on fish stocks to the International Council for the Exploration of the Sea (ICES), which collates and analyses data from all countries that harvest and carry out research on these stocks and it takes part in international efforts to build up knowledge of individual fish stocks so that the overall harvest is sustainable.

10.1.2 National environmental targets linked to Aichi target 7

Norway's national environmental targets relevant to achieving Aichi target 7 are:
4.1. By 2020, the diversity of habitat types in forests will be maintained or restored; this will include safeguarding genetic diversity and important ecological functions and services.
4.2. All forestry areas will be sustainably managed by 2020.
4.5. Management of all harvested stocks of forest animals and plants will be ecosystem-based, and they will be harvested sustainably by 2020.
6.7. All agricultural areas will be sustainably managed by 2020.

Gene conservation units have been established for 10 tree species.108 The units are placed in 23 nature reserves across 11 counties. Common European minimum requirements and standards have been developed for the establishment of these units through the European Forest Genetic Resources Programme (EUFORGEN).

Forestry is the most important factor of influence on forest biodiversity. According to the 2010 Norwegian Red List, many forest species that are threatened or near-threatened are believed to be negatively affected by former or current forestry activities. Key biotopes and other environmental values have been registered in a large proportion of forest areas in Norway. Forest owners are required to take this information into consideration, and to plan forestry activities accordingly. Most productive forest is managed in accordance with the Norwegian PEFC standard. The Nature Index for Norway 2010 gives the status for biodiversity in forests through an index value. The most recent Nature Index work is essentially based on assessments made by experts, while the next version of the Nature Index aims to be based on more factual data.

The way in which logging and climate related measures such as tree planting are carried out will also be of influence on the status of forest biodiversity. The proportion of forest area registered as protected from logging in key biotopes,109 as well as controlling and avoiding the ongoing spread of non-native tree species will also be of importance.

Sustainable agricultural practices, including grazing and management of the cultural landscape, are essential for maintaining biodiversity. Norway is using a variety of economic and legislative instruments (e.g. the designation of selected habitat types and priority species, measures to control alien species, and cross-sector cooperation on specific environmental measures in agriculture) to maintain the diversity of habitat types and species in the cultural landscape.

Nutrient runoff from agricultural areas is a threat to water quality and in this respect measures are also being undertaken.

---

[108] More information on the gene conservation units can be found at: http://www.skogoglandskap.no/seksjoner/skogverndatabase/subject_view

[109] In 2014, approximately 3,4 % of the total productive forest area was classified in this category (Tomter & Dalen, 2014).

Norway published its strategy for an environmentally sustainable aquaculture industry in 2009. One of its goals is for the industry to develop a structure and locate facilities in a way that reduces environmental impacts and the risk of spreading disease. Aquaculture has important impacts in coastal waters and fjords, for example as a result of the escape of farmed salmon and the transmission of salmon lice. Indicators and thresholds for determining acceptable levels of impact on wild salmon spawning grounds are being developed. The Aquaculture Act was amended in 2013 to provide a legal basis for introducing requirements to identify/tag aquaculture organisms. This will make it possible to distinguish between wild and escaped farmed salmon, and track the origin of escaped salmon, but the provision has not yet been applied. About one fifth of the entire Atlantic salmon population is found in Norway, and the country therefore has a major international responsibility for managing the species. Since 1970, wild salmon stocks have shown a negative trend in all parts of the North Atlantic. The aquaculture-related measures may reduce pressure on wild salmon and sea trout from this sector. Nevertheless, it is a challenging task to reconcile the national target of ensuring viable wild stocks of anadromous salmonids with the objective of ensuring that the aquaculture industry grows sustainably. The authorities, the industries and interest groups will have to cooperate to find solutions that reduce the overall pressure on wild fish stocks.

10.1.3 National environmental targets linked to Aichi target 13

Even if no national environmental targets correspond directly to Aichi target 13, targets 2.6. and 6.5. do contribute to achieve this target:
2.6. Wild stocks of anadromous salmonids (including their genetic diversity) will be viable.
6.5. By 2020, the diversity of habitat types in cultural landscapes will be maintained or restored; this will include safeguarding genetic diversity and important ecological functions and services.
In adddition, the overall goals of Norwegian agricultural policy include enhancing the conservation and use of genetic resources for food and agriculture, including safeguarding an as large a proportion as possible of global crop and forest tree seed diversity in the Svalbard Global Seed Vault.

The Norwegian Genetic Resource Centre plays a key role when it comes to achieving Aichi target 13. The Centre is responsible for contributing to the effective management of animal and plant genetic resources for food and agriculture and of forest genetic resources. Its strategic plan and plans of action provide a framework for the three sectors with priorities and activities to conserve and use cultivated plants, farm animals and forest trees that are native to Norway.

Norway has breeding programmes for a total of 13 plant species, including cereals, potatoes, fodder plants, fruits and berries. In 2012, 13 new varieties were included on the Norwegian Official List of Varieties, four of which were developed in Norway. The new varieties list contains plant varieties that have been approved for commercial production in Norway. Before a new variety is included on the list, it has been thoroughly screened to ensure it is different from existing varieties and that it has cultivation potential and use value in Norway.

National field gene banks have been established for the conservation of various fruit crops, berries and potatoes. The Norwegian Genetic Resource Centre also developed a strategy for *in situ* conservation of crop wild relatives in the Norwegian flora, which includes the conservation of their semi-natural habitats, such as hay meadows.

Regarding the management of livestock, the Norwegian breeding organizations for cattle (GENO), pigs (Norsvin), sheep and dairy goats (NSG) annually report both on the effective population sizes of their breeds and on genetic gain on functional traits in addition to traditional production traits. Based on the reported figures, the commercial breeding programmes in Norway are sustainable. With respect to Norway's endangered livestock breeds, the country started to systematically work on their conservation in 1990. Since then, the status of these breeds has in general improved, even if a number of threatened horse and cattle breeds have known a negative trend. Of the 35 livestock breeds classified as native to Norway, 17 are considered to be critically endangered according to FAO's guidelines on the characterization of livestock breeds.
As previously mentioned, gene conservation units have been established for 10 tree species to conserve forest genetic resources *in situ*.

Norway's fisheries and aquaculture regulations include provisions to safeguard aquatic genetic resources. The need for a systematic approach to map and control pollution, pests and diseases, and the genetic interaction between farmed aquaculture organisms (e.g. salmon) and wild populations, resulted in the preparation of the Strategy for an Environmentally Sustainable Norwegian Aquaculture Industry and the Aquaculture Act. Photo: Sjømatrådet

The fisheries and aquaculture authorities are responsible for identifying relevant indicators and establishing mapping programmes and systematic actions to reduce negative effects on wild populations, and for maintaining and enhancing the genetic resources of farmed aquatic organisms. This work must be carried out in cooperation with other authorities, such as the

environmental authorities that are responsible for safeguarding wild populations and the food and agriculture related authorities.

The Norwegian environmental authorities are maintaining the genetic diversity of Atlantic salmon by keeping genetic material from 170 stocks in gene banks. Stock enhancement measures and steps to protect or restore habitats for other threatened and vulnerable aquatic species are also being organized and are relevant to this Aichi target.

As a member of the FAO Commission on Genetic Resources for Food and Agriculture, Norway is committed to the implementation of the Global Plans of Action for plant, animal and forest genetic resources, which were developed under the Commission's umbrella. These action plans directly contribute to the implementation of Aichi target 13, as does the work of the International Treaty on Plant Genetic Resources for Food and Agriculture, to which Norway is a contracting party.

Norway's participation in the forthcoming State of the World Report on aquatic genetic resources will also contribute to reporting on the achievement of Aichi targets (particularly targets 7 and 13).

Finally, the Nature Diversity Act sets out management objectives for different food and agriculture related species. According to this Act, the genetic diversity of domesticated species is also to be maintained.

10.2 Plans and priorities for the management of associated biodiversity, wild food resources and ecosystem services

The Norwegian government is planning to expand the area of protected areas, particularly in the marine environment (White paper Nr.10 (2010-2011).110 This will contribute to the conservation of many marine species, including wild fish species, algae, etc.

At present, the awareness on the need to expand monitoring activities with respect to biodiversity for food and agriculture, and in particular associated biodiversity components, is high and decision makers may decide to use this momentum to enhance activities in this area of work.

The report on the natural benefits-on the value of ecosystem services (NOU, 2013), that was published by the Ministry of Climate and Environment in 2013, includes recommendations that could positively contribute to the future management of biodiversity for food and agriculture and of the ecosystem services it provides. The government is expected to follow up on these recommendations.

[110] As a Contracting Party to the CBD Norway has pledged to protect 10% of its oceans by 2020.

10.3 Plans and priorities for the implementation of ecosystem approaches

Sustainable Forest Management

Norway's forest certification system that aims to promote sustainable forest management by certifying forest properties and forest products is reviewed every five years. The Norwegian PEFC forest standard and other standards that belong to the certification system were reviewed between October 2013 and September 2014 and a proposal to revise the standards has been submitted.

In 2014, the Norwegian Forest and Landscape Institute[111] published a status report on the sustainable management of forests in Norway (Tomter & Dale, 2014) that is expected to be updated on a yearly basis. The findings of this report will be used for the formulation of policies that will contribute to the implementation of the Sustainable Forest Management approach in Norwegian forests.

Other forms of ecosystem approaches for biodiversity for food and agriculture

In the framework of the "Establishment of plant genetic resources *in situ* conservation in protected areas in Norway" project, 200 crop wild relative (CWR) species have been prioritized for *in situ* conservation, including species that are either directly and/or indirectly relevant to the delivery of ecosystem services in and around production systems.

The Norwegian government is committed to continue with the application of ecosystem approaches in its forest and fish related production systems. With respect to agriculture, the government is still determined to increase the production and consumption of organic food to 15% by 2020 (White paper Nr.9 (2011-2012)).

10.4 Plans and priorities for improving stakeholder awareness, involvement and collaboration

10.4.1 Strengthening the institutional setting to improve stakeholder engagement

The Norwegian Genetic Resources Centre's strategic plan and its sectoral action plans lay out the many activities that are being undertaken to improve stakeholder awareness, involvement and collaboration in the conservation and sustainable use of animal, plant and forest genetic resources. To broaden its outreach, the Centre's competence and activities could be expanded to include other sectors of genetic resources, such as micro-organisms and invertebrates of relevance to food and agriculture.

[111] As of 1 July 2015, the Norwegian Forest and Landscape Institute is part of the Norwegian Institute of Bioeconomy Research or NIBIO (Norsk institutt for bioøkonomi).

The government is currently in the process of drawing up an action plan to halt the loss of biodiversity and to implement relevant national goals, including those related to the Aichi biodiversity targets (Norwegian Ministry of Climate and Environment, 2014). This action plan should contribute to improving stakeholder awareness, involvement and collaboration in the conservation and sustainable use of biodiversity for food and agriculture.

The goal of the Norwegian Biodiversity Information Centre (NBIC) is to serve as a national source of information on species and ecosystems in Norway, and to make up-to-date information on biodiversity widely available and easily accessible to society. NBIC's knowledge is continuously expanding through interaction with the scientific community, and close cooperation with policymakers, managers and other data users. A perfect example in this respect is the process that has been followed to date to revise the 2010 Norwegian Red List for Species.

10.4.2 Supporting the role of farmers, pastoralists, fisher folk, forest dwellers, dependent on local ecosystems

The Árbediehtu project that is run by the Sámi University College collects, documents and systematizes the traditional knowledge and methods Sámi have been using for generations to manage the natural resources that are key to their livelihood. The findings of this ongoing project are useful to the work Norway undertakes to implement the conventions and declarations in support of Indigenous Peoples and Local Communities.

Local museums contribute to strengthen the knowledge and recognition of the role of farmers, fishermen and foresters, as well as of indigenous peoples and local communities in the conservation and use of biodiversity for food and agriculture. Among others, museums like these teach schoolchildren and the broader public alike about food production and related traditions (Akershusmuseet, Årsrapport 2009). Farm field trips also continue to be important awareness raising tools in this respect (http://www.torvabarnehage.no/index.php?artID=1225&navB=80).

The increasingly popular Community Supported Agriculture (Andelslandbruk) contributes to linking producers and consumers and to raising awareness on what it takes to produce food. In this form of agriculture, farmers sell their produce directly to the consumer who buys a share of the farmers' production for a determined period of time. The risks related to annual weather variation and crop yields are shared between the farmers and the consumers (http://andelslandbruk.origo.no/?ref=checkpoint).

10.5 Key findings and remaining challenges

Key findings

a. Norway aims to achieve a number of environmental targets in its production systems that will contribute to meet Aichi targets 6, 7 and 13 of the UN Strategic Plan for Biodiversity. The Norwegian Genetic Resource Centre plays a particularly important role when it comes to achieving Aichi target 13. Its strategic plan and plans of action provide a framework with priorities and activities to conserve and use cultivated plants, farm animals and forest trees native to Norway. With respect to plant breeding programmes there is extensive cooperation between the Nordic plant breeding companies. Norway's tree and commercial livestock breeding programs are broad in scope and focus on maintaining high genetic variation within the breeding populations.

b. The government plans to expand the area of protected areas in the marine environment.

c. In 2013, the Ministry of Climate and Environment published a report entitled Natural benefits-on the value of ecosystem services. This report includes recommendations that could positively contribute to the future management of biodiversity for food and agriculture and ecosystem services.

d. In 2014, the Norwegian Forest and Landscape Institute (now NIBIO) published the first status report on the sustainable management of forests in Norway. The findings and annual updates of this report will serve as a basis for the formulation of policies that will contribute to the implementation of the Sustainable Forest Management approach in Norwegian forests.

e. The government is determined to increase the production and consumption of organic food to 15% by 2020.

Remaining challenges

a. Regarding the national environmental targets linked to Aichi target 6, it remains challenging to develop an integrated ecosystem-based management regime for marine resources. In the Barents Sea-Lofoten area, the target of maintaining or restoring populations of threatened species to viable levels has not yet been achieved. In the Norwegian sea the status of a number of endangered and vulnerable species continue to show negative trends.

b. Regarding the national environmental targets linked to Aichi target 7, it is a challenging task to reconcile the national target of ensuring viable wild stocks of anadromous salmonids with the objective of ensuring that the aquaculture industry grows sustainably. The authorities, the industries and interest groups will have to cooperate to find solutions to reduce the overall pressure on wild fish stocks.

c. Regarding the national environmental targets linked to Aichi target 13

d. AnGR: It is a challenge to safeguard the conservation and use of commercial native livestock breeds, which is currently being managed by a small number of cooperative-run

companies. Moreover, while the status of endangered native livestock breeds has in general improved, the native horse breeds are all critically endangered.

e. PGR: the number of plant breeding programmes in Norway has declined over the last decades. The current programmes focus on commercial and semi-commercial crops.

f. FGR: The genetic resources of fifteen of the 34 native forest tree species are considered to be exposed or threatened either at the local or national level.

g. The government is expected to follow up on the recommendations of the report Natural benefits-on the value of ecosystem services. Setting priorities will be challenging.

h. The government is expected to use the recommendations of the report Bærekraftig skogbruk i Norge for the sustainable management of forests in Norway.

i. Increasing the production and consumption of organic food from approximately 5% today to 15% by 2020 is a highly ambitious and perhaps no longer a realistic goal.

11 CONCLUSIONS AND RECOMMENDATIONS

Species, breeds and varieties of an uncountable number of organisms contribute either directly or indirectly to the production of food and forest products. These organisms need to be conserved and used to ensure sustainable food production for present and future generations. In the agricultural sector, most of the management practices or actions that are of benefit to the use of biodiversity for food and agriculture are not necessarily put in place with that objective.

Even if the awareness on the importance of associated biodiversity to food production and food security is increasing, safeguarding associated biodiversity in and around production systems needs to move higher up on the political agenda. This will require the development of awareness raising activities targeting decision-makers, farmers and consumers to enhance their recognition on the importance of these components of biodiversity to sustainable food production.

This section includes a number of recommendations on how to improve the conservation and sustainable use of biodiversity for food and agriculture in Norway.

11.1 Main recommendations

11.1.1 Addressing knowledge gaps and research needs

11.1.1.1 Sustainable use of biodiversity for food and agriculture

There is quite some expertise in Norway on the management and sustainable use of biodiversity for food and agriculture. However, with respect to the less commercialized species, varieties and breeds and to associated biodiversity species, there are still some major knowledge and information gaps. Some of these gaps are the result of the fact that there still is a general lack of understanding of the importance and value of these species, both outside and within the farming community and among the relevant authorities. This is an overriding limitation that needs to be addressed.

Increasing the knowledge of the management and sustainable use of associated species would need thorough survey and identification work. This would require the support of species specialists and taxonomists, of which the country has very few. There are also no financial resources available for conducting such activities.

Knowledge on how to optimally manage biodiversity in and around production systems in a changing climate is also missing, and there is also no information on how farmers balance trade-off between ecosystem services and disservices in their production system

Adoption of ecosystem approaches

Ecosystem approaches are being adopted in several production systems (e.g. in the forestry and fishery sectors). Even so, there are still quite a few major information and knowledge gaps that might hinder the implementation of such approaches. In the various production systems, particularly little is known about regulating and supporting ecosystem services and the extent to which the delivery of these services is exposed to risk.

To address this relatively complex issue, a first step could be to map the main ecosystem services of relevance to the production system, as well as of the organisms involved, followed by a risk assessment to identify their threats, if any. Such information is of crucial importance to the development and implementation of holistic policies and management strategies, such as the ecosystem approach.

To increase the number of organic farmers and the area under organic cultivation a subsidy scheme has been put into place. The subsidies that have been granted so far have mainly been linked to the size of the area under organic cultivation. To further promote the values of organic agriculture it might be useful to also link these subsidies to, inter alia, the extent to which the farmer contributed to improve the soil structure and health of the land under cultivation, or to whether initiatives have been undertaken to (pro)-actively manage the delivery of ecosystem services, for example by adopting pollinator friendly landscape practices.

Finally, the more practical aspects of organic farming could be strengthened in the trainings that are being given to organic farmers; these seem to have received too little attention so far.

11.1.1.2 Associated biodiversity and ecosystem services

In general, there is inadequate capacity and knowledge about most aspects of associated biodiversity and the limited research that is undertaken with respect to these components of biodiversity tends to focus on conservation and not so much on conservation and sustainable use. Moreover, with the declining number of taxonomists in Norway, field knowledge related to these components of biodiversity is further weakening.

Regarding ecosystem services, research activities have been modest so far and Norway's knowledge on the whole is limited and fragmentary. Extrapolating knowledge from studies undertaken in other countries is often of limited use due to Norway's unique climatic and geographical conditions.

The main capacity and resources limitations with respect to associated biodiversity and ecosystem services occur in the areas of mapping and research; taxonomy (i.e. Norway has few good taxonomists making it difficult to identify collected specimens); human capacity (e.g. collecting data on pollinating insects is a time consuming and costly exercise); and higher education (e.g. Norwegian universities currently have no regular offer of education specifically directed at pollination ecology).

Limited knowledge of biological processes, such as the complex interactions that exist between the different components of associated biodiversity in and around production systems, can lead to decisions with unforeseen and often irreversible consequences. An example in this respect is the decision that was taken by the government to remove topsoil from agricultural land to safeguard the fertile soil before the land is used for other purposes (e.g. building projects). Topsoil works in harmony with subsoil and bedrock to produce fertile soils and its removal seriously affects their complex relationship; it can take thousands of years for this relationship to rebuild (between 30 to 1,000 years are needed for the bedrock and subsoil to generate 25 mm of fertile topsoil).

To fill the existing knowledge gaps, one could start by defining and gathering information on the main challenges with respect to the management of ecosystem services in Norway. In terms of pollination, for example, in view of the decline of many wild bee populations and their significance as pollinators, relevant mapping activities could be strengthened; knowledge about bees and which

species of plants they visit could be compiled; ongoing mapping projects could be extended to include new groups of pollinators (especially flies and flower-visiting beetles); depending upon the distribution pattern of the groups being investigated mapping activities could be initiated on national, regional (counties) and local levels; the mapping of specialist plants and pollinators will be a valuable tool in the vulnerability analysis and preservation of such species; and Norwegian universities and experts may wish to cooperate to set up courses on pollination ecology and to initiate joint research projects.

With respect to gaining knowledge on associated biodiversity, a possible starting point could be to try and expand existing monitoring, surveying and mapping activities at the national, regional (counties) and local levels by including groups of associated biodiversity species that have not been systematically assessed before. In selecting these species, priority could be given to functional groups that are considered key to food production (e.g. a set of pollinating species or of soil fertility promoting micro-organisms). Where functional groups have similar ecological roles, those with a single or only a few species could be prioritized for future research activities, as these groups are potentially more vulnerable to emerging challenges, such as climate change.

11.1.1.3 Wild food resources

More financial and human resources need to be allocated to monitor and gain knowledge about wild plant and fungi species, many of which lack population size and resource data. These species have potential as a source of food and are known to play significant role(s) in the delivery of ecosystem services (e.g. certain fungi species facilitate the provision of nitrogen and phosphorus to trees, thereby contributing to the productivity of forests; other wild food species may be of particular cultural value).

11.1.1.4 Invasive alien species

Still little is known on the unintentional introduction, the colonization and the risks associated with invasive alien species and “door knockers”. If Norway intends to continue to develop and expand its assessments of the ecological impact(s) posed by alien species, efforts to strengthen the knowledge base are needed.

The unintentional introduction of invasive alien species is regulated through the Nature Diversity Act. The enforcement of the Act seems to be quite challenging, partly because the philosophies pertaining to alien species in nature conservation policies and those applying to agriculture, forestry and production systems tend to differ. The former are very restrictive with respect to aliens, whereas the latter are open to test and use different species, varieties and breeds, including new ones, to enhance production system development across the different sectors.

With respect to controlling the introduction of invasive alien species into Norway, there are still relatively few measures in place. Areas like these could be strengthened through the allocation of more financial and human resources to responsible authorities like the Norwegian Food Safety Authority (Mattilsynet), that controls the importation of alien plants, parts of plants and other regulated articles into Norway, some of which may carry pests.

To enhance public awareness on the impact of invasive species, control measures and the unintentional introduction of invasive species, more targeted awareness raising activities focusing on hobby gardeners or travelers should also be considered.

Given the global threat of invasive alien species on biodiversity, there is an increasing need for the development of an international methodology that can be used across national boundaries to assess the impacts posed by alien species. In view of its experience in preparing the Black List, Norway is in a good position to promote and participate in the development of such a methodology.

11.1.2 Improving collaboration for the conservation and sustainable use of biodiversity for food and agriculture

Among the relevant stakeholders there is high degree of awareness on the need to manage biodiversity in a sustainable manner. However, the different activities they undertake are usually not coordinated and collaboration between the different authorities and sectors involved remains challenging.

Especially in terms of monitoring and documenting the different organisms and landscapes that are of relevance to food and forest production sectors could improve their collaboration. Strengthening their interaction in this field will provide the basis that is needed for a more holistic approach to the management of biodiversity for food and agriculture.

The preparation of the national biodiversity action plan could be an excellent opportunity for stakeholders from different sectors to agree on and be jointly committed to the conservation and sustainable use of biodiversity in Norway.

11.1.3 Optimizing the use and conservation of traditional foods

In general, the use of diverse animal, plant, forest and aquatic genetic resources is recognized as important for sustainable and healthy food production and knowledge about these resources is well documented. However, maintaining genetic variation is costly and time consuming and is not always in balance with the short term focus of increasing production and economic gains. In this context, particularly the contribution of traditional plant varieties and endangered native livestock breeds to food security tends to be undervalued and as a result underutilized. Characterizing these varieties and breeds should be prioritized to gain a better understanding of their potential values and use.

Wild food resources are also underutilized. In recent years, the harvesting and use of some wild resources that were traditionally used for food (e.g. sorbus for the production of jam and other preserves) significantly decreased, as did the knowledge on the potential uses of these resources. The declining trend in the use and knowledge of wild edible resources is one of main the constraints to their conservation.

To stimulate the use and the conservation of underutilized domesticated and wild resources and create supplementary farm income, the development of niche products promoting programmes could possibly be strengthened. With countries increasingly depending on each other to meet domestic food demand, including in the light of changing climatic conditions, enhancing the use of the more traditional and usually adapted varieties and breeds would also be an asset to Norway's food security status.

11.2 Possible next steps

With the preparation of the national country report on biodiversity for food and agriculture, Norway has for the first time taken such a broad perspective to assess the status and trends of biodiversity for food and agriculture. Even if the report remains incomplete in some areas, this initial assessment has highlighted quite a number of opportunities Norway has to improve the conservation and use of biodiversity for food and agriculture, particularly with respect to associated biodiversity and the delivery of ecosystem services.

As a follow-up to this process, the Ministry for Agriculture and Food may wish to review the report's main recommendations with the support of the Norwegian Genetic Resource Centre that has coordinated the preparation of the report and is responsible for the conservation and sustainable use of national genetic resources for food and agriculture. The Ministry could consider requesting the Centre to elaborate on the most relevant recommendations of the report.

The Norwegian Genetic Resource Centre will annex the conclusions and recommendations from this report to its strategic plan (Sæther et al., 2013). For the implementation of this action plan the mobilization of additional financial and human resources will inevitably be required.

As expected, the preparation process of this national report has nearly been as important as its outcomes. The interviews, meetings and seminars that were mainly organized to collect information for the report also turned out to be efficient awareness raising tools. They facilitated regrouping many types of stakeholders that had never sat around the same table before to exchange (at times very diverging) views on issues of common interest. Those who participated in this process described it as a positive experience and felt encouraged to look at food and forest production from a broader perspective. The momentum created by this process should somehow be built upon.

As previously mentioned in the report, the Norwegian Genetic Resource Centre aims to ensure all national genetic resources for food and agriculture are conserved, monitored and used in a sustainable manner. This requires knowledge building, awareness raising and fostering collaboration between stakeholders within and across the different sectors. To guide the implementation of its broad mandate, the Centre receives advice from three sectoral genetic resource committees on animal, plant and forest genetic resources, respectively. These committees also have joint meetings with interesting exchanges of knowledge and expertise across sectors on issues such as the characterization of genetic resources, *in situ* and *ex situ* conservation and the development of indicators. With some of the current committee members having significant expertise on associated biodiversity and their function in the delivery of ecosystem services (e.g. on soil organisms and soil fertility, and insects and pollination), perhaps these joint committee meetings could also be used to address issues of relevance to the conservation and sustainable use of biodiversity for food and agriculture. In addition, seminars on issues addressing the complexity of biodiversity of food and agriculture, such as on the interactions between different components of associated biodiversity and their functions in food and forest related ecosystems, could become an integral part of the Centre's seminar calendar.

12 GLOSSARY

Apomixis: replacement of the normal sexual reproduction by asexual reproduction, without fertilizationhttps://en.wikipedia.org/wiki/Apomixis - cite_note-1 (Winkler, 1908).

Aquaponics: food production system that combines conventional aquaculture with hydroponics (cultivating plants in water) in a symbiotic environment. In an aquaponic system, water from an aquaculture system is fed to a hydroponic system where the by-products are broken down by nitrification bacteria into nitrates and nitrites, which are utilized by the plants as nutrients. The water is then recirculated back to the aquaculture system (Wikipedia).

Associated biodiversity: species of importance to ecosystem function, for example through pollination, control of plant, animal and aquatic pests, soil formation and health, water provision and quality, etc. including inter alia micro-organisms, invertebrates, vertebrates including amphibians, reptiles and wild birds and mammals and wild and cultivated terrestrial and aquatic plants other than crops and wild relatives (FAO)

Becquerel (Bq): the unit of radioactivity in the International System of units (SI). One Bq is defined as the activity of a quantity of radioactive material in which one nucleus decays per second.

Biodiversity: the variability among living organisms. It includes diversity within and among species and diversity within and among ecosystems. Biodiversity is the source of many ecosystem goods, such as food and genetic resources. Changes in biodiversity can influence the supply of ecosystem services (UNEP).

Biodiversity for food and agriculture: The variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the structures, functions and processes in and around production systems (whereby production systems include the livestock, crop, fisheries and aquaculture and forest sectors) and that provide food and non-food agriculture products (FAO).

Ecosystem approach: The Ecosystem Approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The Ecosystem Approach places human needs at the centre of biodiversity management. It aims to manage the ecosystem, based on the multiple functions that ecosystems perform and the multiple uses that are made of these functions. The ecosystem approach does not aim for short-term economic gains, but aims to optimize the use of an ecosystem without damaging it (CBD Biodiversity Glossary).

Ecosystem services: Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth (UNEP). This report primarily focuses on regulating and supporting ecosystem services, most of which are described in Annex 4 of the FAO questionnaire.

***Ex situ* conservation:** A conservation method that entails the removal of germplasm resources (seed, pollen, sperm, individual organisms, from their original habitat or natural environment. Keeping components of biodiversity alive outside of their original habitat or natural environment (CBD Biodiversity Glossary).

Habitat: A place or type of site where an organism or population naturally occurs (CBD Biodiversity Glossary).

Indigenous people: People whose ancestors inhabited a place or country when persons from another culture or ethnic background arrived on the scene and dominated them through conquest, settlement, or other means and who today live more in conformity with their own social, economic, and cultural customs and traditions than with those of the country of which they now form a part. (also: 'native peoples' or 'tribal peoples') (CBD Biodiversity Glossary).

***In situ* conservation:** A conservation method that attempts to preserve the genetic integrity of gene resources by conserving them within the evolutionary dynamic ecosystems of the original habitat or natural environment (CBD Biodiversity Glossary).

Invasive species: Invasive species are those that are introduced—intentionally or unintentionally—to an ecosystem in which they do not naturally appear and which threaten habitats, ecosystems, or native species. These species become invasive due to their high reproduction rates and by competing with and displacing native species that naturally appear in that ecosystem. Unintentional introduction can be the result of accidents (e.g. when species escape from a zoo), transport (e.g. in the ballast water of a ship); intentional introduction can be the result of, for example, importing animals or plants or the genetic modification of organisms (CBD Biodiversity Glossary).

Kelp forest: Kelp forests are underwater areas with a high density of brown macro-algae belonging to the taxonomic order Laminariales. Kelp forests provide a unique three-dimensional habitat for marine organisms and are a source for understanding many ecological processes. They are recognized as one of the most productive and dynamic ecosystems on Earth. Kelp forests occur worldwide throughout temperate and polar coastal oceans (Wikipedia).

Marine Protected Area: An area of sea (or coast) especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means (CBD Biodiversity Glossary).

Native species: Flora and fauna species that occur naturally in a given area or region. Also referred to as indigenous species (CBD Biodiversity Glossary).

Protected forest area: Forest area designated primarily for conservation of biological diversity. Includes but is not limited to areas designated for biodiversity conservation within the protected areas; Areas especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means; and Forest area within formally established protected areas independently of the purpose for which the protected areas were established (FRA 2015-Terms and Definitions).

Productive forest: An area of forest capable of producing wood for more than a certain predicted amount, e.g. the increment volume is more than 1 m3/ha/year in the foreseeable future (FAO).

Protective forest: Forest area designated or managed for protection of soil and water; for water production, where most human uses are excluded or heavily modified to protect water quality; for coastal stabilization; for desertification control; to prevent the development or impact of avalanches on human life, assets or infrastructure; for protecting communities or assets from the impacts of: erosion, riparian floods and landslides, or for providing flood plain services; for selected ecosystem services or cultural or spiritual values; for public recreation; and/or for carbon storage or sequestration (FRA 2015-Terms and Definitions).

Riparian area: Interface between land and a river or stream. Riparian zones are significant in environmental management because of their role in soil conservation, their habitat biodiversity, and the influence they have on grasslands, woodlands and wetlands (Wikipedia).

Species: A group of organisms capable of interbreeding freely with each other but not with members of other species (CBD Biodiversity Glossary).

Species diversity: The number and variety of species found in a given area in a region (CBD Biodiversity Glossary).

Sustainable development: Development that meets the needs and aspirations of the current generation without compromising the ability to meet those of future generations (CBD Biodiversity Glossary).

Threatened species: Species that are believed to be in danger of extinction.

13 REFERENCE LIST

Amilien, V., Torjusen, H. and Vittersø, G. (2005). 'From local food to terroir product? Some views about Tjukkmjølk, the traditional thick sour milk from Røros, Norway', *Anthropology of food*, 4, May.

Andreassen, K. (2014). Retrieved on 13 January 2014 from: http://www.skogoglandskap.no/nyheter/2014/guide_om_sitkagran

Asdal, Å. (ed.) (2008). Country report on the state of plant genetic resources for food and agriculture-Norway. Norwegian Genetic Resource Centre, Norwegian Forest and Landscape Institute, Ås, Norway.

Bele, B. and Norderhaug, A. (2008). 'Bondens kulturmarksflora for Midt-Norge', *Bioforsk FOKUS*, 3(9), pp 1-121.

Bekkby, T., Angeltveit, G., Gundersen, H., Tveiten, L.A. and Norderhaug, K.M. (2014). 'Red sea urchins (Echinus esculentus) and water flow influence epiphytic macroalgae density', *Marine Biology Research*, 11 (4).

Bioforsk (n.d.) *Grassland and landscapes*. Retrieved on 24 July 2014 from: http://www.bioforsk.no/ikbViewer/page/en/research-area?p_document_id=98424.

Bjerknes, A.L., Totland, Ø., Hegland, S.J. and Nielsen, A. (2007). 'Do alien plant invasions really affect pollination success in native plant species? ', *Biological Conservation*, 138 (1-2): 1-12.

Bjørkhaug, H. (2009). *Trender i økologisk landbruk*, Notat 4/09 ISSN 1503-2027. Available at: http://d3861196.hosted418.moonrocketadmin.net/filarkiv/2010/03/05/14b90d2b2d68c0.pdf

Bjørnsen, H.M. and Johansen, S. (2006). *Gårdbrukeres arbeidstilbud i et regionalpolitisk perspektiv*, Levekår i landbruket 1995-2004. Available at: http://www.ssb.no/a/publikasjoner/pdf/sa108/arbeidstilbud.pdf

Blackwell, M. (2003). *Effects of the Chernobyl Disaster on Sámi Life*. Available at: http://www.utexas.edu/courses/sami/dieda/socio/chernobyl.htm

Borch, T., Moilanen, M. and Olsen, F. (2011). *Sjøfisketurisme i Norge-Debatter, regulering, struktur og ringvirkninger*. NORUT: Rapport 01/2011. Northern Research Institute (NORUT), Tromsø, Norway.

Christie, H., Leinaas, H.P. and Skadsheim, A. (1995). Local patterns in mortality of the green sea urchin, *Strongylocentrotus droebachiensis*, at the Norwegian coast. In: Skjoldal, H.R., Hopkins, C., Erikstad, K.E. and Leinaas, H.P. (eds) *Ecology of fjords and coastal waters*, Elsevier Science, Amsterdam: 573□584.

Convention on Biological Diversity (CBD) (2009). *Norway's National Report on Implementation of the Convention on Biological Diversity*. Retrieved on 26 March 2014 from: http://www.regjeringen.no/upload/MD/Vedlegg/Rapporter/Norways_national_report_on_implementation_of_the_convention_on_biological_diversity.pdf

CBD Biodiversity Glossary, https://www.cbd.int/cepa/toolkit/2008/doc/CBD-Toolkit-Glossaries.pdf

Cury, P.M., Boyd, I. L., Bonhommeau S., Anker-Nilssen, T., Crawford, R. J. M., Furness, R. W., Mills, J. A., Murphy, E. J., Osterblom, H., Paleczny, M., Piatt, J. F., Roux, J.-P., Shannon, L. and Sydeman, W.J. (2011). *Global Seabird Response to Forage Fish Depletion--One-Third for the Birds*. Science, 334 (6063): 1703 DOI: 10.1126/science.1212928.

Det norske Skogselskap på oppdrag av Landbruks-og matdepartementet (2011). Norwegian Forests- Policy and Resources.

Directorate of Fisheries (2010). *Nøkkeltall fra norsk havbruksnæring-År 2009*. Fiskeridirektoratet (ISBN 82-91065-15-2). All information can be retrieved from www.fiskeridir.no

Directorate of Fisheries (2013). *Norwegian aquaculture*. Retrieved on 28 July 2014 from: http://www.fiskeridir.no/english/statistics/norwegian-aquaculture/aquaculture-statistics/atlantic-salmon-and-rainbow-trout

Fagerli, C.W., Norderhaug, K.M. and Christie, H.C (2013). Lack of sea urchin settlement may explain kelp forest recovery in overgrazed areas in Norway. *Marine Ecology Progress Series*, 488:119-132.

Food and Agriculture Organization of the United Nations (FAO) (2002). 'Proceedings Second Expert Meeting on harmonizing forest-related definitions for use by various stakeholders' . *Second Expert Meeting on harmonizing forest-related definitions for use by various stakeholders, FAO – IPCC-CIFOR- IUFRO-UNEP, Rome, Italy, September 11 to 13, 2002*. Can be retrieved from: http://www.fao.org/docrep/005/y4171e/y4171e00.HTM

FAO (2011) *Fishery and Aquaculture Country Profiles-The Kingdom of Norway*. Retrieved on 24 July 2014 from http://www.fao.org/fishery/facp/NOR/en

Flaten, O., A. Veidal and Svennerud, M. (2007). *Bondens marked - en attraktiv markedskanal for nyskapende nisjeprodusenter? Resultater fra en spørreundersøkelse*. NILF: rapport 2007-4. Norwegian Agricultural Economics Research Institute (NILF), Oslo, Norway.

Forskning.no (2011). *Ville bær skal temmes*. Retrieved on 21 July 2014 from: http://www.forskning.no/artikler/2011/oktober/301269

Framstad, E. (red.) (2013). Terrestrisk naturovervåking i 2013: Markvegetasjon, epifytter, smågnagere og fugl-Sammenfatning av resultater. NINA Rapport 1036. Norwegian Institute for Nature Research, Trondheim, Norway.

Gederaas, L., Moen, T.L., Skjelseth, S. and Larsen, L.-K. (eds.) (2012). Alien species in Norway– with the Norwegian Black List 2012. Norwegian Biodiversity Information Centre, Trondheim, Norway.

Gjerde, I., Sætersdal, M. and Blom, H.H. (2007). 'Complementary Hotspot Inventory – A method for identification of important areas for biodiversity at the forest stand level', *Biological Conservation*, 137: 549-557.

Goulson, D. (2003). 'Effects of introduced bees on native ecosystems', *Annual Review of Ecology, Evolution and Systematics*, 34: 1–26.

Goulson, D. Hughes, W.O.H. Derwent, L.C. and Stout, J.C. (2002a). 'Colony growth of the bumblebee, Bombus terrestris, in improved and conventional agricultural and suburban habitats'. *Oecologia*, 130: 267–273.

Grenier, L. (1998). Working with Indigenous knowledge: A guide for researchers. International Development Research Centre, Ottawa, Canada.

Grundt, H.H. and Salvesen, P.H. (2011). *Kjenn din sorbus-Rogn og asal i Norge*. Rapport 23/2011 fra Genressurssenteret ved Skog og landskap. Norwegian Genetic Resource Centre at the Norwegian Forest and Landscape Institute, Ås, Norway.

Haglin, L. (1991). 'Nutrient intake among Saami people today compared with an old, traditional Saami diet', *Arctic Medical Research*, (Suppl):741–6.

Haglin, L. (1999). 'The nutrient density of present-day and traditional diets and their health aspects: the Sami- and lumberjack families living in rural areas of Northern Sweden', *International Journal of Circumpolar Health*, 58:30–43.

Haugland, H., Anfinnsen, B., Aasen, H., Løbersli, E., Selboe, O.-K., Terum, T., Lileng, J., Granhus, A., Søgaard, G. and Hanssen, K.H. (2013). Planting av skog på nye arealer som klimatiltak - egnede arealer og miljøkriterier. *Rapport Miljødirektoratet*, M26-2013: 149.

Heggenes, J., Roed, K. H., Hoyheim, B. and Rosef, L. (2002). 'Microsatellite diversity assessment of brown trout (Salmo trutta) population structure indicate limited genetic impact of stocking in a Norwegian alpine lake', *Ecology of Freshwater Fish,* 11: 93–100.

Hegland, S.J., Nielsen, A., Lazaro, A., Bjerknes, A.L. & Totland, Ø.(2009). 'How does climate warming affect plant-pollinator interactions? ', *Ecology Letters*, 12: 184-195.

Henrikson, L. (2000). *Skogbruk vid vatten*. Skogstyrelsens förlag 2000. Vannområdeutvalget Morsa, Moss, Norway.

Horg, B. (2013). *Lack of knowledge about insect pollination*. The Norwegian Biodiversity Information Centre, Trondheim, Norway. Available at: http://sciencenordic.com/lack-knowledge-about-insect-pollination

Inari, N. Nagamitsu, T. Kenta, T. Goka, K. and Hiura, T. (2005). 'Spatial and temporal pattern of introduced Bombus terrestris abundance in Hokkaido, Japan, and its potential impact on native bumblebees', *Population Ecology*, 47: 77–82.

Ings, T.C., Ward, N.L. and Chittka, L. (2006). 'Can commercially imported bumble bees out-compete their native conspecifics? ', *Journal of Applied Ecology*, 43: 940–948.

Jensen, R.S. (2005). Women towards ownership, in business and agriculture-National Report Norway (Programme relating to the Community Framework Strategy on Gender Equality (2001–2005), European Community). Institute for Social Research, Oslo, Norway.

Johnsen, K.I. (2014). The paradox of reindeer pasture management in Finnmark, Norway. Strategic Environmental Impact Assessment of development of the Arctic. Department of International Environment and Development Studies (Noragric), Norwegian University of Life Sciences (NMBU), Ås, Norway.

Jonsson, B., Fleming, I. A. and Sundes, G. (1993). Enhancement of wild salmon populations. In "Human Impact on Self-Recruiting Populations" (G. Sundes, ed.): 209–238. The Royal Norwegian Society of Sciences and Letters Foundation, Tapir Publishers, Trondheim, Norway.

Kålås, J.A., Viken, Å., Henriksen and S. and Skjelseth, S. (red.). (2010). Norsk rødliste for arter 2010. Artsdatabanken, Norge. Kålås, J.A., Viken, Å., Henriksen, S. and Skjelseth, S. (eds.). (2010). The 2010 Norwegian Red List for Species. Norwegian Biodiversity Information Centre, Trondheim, Norway.

Kvakkestad, V. and Aalerud, E.H. (2012). Gjennomgang av de direkte og kostnadssenkende tilskuddene over reindriftsavtalen, *Notat 2012-23*. Norwegian Agricultural Economics Research Institute (NILF), Oslo, Norway.

Kvamme, M., Berge, J. and Kaland, P.E. (1992). Vegetasjonshistoriske undersøkelser i Nyset-Steggjevassdraget. Arkeologisk rapport 17. Historisk museum, Bergen.

Liltved, H., Homme, M., Gangnes Skar, S.L., Hess-Erga, O.K., Uleberg, S. and Drengstig, A. (2012). 'Can aquaponic systems be adapted to Norwegian aquaculture? ', *Fiskehelse,* juni 2012.

Matsumura, C. Nakajima, M. Yokoyama, J. and Washitani, I. (2004). 'High reproductive ability of an alien bumblebee invader, *Bombus terrestris* L., in the Hidaka region of southern Hokkaido, Japan', *Japanese Journal of Conservation Ecology*, 9: 93–102.

Meteorologisk institutt (2015). Retrieved on 21 January 2015 from: http://met.no/english/climate_in_norway

Morandin, L.A. Laverty, T.M. Kevan, P.G. Khosla, S. and Shipp, L. (2001). 'Bumble bee (*Hymenoptera: Apidae*) activity and loss in commercial tomato greenhouses', *Canadian Entomologist*, 133: 883–893.

Moritz, R.F.A. Hartel, S. and Neumann, P. (2005). 'Global invasions of the western honeybee (Apis mellifera) and the consequences for biodiversity', *Ecoscience*, 12: 289–301.

Myking, T. and Skrøppa, T. (2001). Bevaring av genetiske ressurser hos norske skogstrær. Aktuelt fra skogforskningen 2/01: 1-44.

Naish, K.A., Taylor, J.E., Levin, P.S., Quinn, T.P., Winton, J.R., Huppert, D. and Hilborn, R. (2008). 'An evaluation of the effects of conservation and fishery enhancement hatcheries on wild populations of Salmon', *Advances in Marine Biology*, 53.

Nilsen H., Utsi E. and Bønaa K.H. (1999). 'Dietary and nutrient intake of a Sami population living in traditional reindeer herding areas in north Norway: comparisons with a group of Norwegians', *International Journal of Circumpolar Health*, 58(2):120-33.

Nilsson, L.M., Dahlgren, L., Johansson, I., Brustad, M., Sjölander, P. and Van Guelpen, B. (2011). 'Diet and lifestyle of the Sami of southern Lapland in the 1930s–1950s and today', *International Journal of Circumpolar Health*, 70:3 2011.

Nordin Jonsson, Å. (2011). 'Working with Traditional Knowledge: Communities, Institutions, Information Systems, Law and Ethics'. Writings from the Árbediehtu Pilot Project on Documentation and Protection of Sami Traditional Knowledge. Die□ut 1/2011. Sámi allaskuvla / Sámi University College 2011. 97–125.

Nordic Family Forestry (n.d.). Retrieved on 4 November, 2014 from: http://www.nordicforestry.org/facts/Norway.asp#Seks

Nordisk ekspertgruppe (2005). Nordisk samekonvensjon, utkast fra finsk-norsk-svensk-samisk ekspertgruppe, avgitt 26. oktober 2005. Publikasjonsnr. H-2183 (Kopi og distribusjonsservice, Norge).

Norske lakseelver (n.d.). Retrieved on 24 July, 2014 from: http://www.lakseelver.no/

Norwegian Environment Agency (2013). *Impacts of climate change in Norway*. Available at: http://www.environment.no/Topics/Climate/Norways-climate/Impacts-in-Norway/ (Published on 4 January 2013).

Norwegian Food Safety Authority (2013). *Obligations for importers of foods to Norway*. Available at: http://www.mattilsynet.no/language/english/food_and_water/Commercial_import_of_foods_to_Norway/obligations_for_importers_of_foods_to_norway.11700

Norwegian Forest and Landscape Institute (2008). Retrieved on 13 January 2015 from: http://www.skogoglandskap.no/artikler/2008/SkogtreiNorge

Norwegian Forest and Landscape Institute (2011). *Dammer og bekker er viktige livsmiljøer i kulturlandskapet*. Available at: http://www.skogoglandskap.no/fagartikler/2011/dammer_og_bekker_er_viktige_livsmiljoer_i_kulturlandskapet/newsitem

Norwegian Ministry of Climate and Environment (2014). *Norway's Fifth National Report to the Convention on Biological Diversity*. Available at: http://www.regjeringen.no/pages/38756420/5NR_CBD_Norway_final.pdf

Norwegian Ministry of the Environment (2007). *Strategy on Invasive Alien Species*. Available at: http://www.regjeringen.no/upload/MD/Vedlegg/Planer/T-1460_eng.pdf

NOU (Official Norwegian Reports), 2013:10. Naturens goder-om verdier av økosystemtjenester, Ministry of Climate and Environment.

Oikos-Økologisk Norge (2014). *Listhaug svarer om økologisk landbruk (17.11.2014)*. Available at: http://www.oikos.no/aktuelt/listhaug-svarer-om-okologisk-landbruk.aspx

Pettersson, M. W., Cederberg & B., Nilsson, L. A. (2004). Grödor och vildbin i Sverige. Svenska Vildbiprojektet vid Artdatabanken, SLU & Avdelningen för Växtekologi, Uppsala University, Sweden.

Ross, A.B., Johansson, Å., Ingman, M. & Gyllensten, U. (2006). 'Lifestyle, Genetics, and Disease in Sami', *Croatian Medical Journal*, 47(4): 553–565.

Fagleg analysegruppe for samisk statistikk (2009). Samisk tall forteller 2, Kommentert samisk statistikk 2009, Rapport 1/2009.

Fagleg analysegruppe for samisk statistikk (2013). Samisk tall forteller 6, Kommentert samisk statistikk 2013, Rapport 1/2013.

Schartau, A.K., Dolmen, D., Hesthagen, T., Mjelde, M., Walseng, B., Ødegaard, F., Økland, J., Økland, K.A. and Bongard, T. (2010). Fresh water – In: Kålås, J.A., Henriksen, S., Skjelseth, S. and Viken, Å. (eds.) (2010). Environmental conditions and impacts for Red List species. Norwegian Biodiversity Information Centre, Trondheim, Norway.

Sea Lice Research Centre (Bergen) (2013). Retrieved on 24 July, 2014 from: http://www.slrc.no/

Sexton, R. and Stabbursvik, E.A.B. (2010). 'Healing in the Sámi North', *Culture, Medicine and Psychiatry*, 34(4): 571–589.

Skaala, O., Jorstad, K. E. and Borgstrom, R. (1996). 'Genetic impact on two wild brown trout (Salmo trutta) populations after release of non-indigenous hatchery spawners', *Canadian Journal of Fisheries and Aquatic Sciences*, 53: 2027–2035.

Skadsheim, A., Christie, H. and Leinaas, H.P. (1995). Population reductions of *Strongylocentrotus droebachiensis* (Echinodermata) in Norway and the distribution of its endoparasite *Echinomermella matsi* (Nematoda). *Marine Ecology Progress Series*, 119: 199□209.

Skrøppa, T. (2012). State of Forest Genetic Resources in Norway (Norwegian Country Report to the Preparation of the FAO Report on the State of the World's Forest Genetic Resources). Norwegian Genetic Resource Centre, Norwegian Forest and Landscape Institute, Ås, Norway.

Sletvold, N. and Ågren, J. (2010). 'Pollinator-mediated selection on floral display and spur length in the orchid Gymnadenia conopsea', *International Journal of Plant Sciences*, 171, pp 999-1009.

Staverløkk, A. (2006). 'Occurrence of alien species and other unwanted stowaways in imported horticultural plants', M.Sc. thesis, pp. 111. Department of Ecology and Natural Resources Management (INA), University of Life Sciences (UMB), Norway.

Stensland, S. (2008). 'Hva vil elveeierne med fiskeretten sin?', *Bondebladet*, 17 February 2011. Available at: http://www.umb.no/statisk/ina/ina_media/2011/Bondebladet_februar.pdf

Store Norske Leksikon (n.d.) *Jordbruk i Norge*. Retrieved on 24 July, 2014 from: http://snl.no/Jordbruk_i_Norge

Storm, H. and Mittenzwei, K. (2013). 'Farm survival and direct payments in the Norwegian farm sector', *Discussion paper No. 2013–5*, 26 April. Norwegian Agricultural Economics Research Institute (NILF), Oslo, Norway.

Solberg, E. J., Strand, O., Veiberg, V., Andersen, R., Heim, M., Rolandsen, C. M., Holmstrøm, F., Solem, M. I., Eriksen, R. and Astrup, R. (2009). Hjortevilt 2009 – Årsrapport fra Overvåkingsprogrammet for hjortevilt. NINA Rapport 584. Norwegian Institute for Nature Research, Trondheim, Norway.

Solberg, E. J., Strand, O., Veiberg, V., Andersen, R., Heim, M., Rolandsen, C. M., Langvatn, R., Holmstrøm, F., Solem, M. I., Eriksen, R., Astrup, R. and Ueno, M. (2012). Hjortevilt 1991-2011 – Oppsummeringsrapport fra Overvåkingsprogrammet for hjortevilt. NINA Rapport 885, p 156. Norwegian Institute for Nature Research, Trondheim, Norway.

Solheim, H., Timmermann, V., Talgø, V. and Røsberg, I. (2012). Ash dieback in Norway. In: Steyrer, G., Tomiczek, C., Hoch, G. & Lackner, C. (eds.) Proceedings of the Third Meeting of Forest Protection and Forest Phytosanitary Experts, October 14-16, 2009, Vienna, Austria. *Forstschutz Aktuell* 55: 49-51.

Sæther, N.H. (ed.) (2013). Country Report for the preparation of The Second Report on the State of the World's Animal Genetic Resources, Agriculture, including sector-specific data contributing to The State of the World's Biodiversity for Food and Agriculture-Norway. Norwegian Genetic Resource Centre, Norwegian Forest and Landscape Institute, Ås, Norway.

Sæther, N.H. (ed.) (2002).Norway Country Report on Farm Animal Genetic Resources, 2002. Norwegian Genetic Resource Centre, Norwegian Forest and Landscape Institute, Ås, Norway.

Sæther, N.H., Asdal, Å., Fjellstad, K.B. and Rehnberg, A. (2013). Strategiplan for Norsk genressurssenter. Rapport 19/2013. Norwegian Genetic Resource Centre, Norwegian Forest and Landscape Institute, Ås, Norway.

Søgaard, G., Eriksen, R., Astrup, R. and Øyen, B.H. (2012). Effekter av ulike miljøhensyn på tilgjengelig skogareal og volum i norske skoger. Rapport 02/2012. Norwegian Forest and Landscape Institute, Ås, Norway.

Tangeland, T. Andersen, O., Aas, Ø. and Fiske, P. (2008). Elvefiske etter anadrome laksefisk i Norge sesongen 2008. Fiskevaner, fangst, innsats og holdninger til fangstreguleringer, herunder fiskernes syn på reguleringene for sesongen 2008. NINA Rapport 545. Norwegian Institute for Nature Research, Trondheim, Norway.

Toivonen, A.L., Appelblad, H., Bengtsson, B., Geertz-Hansen, P., Guðbergsson, G., Kristofersson, D., Kyrkjebø, H., Navrud, S., Roth, E., Tuunainen, P. and Weissglas, G. (2000). Economic value of recreational fisheries in the Nordic countries. Nordic Council of Ministers, *TemaNord 2000*, 604: 70.

Tomter, S.M. and Dalen, L.S. (eds.) (2014). Bærekraftig skogbruk I Norge. Norsk Institutt for skog og landskap, Ås, Norway.

Steinset, T.A.,Statistisk sentralbyrå (SSB)

Miljødirektoratet (2013). Retrieved on 22 April, 2014 from: http://www.miljostatus.no/miljomal/Mal-og-nokkeltall/Skog/

Skjeggedal, T., Gundersen, V., K. Harvold, A. and Vistad, O. I. (2010). Frivillig vern av skog

– evaluering av arbeidsform. Samarbeids-rapport NIBR/NINA 2010.

Totland, T.H., Melnæs, B.K., Hallén, N.L., Kigen, K.M.H, Blix, N.A.L., Myhre, J.B., Johansen, A.M.W., Løken, E.B. and Andersen, L.F. (2012). Norkost 3-En landsomfattende kostholdsundersøkelse blant men og kvinner i Norge i Alderen 18-70 år, 2010-11. Helsedirektoratet, Oslo, Norway.

Totland, Ø., Hovstad, K. A., Ødegaard and F., Åström, J. (2013). State of knowledge regarding insect pollination in Norway – the importance of the complex interaction between plants and insects. Norwegian Biodiversity Information Centre, Trondheim, Norway.

Vaissière, B. E., Freitas, B. M., Gemmill-Herren, B. (2011). Protocol to detect and assess pollination deficits in crops: a handbook for its use. Food and Agriculture Organization of the United Nations. Available at: http://www.internationalpollinatorsinitiative.org/jsp/documents/documents.jsp

Verdensarv Vegaøyen. *The egg- and down-collecting tradition*. Retrieved on 7 October 2014 from: http://www.verdensarvvega.no/index.php/en/egg-og-duntradisjonen

Vila, M., Bartomeus, I., Dietzsch, A.C., Petanidou, T., Steffan-Dewenter, I., Stout, J.C. and Tscheulin, T. (2009). 'Invasive plant integration into native plant-pollinator networks across Europe'. Proceedings of the Royal Society B, *Biological Sciences*, 276: 3887-3893.

Vitousek, P.M., Dantonio, C.M., Loope, L.L., Rejmanek, M. and Westbrooks, R. (1997). 'Introduced species: a significant component of human-caused global change', *New Zealand Journal of Ecology*, 21: 1–16.

Ward, A.J. and Løes, A. K., 2011. 'The potential of fish and fish oil waste for bioenergy generation: Norway and Beyond', *Biofuels* (2011), 2 (4): 375-387.

White Paper Nr.9 (2011-2012): Landbruks-og matpolitikken. Velkommen til bords.

White Paper Nr.12 (2002-2003): About animal husbandry and animal welfare.

White Paper Nr.12 (2012–2013): Long-term Perspectives on the Norwegian Economy 2013.

White paper Nr.26 (2012–2013): National transport plan 2014-2023.

White paper Nr.34 (2006-2007): Norwegian climate policy.

White paper Nr.37 (2012-2013): Integrated Management of the Marine Environment of the North Sea and Skagerrak (Management Plan)

White paper Nr.39 (2008-2009): Climate Challenges - Agriculture part of the Solution, focusing on the agricultural sector and the efforts it needs to make to face new climate conditions.

White paper Nr.42 (2000-2001): Biological diversity - Sector responsibility and coordination.

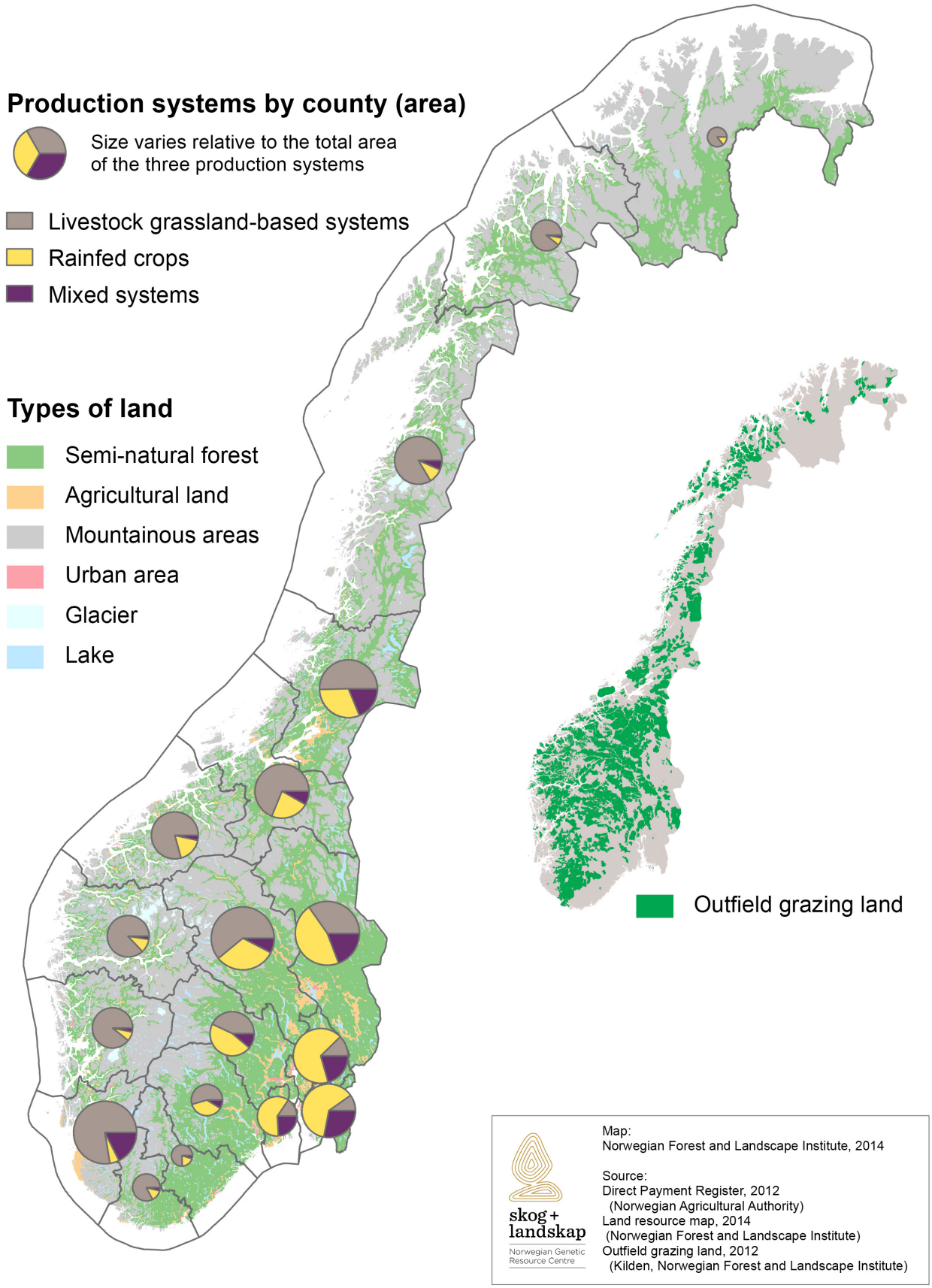
Winkler, H. (1908). 'Über Parthenogenesis und Apogamie im Pflanzenreich', *Progressus Rei Botanicae*, 2 (3): 293–454.

World Bank - Country data (2012). Retrieved on 24 July 2014 from: http://data.worldbank.org/country/norway

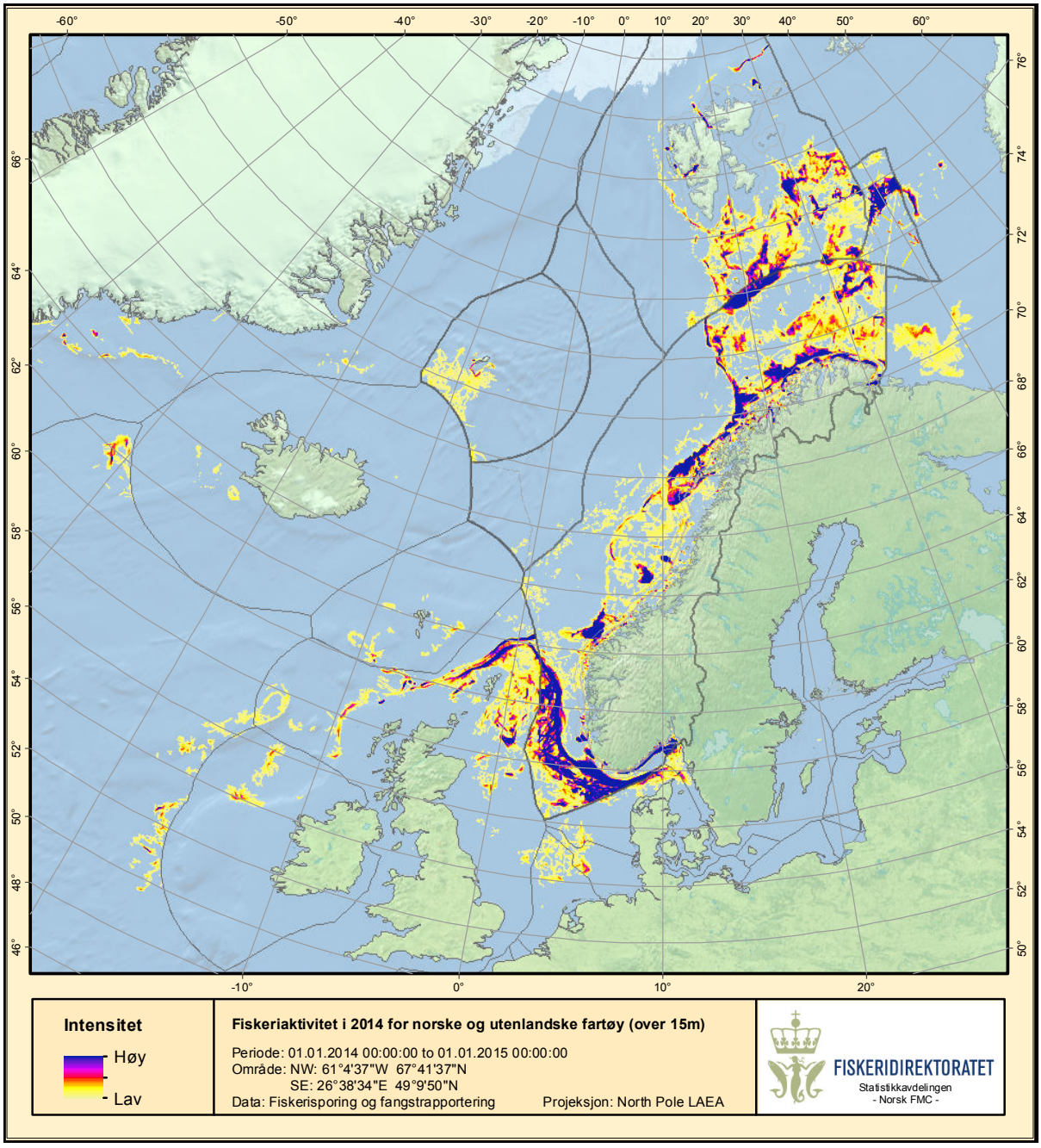
Åström, J., Dramstad, W., Debella-Gilo, M., Hovstad, K. A., Åström, S. & Rusch, G. M. (2014). Assessing Norwegian pollination deficits. Capacity building towards IPBES - implementation and methodological evaluation of the "Protocol to Detect and Assess Pollination Deficits in crops". NINA Report 1101. Norwegian Institute for Nature Research, Trondheim, Norway.

14 ANNEXES

ANNEX 1: Main production systems in Norway



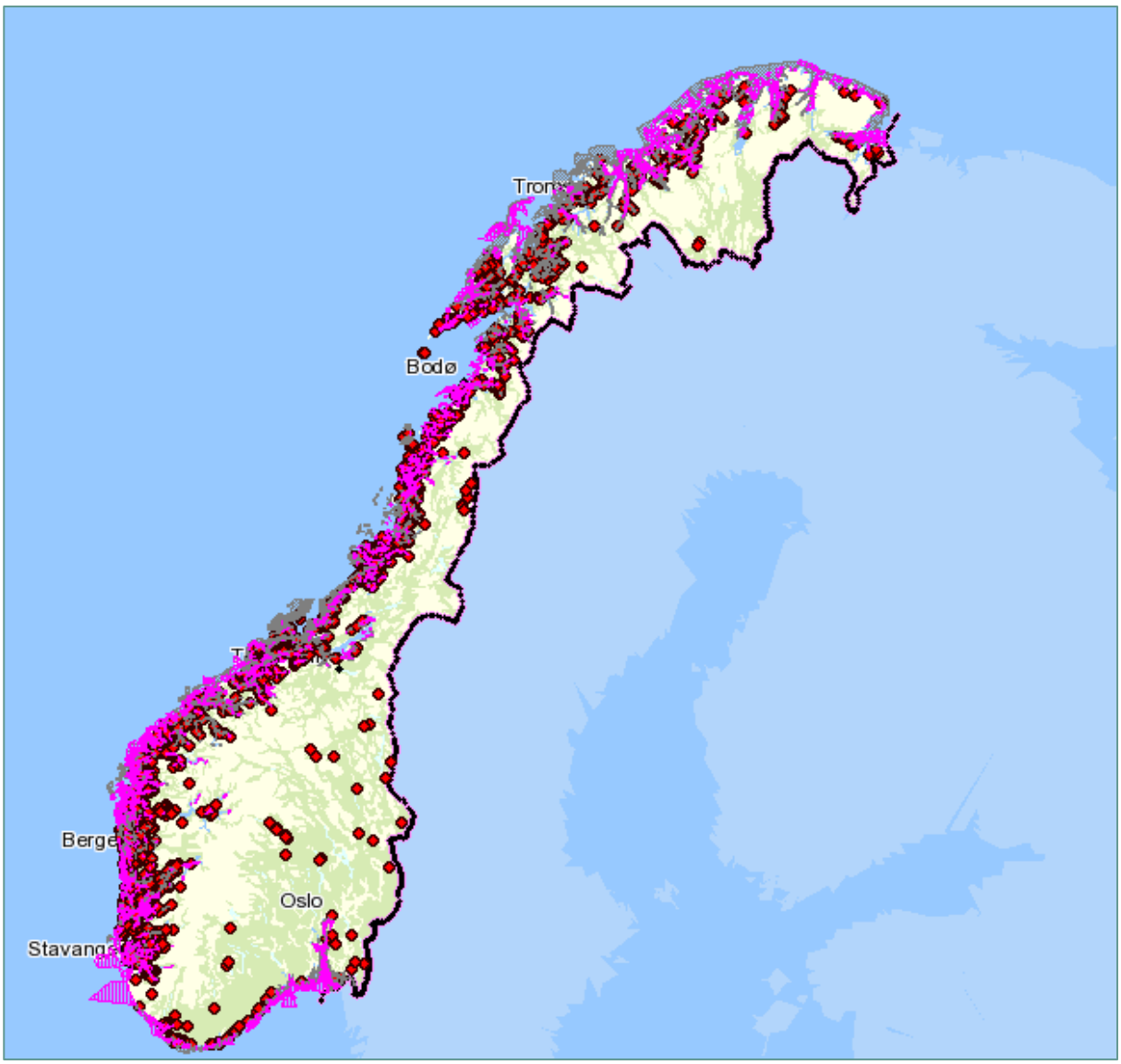
ANNEX 2: Fishing activity by Norwegian and foreign vessels in 2014



Areas with fishing activity are colored from yellow to dark blue. Yellow indicates areas with low intensive fishing activity and dark blue reflects areas where fishing activity is intense.

Period covered:	01/01/2014 to 01/01/2015
Area covered:	NW: 61°4'37"W 67°41'37"N
	SE: 26°38'34"E 49°9'50"N
Data source:	Fiskerisporing og fangstrapportering
Imagery:	North Pole LAEA
Map source:	Norwegian Directorate of Fisheries - Statistical department - Norwegian Fisheries Monitoring Centre

ANNEX 3: Norwegian fisheries and aquaculture (2014)



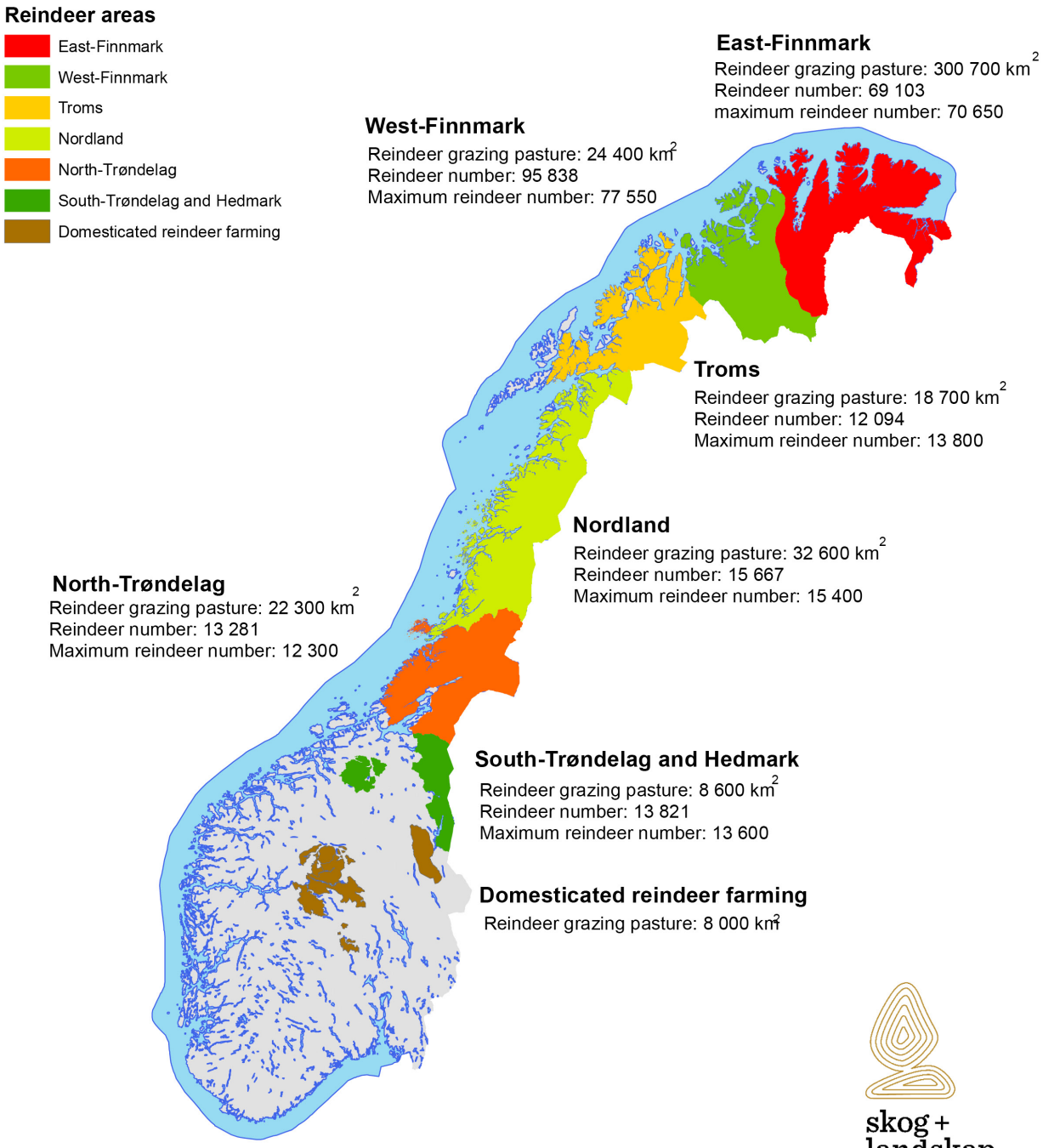
Source: Kystinfo, Kystverkets map service
(see: http://kart.kystverket.no/default.aspx?gui=1&lang=1)

Fishing areas (active fishing gear)

Fishing areas (passive fishing gear)

Active aquaculture permits

ANNEX 4: Reindeer farming in Norway



skog + landskap
Norwegian Genetic Resource Centre

Scale: 1:8 000 000

Sources:
Reindeer Administration (Reindriftsforvaltningen):
- Map (modified by Norwegian Genetic Resource Centre)
- Regional data (2010); data for West and East Finnmark (31.03.2014)

Norwegian Agricultural Economics Research Institute (NILF):
Notat 2012-2013: Gjennomgang av de direkte og kostnadskrevende tilskuddene over reindriftsavtalen - NILF

NIBIO
NORWEGIAN INSTITUTE OF
BIOECONOMY RESEARCH

NIBIO - Norwegian Institute of Bioeconomy Research was established July 1, 2015 as a merger between the Norwegian Institute for Agricultural and Environmental Research, the Norwegian Agricultural Economics Research Institute and Norwegian Forest and Landscape Institute.

The basis of bioeconomy is the utilisation and management of fresh photosynthesis, rather than a fossile economy based on preserved photosynthesis. NIBIO is to become the leading national centre for development of knowledge within the field of bioeconomy. The goal of the Institute is to contribute to food security, sustainable resource management, innovation and value creation through research and knowledge production within food, forestry and other biobased industries. The Institute will deliver research, managerial support and knowledge for use in national preparedness, as well as for businesses and the society at large.
NIBIO is owned by the Ministry of Agriculture and Food as an administrative agency with special authorization and its own supervisory board. The main office is located at Ås. The Institute also has several regional offices and research station.

nibio.no