PART II

Chapter 5

Biodiversity conservation and sustainable use

This chapter reviews the pressures on Switzerland's biodiversity and its status and trends, as well as institutional, governance and financing arrangements to promote conservation and sustainable use. It also assesses Switzerland's progress in using regulatory and economic instruments for biodiversity conservation and sustainable use, and efforts to mainstream biodiversity considerations into sectoral and other policies.

1. Introduction

Switzerland is at an important point in the evolution of its biodiversity conservation and sustainable use policies. While improvement has been made in some areas (such as water quality and forest cover), biodiversity's overall state is poor and pressures persist. The adoption of the Swiss Biodiversity Strategy in 2012 held the promise of reversing downward trends and restoration of ecosystems and habitats. The accompanying action plan was only recently launched and it is not clear whether there will be sufficient financial resources to implement the actions. Efforts to mainstream biodiversity considerations into sectoral and other policies, and the knowledge basis to underpin integration, have improved but have been inadequate to address key pressures such as pesticide use, ammonia emissions, landscape fragmentation and habitat disturbance. There are opportunities to improve the situation, however, through greater use of economic instruments, better information and awareness, a renewed effort on protected areas and pursuit of creative measures such as wildlife corridors and refuges to limit and mitigate the adverse impacts of development.

2. Status, trends and pressures on biodiversity

Switzerland, located in the heart of Europe, has a varied geography and climate that have produced a wealth of biodiversity (EDA, 2016) and ecosystems (Box 5.1). Much of the country is mountainous, with the Alps to the south and south-east covering 60% of the total surface area and the Jura to the north-west covering 10%. These mountains surround the central Swiss Plateau, which takes up the remaining 30% (EDA, 2016).

Biodiversity was significantly affected by intensive land use change in the 19th century, with the development of urban and agricultural areas (predominantly on the plateau). Deforestation, watercourse alteration and wetland destruction harmed ecosystems and species. The country is restoring and reconnecting degraded ecosystems and trying to prevent further species loss, but progress is challenged by agricultural intensification and urban sprawl on the plateau, land abandonment and climate change in the mountains, and invasive species (Federal Council, 2015; CBD, 2016a). The latest report by the Federal Office for the Environment (FOEN) finds that biodiversity is in an unacceptable state, with the quality and area of valuable habitats in decline and threats to endangered species growing (FOEN, 2017a).

Biodiversity loss threatens crucial ecosystem services that people need, such as clean air and water, soil fertility, climate regulation and pollination of crops and wild plants. Biodiversity helps protect against natural hazards, benefits human health and well-being, absorbs CO_2 emissions and provides with food, fabric fibres and construction materials. Well-functioning ecosystems help filter and store precipitation for drinking water and regulate pathogens and invasive species. Mires and wetlands absorb excess precipitation and forest ecosystems protect against rockfalls, avalanches, landslides and floods. The resiliency of ecosystems against extreme events is depends on the presence of a variety of animals, plants, fungi and microorganisms (Federal Council, 2015).

Box 5.1. **Ecosystems of Switzerland**

Agro-ecosystems: With almost 11% of the country consisting of arable land and cropland and 30% covered in pastures and meadows, agro-ecosystems are an important factor in biodiversity. Agricultural land use decreased by around 1% between 2005 and 2014, with cropland at lower altitudes being converted to settlements, transport infrastructure, and commercial and industrial buildings, and higher-altitude pastures being abandoned.

Forest ecosystems: In the 19th century, many forests were harvested for timber and their area reached a low of about 0.7 million ha in 1840 (WSL, 2017). They have since recovered to 1.28 million ha as a result of policy changes and now represent 31% of the surface area. Forest cover was enhanced by near-natural management introduced in the 1876 Forest Inspectorate Act and 1991 Forest Act. However, the area of old forests, forests with high deadwood levels or young well-lit forests is insufficient to support biodiversity. While natural regrowth on abandoned pasture continues to take place in the Alps, forests at lower altitudes face pressures from urban sprawl and infrastructure development.

Inland water and wetland ecosystems: Large-scale alteration of surface waters' structure and channelling or straightening of watercourses to allow for land use or flood protection has significantly affected water and wetland ecosystems. Between 1900 and 2010, the surface area of biodiversity-rich mires (wetlands such as bogs and fens) decreased by 82% and that of alluvial zones adjacent to watercourses by 36%. Water ecosystems have also deteriorated due to development and pollution.

Grasslands: In the mountains, pasture abandonment is resulting in forest regrowth but also grassland loss. While expansion of forest cover can be positive for some species, grasslands are important ecosystems for butterflies, pollinators, birds and plants. Butterflies in Europe have declined by almost 50% since 1990.

Alpine and subalpine areas: Alpine areas have a high level of biodiversity. For example, 600 species of plants and flowers live exclusively in alpine areas. Around half the alpine area was wooded originally, but was transformed into mountain pasture, creating new ecosystems. The state of alpine and subalpine ecosystems is generally better than at lower altitudes, but faces pressure from tourism, sport and recreation. Climate change is also a significant threat, with lower-altitude species colonising higher altitudes and alpine habitats shrinking.

Source: FOEN (2017), *State of biodiversity in Switzerland: Results of the biodiversity monitoring system in 2016*; FOEN (2014a), FOEN (2014a), *Switzerland's Fifth National Report under the Convention on Biological Diversity*, *www.cbd.int/doc/world/ch/ch-nr-05-en.pdf*; Fischer et al. (2015), *État de la biodiversité en Suisse en 2014*, *https://sciencesnaturelles.ch/uuid/b126284d-fe5b-566d-859f-427b241c5366*; EEA (2013), *The European Grassland Butterfly Indicator: 1990-2011*, *www.eea.europa.eu/publications/the-european-grassland-butterfly-indicator-19902011/at_download/file*.

2.1. Biodiversity data collection, monitoring and dissemination, and scientific expertise

Switzerland has a strong biodiversity monitoring and research system relying on public, academic and independent organisations. In the 1990s, the country initiated groundbreaking work in conservation biology through the Integrated Biodiversity Project of the Swiss National Science Foundation, which was triggered by ratification of the Convention on Biological Diversity (CBD). This led to the 1999 founding of the Swiss Biodiversity Forum, a platform of the Swiss Academy of Sciences that contributes to basic scientific knowledge, processes data and disseminates them among target groups, and promotes national and international collaboration and networking. The forum and FOEN constitute the local branch

of the Intergovernmental Platform on Biodiversity and Ecosystem Services, established in 2012 (SCNAT, 2016a).

With regard to monitoring, FOEN is obliged by the Ordinance on the Protection of Nature and Cultural Heritage (1991, amended 2015) to monitor long-term development of biodiversity nationwide. Switzerland has monitored biodiversity since 2001 through the Swiss Biodiversity Monitoring (BDM) programme (BDM, 2016; FOEN, 2014a), which is based on the OECD pressure-state-response model (OECD, 2003). It tracks and reports on 32 indicators, many of which are relevant to tracking progress towards the Aichi targets. In 2011, FOEN and the Swiss Federal Institute for Forest, Snow and Landscape Research jointly launched Monitoring the Effectiveness of Habitat Conservation in Switzerland, a programme focused on biotopes of national importance that tracks and analyses habitat state through flora and fauna surveys and aerial images.

FOEN maintains red lists of threatened species, in addition to species diversity data managed by publicly funded external organisations (FOEN, 2014b). Federal inventories of mires, landscapes and natural monuments of national importance have been developed, and the inventory on alluvial zones is being extended (Federal Council, 2015). The national data and information centre on Swiss flora maintains a black list of invasive plant species with adverse effects on biodiversity, public health or the economy, and a watch list of species that could cause damage (FOEN, 2010). Since biodiversity policy responsibilities and accountability, as well as biodiversity databases, are spread across several institutions and governance levels, the Swiss Information System Biodiversity (SIB) was set up as a single-window tool as part of Switzerland's contribution to the global network of clearing-house mechanisms under the CBD.

Other monitoring programmes relevant to biodiversity include the Agricultural Species and Habitats' Monitoring Programme, the National Forest Inventory, a river monitoring and survey programme, a programme monitoring spatial development, national landscape monitoring, air pollution monitoring, soil monitoring and the national climate observation system (FOEN, 2014b). In addition, non-government organisations (NGOs) contribute through initiatives such as the Swiss Species Recovery Programme for Birds, launched in 2003 by SVS/BirdLife Switzerland, the Swiss Ornithological Institute at Sempach, and FOEN, and research projects on carnivore ecology by a group known as KORA.

While overall Switzerland is deemed to have robust biodiversity monitoring, there is no publicly available map showing ecosystem distribution at the national level, and biodiversity information at the cantonal, regional and local level is not always geo-referenced. Moreover, many data sets are categorised differently (e.g. by region or using differing ecosystem categories), making it difficult to develop a complete national picture. Cantons are, however, working towards implementing federally defined standards. Connecting data from biodiversity monitoring with real-time information on land use or pressures (e.g. regarding agricultural inputs or management practices) could greatly benefit analysis. A national ecosystem map could also serve as the basis for a formal, legally binding spatial planning tool (Section 4.2).

Despite hosting the secretariat of The Economics of Ecosystems and Biodiversity, an initiative of the United Nations Environment Programme, Switzerland has not progressed significantly on estimating the economic benefits of ecosystem services, though it has developed biophysical indicators for some services and an ecosystem service planning tool to assist in assessments, including environmental impact assessments (ÖSL, 2016). The

Swiss Biodiversity Strategy includes a commitment to quantitatively record ecosystem services by 2020 as complementary indicators to GDP and for use in regulatory impact assessments (FOEN, 2012a). This work, combined with the development of a comprehensive nationwide map of ecosystems and habitats of importance, will help lay the groundwork for development of monetary values for ecosystem services that will support consideration of biodiversity alongside economic and social factors in decision making. For example, an analysis showing that Switzerland saves USD 64 million a year by using untreated groundwater, naturally filtered through forested watersheds, makes a strong business case for protecting that ecosystem service (IUCN, 2011).

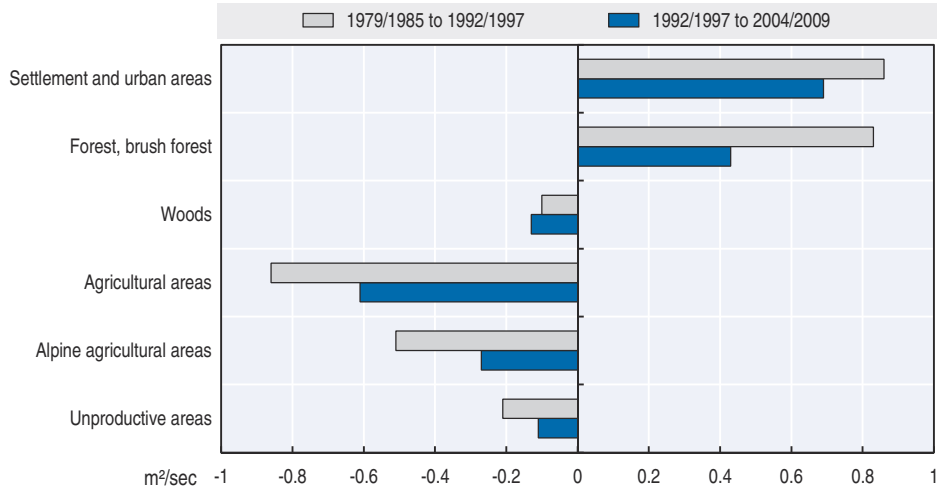
2.2. Ecosystems

Over the last decade, ecosystems such as wetlands and grasslands have experienced increasing pressures due to land use change and landscape fragmentation, as well as deteriorating quality from pollution. Settlement and urban areas have expanded, while dry meadows and pastures have been lost. An estimated 47% of ecosystems are threatened, though forest area has increased. Water-dependent and wetland ecosystems are particularly vulnerable, with reduced surface area and quality.

Land use change

Land use has changed over the past two decades (Figure 5.1). Between 1985 and 2009, 54 516 ha of agricultural area was transformed into settlement and urban areas. Between 1992-97 and 2004-09, agricultural area declined by 2.2%. Some two-thirds of the loss was due to the spread of settlement and urban areas, with the remaining third due to reforestation on hill and mountain areas no longer used for grazing (Federal Council, 2015). Abandoned pastures in the mountains have been returning to forest, which can have a positive impact for some species and a negative impact on those dependent on grasslands. Biodiversity-rich dry meadows and pastures lost around 95% of their area between 1900 and 2010, resulting in a loss of breeding birds and specialised plants (FOEN, 2017a).

Figure 5.1. **Urban areas and forests expanded while agricultural areas shrank**



Source: Federal Council (2015), Environment Switzerland 2015, based on Federal Statistical Office land use statistics.

StatLink http://dx.doi.org/10.1787/888933571777

Expansion of urban areas can diminish ecosystem quality, reduce wildlife habitat size, increase landscape fragmentation, hasten the spread of invasive species, disturb nocturnal species with artificial light and increase conflict with protected area objectives (EEA and FOEN, 2016). For a small country such as Switzerland with a growing population, urban sprawl is a significant issue for biodiversity conservation and sustainable use. Switzerland has one of the highest population densities in the OECD, particularly on the Swiss Plateau.

The rate of increase in land use for infrastructure has exceeded those of population and GDP growth over the past two decades, indicating that land use expansion has not been decoupled from economic and population growth. Settlement and urban area per capita has remained relatively stable in urban agglomerations but increased significantly in rural areas with a smaller population spread across a larger area. For example, urban sprawl in Basel, Geneva and Zurich declined between 2002 and 2010, but increased considerably in 93% of municipalities (Federal Council, 2015).

Landscape fragmentation

Landscape fragmentation in terrestrial ecosystems remains a significant issue for biodiversity. Over the past 70 years, the landscape has increasingly been fragmented by expanding development and infrastructure. Barriers in the landscape restrict species movement and reduce habitat size. Vertebrates and insects also face risks from traffic on roads. Fragmentation has a greater impact on species requiring substantial space, such as European lynx, red deer, and frogs and toads (BDM, 2010). A 2012 inventory of 304 wildlife corridors (habitat areas connecting wildlife populations separated by human activities or structures) revealed that only 80 were intact. Over 57% of them had reduced functionality, and over 16% could no longer be used by large animals (FOEN, 2016a). Fragmentation and decreased connectivity may also decrease ecosystem resilience and species' ability to move and adapt to climate change.

One measure of fragmentation is effective mesh size, i.e. the size of patches remaining free of barriers that cut up landscape, such as roads and railway tracks. Figure 5.2 shows the reduction in effective mesh size by region between 1935 and 2007. Increasing connectivity of landscapes will be an important component of biodiversity conservation and sustainable use efforts, particularly in the Swiss Plateau and Jura, which have very low mesh size due to major population centres as well as agriculture, industry and tourism. Mountain regions are also becoming more fragmented, increasing the importance of maintaining and improving connectivity.

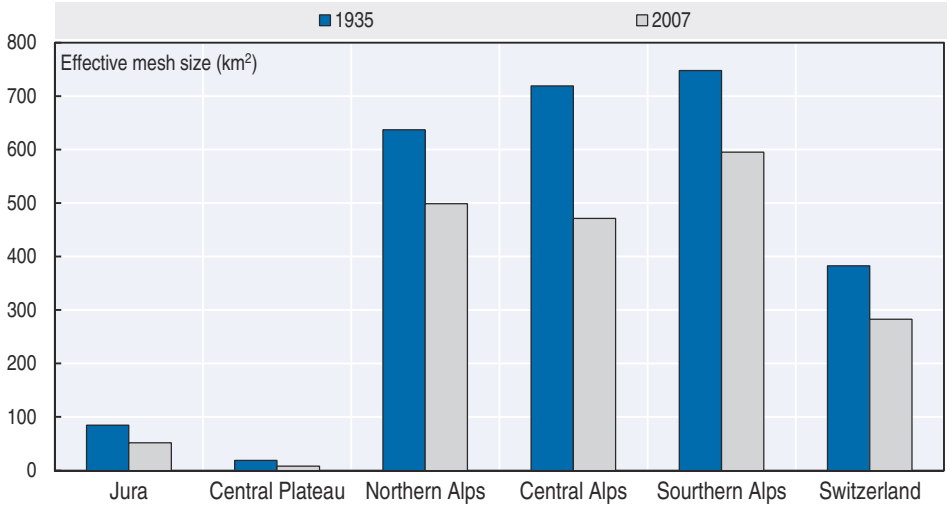
Threatened ecosystems

A 2014 assessment by academics of 162 ecosystems in Switzerland found that close to half were threatened (Table 5.1). In the European Union, about three-quarters of habitats covered by the Birds and Habitats Directives are in an unfavourable state (EC, 2015). Switzerland faces similar challenges to EU countries, with wetlands and grasslands among the most threatened ecosystems. Still waters (lakes and ponds) are also significantly threatened in Switzerland. Pressures stem from both a loss of territory and deterioration in quality (Fischer et al., 2015).

Impact of air pollution on ecosystems

There is ample evidence of nitrogen deposition's impact on biodiversity, particularly in meadows and wetlands, where it leads to eutrophication and the disappearance of

Figure 5.2. **Landscape fragmentation is highest in the Jura and Swiss Plateau, but mountain regions are also increasingly fragmented**



Source: BDM (2010), Landscape Fragmentation.

StatLink http://dx.doi.org/10.1787/888933571796

Table 5.1. **Still waters, shores and wetland ecosystems are particularly threatened**

Ecosystem (# of ecosystems evaluated)	Percentage threatened of areas assessed %
Still waters (8)	100
Running water (18)	50
Shores and wetlands (20)	85
Glaciers, rocks, moraines and rockfalls (14)	29
Meadows and pastures (30)	43
Forest edges (treeline), tall grasses, scrub (25)	12
Forests (29)	41
Pioneer vegetation and weeds (18)	61
Total (162)	47

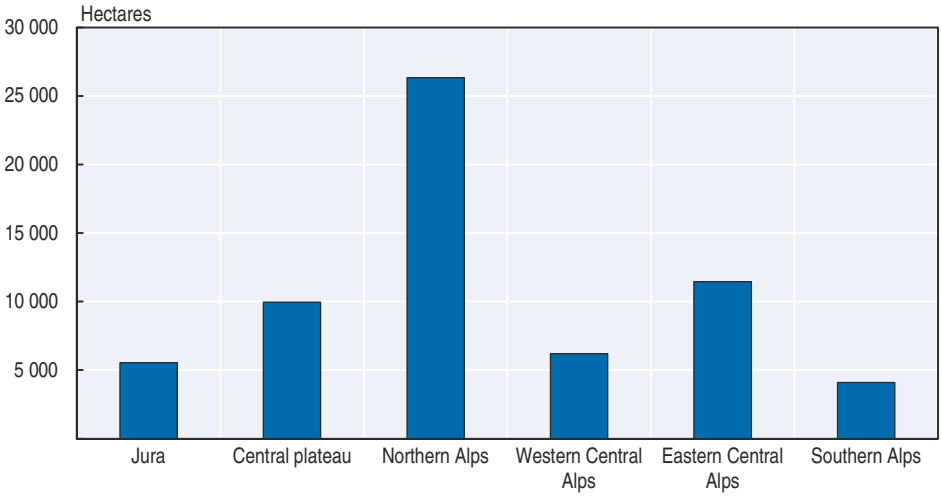
Source: Fischer et al. (2015), *État de la biodiversité en Suisse en 2014*, *https://sciencesnaturelles.ch/uuid/b126284d-fe5b-566d-859f-427b241c5366*.

oligotrophic species. Two-thirds of the nitrogen originates as ammonia from agriculture and the rest as nitrogen oxides (NO_X) from fossil fuel combustion. This is also an international issue, under the Convention on Long-range Transboundary Air Pollution.

Habitats of national importance

Habitats of national importance (HNIs) were established in Switzerland in the early 1990s with raised bogs and alluvial zones and later expanded to include fens and amphibian spawning areas, and finally dry meadows and pastures in about 2010. The areas were selected because they were particularly beautiful, were typical of certain kinds of habitat and provided shelter for unique animal and plant communities (BDM, 2016). HNIs cover 23% of Switzerland, but only 4% of the country is strictly protected in terms of conservation enshrined in law (FSO, 2016). The Northern Alps have the largest area of HNIs, followed by the Eastern Alps and Swiss Plateau (Figure 5.3).

Figure 5.3. **Few habitats of national importance are strictly protected, and they are mostly in mountainous regions**



Source: BDM (2016), Biodiversity Indicators.

StatLink http://dx.doi.org/10.1787/888933571815

HNIs are often endangered. They were significantly affected in the last century, and continue to face pressures from urban sprawl, infrastructure, agriculture and other activities. This is particularly the case for water-dependent and wetland ecosystems.

Water-dependent and wetland ecosystems

Only around 60% of Switzerland's watercourses (50% of those below 600 m) are in an ecomorphologically natural or near-natural state (Chapter 4). Some 25% of watercourses are fragmented by artificial barriers that affect their physical processes and ecological functions (Chapter 4). Unsurprisingly, the proportion of adversely affected watercourses is higher in the more densely populated Swiss Plateau and Jura. In 2011, Switzerland put in place a policy to rehabilitate some watercourses (Chapter 4). To avoid overflows and flooding, lake water levels have also become more regulated over the past two decades, causing lower than-normal-natural seasonal water level fluctuations and the shrinking of marshes and alluvial zones (FOEN, 2017).

Between 1997 and 2006, the surface area of raised bogs shrank by 10% and of peat-forming fens by 6%, while non-peat-forming fens grew by 9% (BDM, 2016). Over the period, mires (bogs and fens) became drier and more nutrient-rich, lost peat content and saw an increased share of woody plants. These trends indicate that HNIs have not been effective in protecting wetlands.

Ecosystem quality has also deteriorated due to micro-pollutants in water. In particular, around 4 800 km of waterways contain micro-pollutants that come mainly from sewage treatment plants (Chapter 4). These substances (e.g. from plant protection, medicinal and cosmetic products) can affect the nervous and immune systems of aquatic organisms as well as fish reproduction (FOEN, 2014b).

2.3. Species

Switzerland is known to be home to 46 000 species, and experts estimate that another roughly 20 000 species exist in the country. Only 49 species are endemic (not found

elsewhere); 97 species and 19 subspecies have over 50% of their global range restricted to Switzerland (FOEN, 2017a, 2014a). Between 1900 and 1990, significant declines in species occurred (Box 5.2). Since then, the rate of decline has slowed but many rare species are at risk of extinction due to their small population size (FOEN, 2014b).

Box 5.2. **Bat populations have declined due to pesticides and habitat fragmentation**

About 60% of bats are considered threatened in Switzerland. Studies exploring the reasons have found pesticides to be the most significant culprit, particularly dichlorodiphenyltrichloroethane (DDT) for timber treatment in attics. Some populations have recovered since substances including DDT were banned in the 1970s. Habitat fragmentation and loss present an obstacle to recolonisation of former ranges, however, given bat feeding patterns.

The lesser horseshoe bat (*Rhinolophus Hipposideros*), for example, has seen its population severely decline over the past 50 years. The species was once common and widespread, but has faced regional extinction in northern and western Switzerland. Lesser horseshoe bats are particularly sensitive to disturbance in their nurseries, winter roosts and foraging habitats.

Source: BDM (2016), *Biodiversity Indicators*, *www.biodiversitymonitoring.ch/en/home.html*; Universitat Bern (2016), *Conservation Biology: Lesser Horseshoe Bat, www.iee.unibe.ch/abt_cb/content/research/lesser_horseshoe_bat/index_eng.html*; Bontadina et al. (2001), *The Lesser Horseshoe Bat Rhinolophus hipposideros in Switzerland: Present Status and Research Recommendations, www.researchgate.net/publication/228083819_The_lesser_horseshoe_bat_Rhinolophus_hipposideros_in_Switzerland_Present_status_and_research_recommendations.*

As of 2012, one-quarter of known species had been evaluated in terms of the categories defined by the International Union for Conservation of Nature (IUCN). Of these, 36% were categorised as threatened: 3% regionally extinct, 5% critically endangered, 11% endangered and 17% vulnerable (FOEN, 2014b). As in most OECD countries, reptiles and amphibians are particularly under threat (Figure 5.4). Switzerland has some of the highest percentages of threatened species across OECD countries, particularly for mammals and amphibians (Figure 5.5). Over the past ten years, the overall situation for endangered species has not significantly improved, though in recent years small numbers of previously extinct mammals have begun to return, including bears, wolves, golden jackals, lynxes and foxes, as a result of forest cover expansion and increases in prey such as deer (FOEN, 2017a).

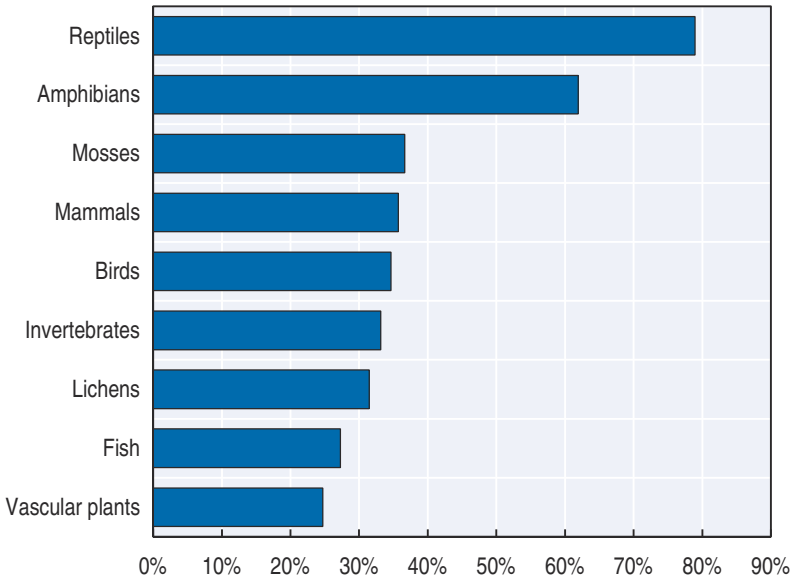
Many of the lost species were specialised, dependent on particular habitat types. In recent decades, the most significant causes of species endangerment have been farming, removal of habitats such as trees, changes to groundwater and alteration of surface water bodies (FOEN, 2014b).

Species diversity

Recent biodiversity monitoring shows that while the number of species in sampled areas is increasing or staying the same across Switzerland, vascular plant communities are becoming increasingly similar in most of the country (Table 5.2). In the Jura, breeding bird species are also becoming more uniform (BDM, 2016). The homogenisation of habitats and species communities is attributed to land use change and high nitrogen inputs that contribute to ecosystem eutrophication (Section 4.1) (FOEN, 2017a).

Figure 5.4. **More than one in three species is threatened**

Threatened species as % of known species, late 2000s



Note : Threatened species = IUCN categories critically endangered, endangered and vulnerable.
Source: OECD (2016a), "Threatened species", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571834

Invasive species

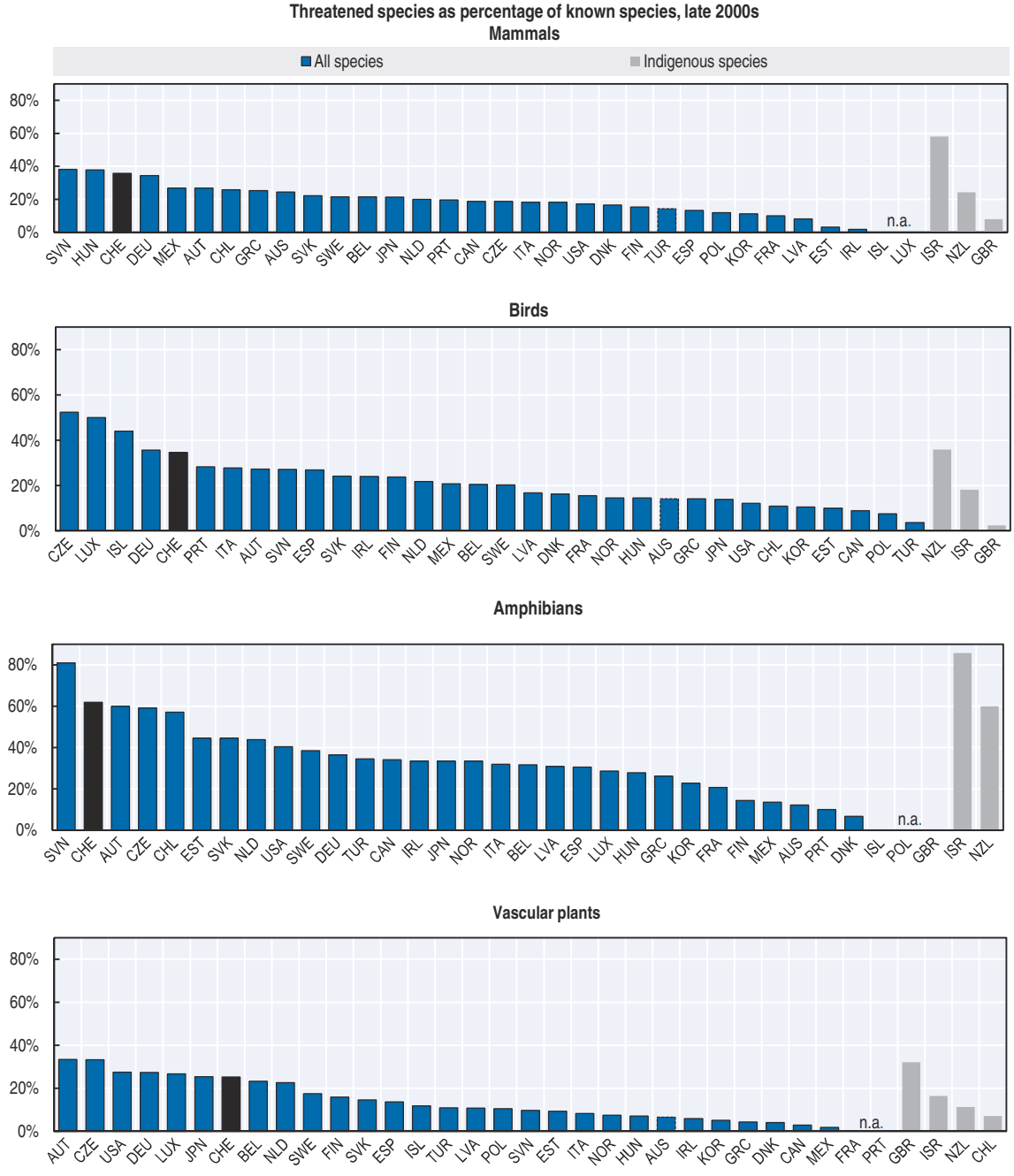
Ecosystems that are degraded due to other pressures are often vulnerable to invasion and establishment of alien species. Around 800 alien species have been documented in Switzerland, with 107 assessed as invasive: five mammals, four birds, one reptile, three amphibians, seven fish, four molluscs, sixteen insects, six crustaceans, three spiders, two worms, seven fungi, one bacterium and forty-eight plants (FOEN, 2014b). Invasive species can replace native species, cause illness and transfer parasites to local species. The emergence of invasive species in valuable habitats such as alluvial zones and amphibian spawning sites has posed particularly problems (FOEN, 2017a). The Asian lady beetle (*Harmonia axyridis*), for example, was introduced to Europe to control aphid species in agriculture. While it is effective at controlling aphids, it also displaces native coccinellids, is a pest in fruit production and can infest homes (GISD, 2016).

Impact of climate change on species

Warming temperatures are resulting in plants developing earlier in the spring and previously low-altitude species being seen in Alpine areas. Over the long term, species ranges are expected to shift northward and the treeline will move to higher altitudes (Federal Council, 2015). Switzerland is fortunate to have many Alpine areas, which are believed to offer species a refuge from increased temperatures. A study found that plant, bird and butterfly communities at 500 m showed an average uphill shift of 8 m, 42 m and 38 m, respectively, over eight years (Roth et al., 2014). Some bird species, such as yellow-legged gull and European bee-eater, are expanding as a result of climate change (Federal Council, 2015). Butterflies, dragonflies, birds and several plant species from the Mediterranean are spreading into Switzerland (FOEN, 2017a).

Climate change is negatively affecting fish species, such as brown trout, which need cool temperatures to survive, and breeding birds in the alpine region. In Valais canton,

Figure 5.5. **Among OECD countries, Switzerland's shares of threatened species are high**



Source: OECD (2016a), "Threatened species", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571853

Scots pine is being gradually replaced by downy oak due to drought linked to climate change (Federal Council, 2015). Extreme weather and mild winters are contributing to the spread of harmful organisms such as European spruce bark beetles, which damage trees. Between 1995 and 2005, 3.7 million m^3 of spruce wood was lost to infestations of harmful organisms (Federal Council, 2015).

Table 5.2. **The species diversity of vascular plants, and breeding birds in the Jura, is declining**

Species diversity, trends between 2005 and 2014

Biogeographical regions	Vascular plant developments	Breeding bird developments	Butterfly developments
Nationwide	↘	→	→
Jura	↘	↘	→
Central Plateau	↘	→	→
Northern Alps	→	→	→
Central Alps	↘	→	→
Southern Alps	↘	→	→

Source: BDM (2016), "Z12 Indicator, Status end 2012", Biodiversity Indicators, *www.biodiversitymonitoring.ch/en/home.html*.

Over time, climate change is expected to result in increased threats to species at both lower and higher levels of elevation. Lowland species will suffer from higher temperatures and drought, while alpine species will face increased competition and loss of habitat. Landscape fragmentation could also hinder species migration (Vittoz et al., 2012). To better understand the potential impact of climate change, Switzerland is undertaking a risk analysis of potential damage and gains expected by 2060 in the areas of health, agriculture, forestry, energy, tourism, infrastructure and buildings, water management, biodiversity and green spaces to identify priority areas for action at the national and regional levels.

3. Institutional, legal and strategic framework

As discussed in Chapter 2, Switzerland's political system can be characterised as highly decentralised, with significant delegation of powers to the cantons and municipalities under the subsidiarity principle. Non-government actors, whether private or from civil society, also have a say in government decisions via direct democracy in the form of referendums and popular initiatives. On biodiversity policies, the Confederation is responsible for setting the overall agenda and has jurisdiction over international commitments, subject to consultation with cantonal and municipal governments on implementation. This added level of complexity may partly explain Switzerland's occasional delays on international agreement ratifications and national strategies, and uneven national policy implementation.

3.1. Institutional framework

Government

Switzerland has a strong bottom-up governance system, with cantons having a high degree of autonomy in implementing environmental policy. Jurisdiction on biodiversity conservation, like most environment policies, is shared among the federal, cantonal and municipal levels of government. Broadly speaking, the Confederation sets overarching principles through acts and regulatory ordinances and provides financial support to the cantons for implementation. In turn, municipalities implement cantonal provisions through by-laws and local regulations on issues such as conservation and nature reserves. Programmatic contracts between the Confederation and the cantons, redefined every four years, are used to set management priorities and objectives. Thus the effectiveness of biodiversity policies and measures is highly dependent on effective co-operation among the three levels of government (OECD, 2007).

Within the Federal Council, nature protection and other biodiversity issues are mainly the responsibility of the Department of the Environment, Transport, Energy and Communications

and, under it, FOEN and the Federal Office for Spatial Development. An exception concerns agriculture-related issues, which fall under the Department of Economic Affairs, Education and Research and its Federal Office for Agriculture.

NGOs and the private sector

NGOs continue to be active players in biodiversity conservation and government policy development initiatives. They generate most of their funding from private donations, including membership fees, and the different government levels also provide core funding. In 2014, domestic NGOs spent CHF 55.4 million on biodiversity-related projects, excluding government support (CBD, 2016b). Swiss NGOs also manage 30 nature protection centres, which offer excursions, courses and exhibitions to some 200 000 visitors per year (SVS/BirdLife Schweiz, 2013). A programme to restore dry alpine grasslands is an example of how to achieve co-operation among stakeholders (Box 5.3).

Box 5.3. **The "Allegra Peter the Goatherd" programme: goats, donkeys and cattle graze for biodiversity**

More than 95% of Swiss dry grasslands and pastures have disappeared over the last century due to lack of grazing and maintenance, leading to a significant loss of biodiversity.

In 2006, Pro Natura, a Swiss conservation NGO, revived the character of Peter, the young goatherd from the famous Swiss children's book *Heidi*, through its "Allegra Peter the Goatherd" programme.

Working with farmers, local authorities and cantonal officials, Pro Natura launched several projects to prevent brushwood overgrowth and afforestation by reintroducing grazing animals to sustainably preserve dry grasslands in the alpine cantons of Valais and Grisons. Goats, donkeys and cattle are used, depending on the topography and type of overgrowth.

Between 2006 and 2016, more than 80 hectares of dry grasslands were restored through the programme. Traditional dry grassland floral species have returned, and the number and variety of butterfly species have more than doubled in one project.

Source: Pro Natura (2017), *"Allegra Pierre le Chevrier": des chèvres, ânes et autres bovins paissent pour la biodiversité, www.pronatura.ch/allegra-pierre-le-chevrier*.

The private sector also plays a critical role in determining how biodiversity is used and conserved. A number of progressive businesses are integrating natural capital values into their operations and investing in biodiversity protection. However, FOEN reported that attempts to co-operate with the private sector to assess private sector investment in biodiversity have had little success. Tracking private sector financial flows has proved very difficult due to lack of data accessibility, difficulty in identifying relevant activities and confidentiality issues. In addition, an attempt to obtain voluntary biodiversity data from private companies failed when only 2 companies provided quantified answers to a questionnaire sent to 249 companies (FOEN, 2015a).

There is evidence, however, that private individuals and organisations are donating or selling land of high ecological value to conservation organisations. For instance, the NGO Pro Natura has secured contracts, through a mix of transfers of ownership and conservation management services, with over 650 landowners for a total area of around 250 km^2, of which Pro Natura owns over 60 km^2. This makes Pro Natura the country's largest private landowner, its primary objective being to adequately protect habitats for animal and plant species (Pro Natura, 2016).

3.2. Legal framework

The Federal Constitution (1999) is the keystone of the legislative framework. It enshrines protection and conservation of the natural environment and landscape, notably in Article 78, which prescribes the Confederation's responsibility to legislate on animal and plant life protection, preservation of their natural habitats and diversity, and protection of endangered species from extinction.

Switzerland has a long tradition of biodiversity conservation, going back as far as 1876 with the Forest Inspectorate Act, which introduced early notions of sustainable management for the forestry sector through, notably, reforestation practices (Dictionnaire historique de la Suisse, 2015).

The modern biodiversity-related legislative framework rests on three main federal laws and their ordinances (FOEN, 2013a): the Act on Protection of Nature and Cultural Heritage (NCHA, 1966, last amended 2014), the Act on Hunting and Protection of Wild Mammals and Birds (1986, last amended 2014), and the Fishing Act (1991, last amended 2013).

The NCHA mandates the Confederation, cantons and municipalities to preserve habitats and heritage sites requiring ecological protection for native animal and plant species and for biotopes of high ecological value, and to mitigate the extinction of wildlife. Since 1991, red lists showing the extent to which species are threatened have been required under the NCHA.

Other federal laws taking into account the interests of nature conservation by protecting biodiversity and natural habitats include the Agriculture Act (1998, last amended 2015); the Forest Act, which introduced near-natural management for all forests (1991, last amended 2013); and the Spatial Planning Act (1979, last amended 2016).

In addition, an important milestone has been reached in water protection: the Water Protection Act (1991, last amended 2016) now contains provisions for restoring rivers and lakes so they can fulfil their natural functions and contribute to biodiversity conservation and promotion (EEA, 2015) (Chapter 4).

3.3. Strategic framework

The Swiss Biodiversity Strategy

Switzerland ratified the CBD in 1995 but did not submit a national biodiversity strategy until 2012, when the Federal Council adopted the Swiss Biodiversity Strategy after consultation with the cantons, civil society and the private sector. The strategy was developed according to the 2011-20 CBD Strategic Plan and generally followed the Aichi Biodiversity Targets' intent and structure, while taking into consideration the country's specific circumstances (FOEN, 2012a).

A central element of the strategy is the development of an "ecological infrastructure consisting of protected and connected areas" (Table 5.3, Strategic Goal 2). As per Section 2.2, landscape fragmentation and the poor state of ecosystems call for improved habitat protection and connection. This goal relates to Aichi Target 11, which requires at least 17% of a country's territory to be designated as protected area and protected. Section 4.1 discusses Switzerland's progress towards this target.

Also of note, Switzerland has pledged to strengthen its "commitment to the conservation of global biodiversity at international level" by 2020 (Table 5.3, Strategic Goal 9). This goal is not quantified, but includes "doing its part to fund project implementation at the global level

and particularly in countries of the South". Swiss biodiversity-related official development assistance (ODA) has been on a general uptrend in the past decade, reaching up to 4% of total ODA commitments, but is still lower than the OECD Development Assistance Committee average of 6% of total ODA in 2015 (Figure 5.6). Switzerland stated at the CBD 12th Conference of the Parties in 2014 that it would not meet the international commitment of doubling biodiversity-related ODA by 2015 but would try to meet it by 2020.

Table 5.3. **The Aichi Biodiversity Targets are reflected in the Swiss Biodiversity Strategy**

Reference	Target	Related strategic goals/Aichi targets
Strategic Goal 1	By 2020, the use of natural resources and interventions involving them are sustainable so that the conservation of ecosystems and their services and of species and their genetic diversity is ensured.	4, 7
Strategic Goal 2	By 2020, an ecological infrastructure consisting of protected and connected areas is developed. The state of threatened habitats is improved.	5, 8, 11, 14, 15
Strategic Goal 3	By 2020, the conservation status of the populations of national priority species is improved and their extinction prevented insofar as possible. The spread of invasive alien species with the potential to cause damage is contained.	9, 12
Strategic Goal 4	By 2020, genetic impoverishment is decelerated and, if possible, halted. The conservation and sustainable use of genetic resources, including that of livestock and crops, is ensured.	13, 16
Strategic Goal 5	By 2020, the negative impacts of existing financial incentives on biodiversity are identified and avoided, if possible. Where appropriate, new positive incentives are created.	3
Strategic Goal 6	By 2020, ecosystem services are recorded quantitatively. This enables their consideration in the measurement of welfare as complementary indicators to gross domestic product and in regulatory impact assessments.	2, 3, 20
Strategic Goal 7	By 2020, sufficient knowledge about biodiversity is available to society and provides the basis for the universal understanding of biodiversity as a central pillar of life, and for its consideration in relevant decision-making processes.	1, 19
Strategic Goal 8	By 2020, biodiversity in settlement areas is promoted so that settlement areas contribute to the connection of habitats, settlement-specific species are conserved and the population is able to experience nature in the residential environment and in local recreational areas.	4, 7
Strategic Goal 9	By 2020, Switzerland's commitment to the conservation of global biodiversity at international level is strengthened.	6, 10, 16, 18, 20
Strategic Goal 10	By 2020, the monitoring of changes in ecosystems and in species and genetic diversity is ensured.	17, 19

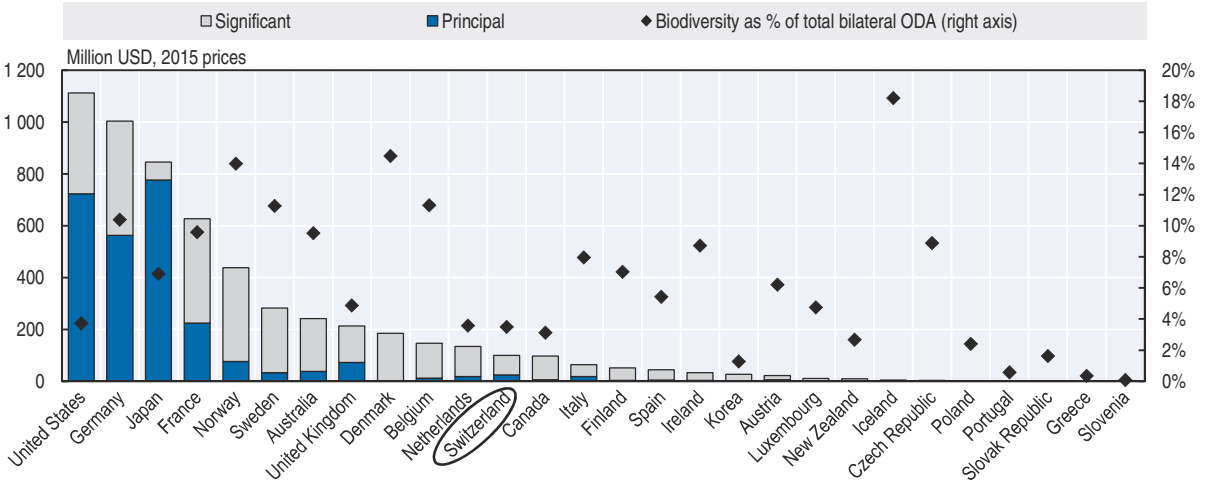
Source: FOEN (2012a), Swiss Biodiversity Strategy, *www.bafu.admin.ch/ud-1060-e*.

The other strategic goals are equally ambitious. Although the Swiss Biodiversity Strategy was never meant to be a detailed instruction manual on how to meet the goals, it provided few details on how they would be put into operation. The recent biodiversity action plan will thus be key in enabling domestic stakeholders and the international community to determine if Switzerland is going in the right direction.

Action plan

A 2010 CBD decision gave parties two years to submit a revised national biodiversity strategy (the first one, in Switzerland's case) and related action plan. Switzerland submitted its strategy on time but has only recently submitted its action plan. The Federal Council had asked FOEN to develop a plan by April 2014 to concretise the strategic goals, but it has taken more than three years past the target date for the council to approve the plan.

Figure 5.6. **Swiss biodiversity-related official development assistance is lower than in many other OECD countries**



Note: Bilateral biodiversity-related ODA, 2011-15 average.
Source: OECD (2017a), *OECD International Development Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571872

Elaboration of the plan began in 2013 with an extensive, bottom-up collaborative process involving federal, cantonal and municipal authorities, the scientific community, farmer organisations, environmental NGOs and business organisations. A first set of 320 potential measures was identified through collaboration of over 650 experts from over 250 associations and organisations in all fields.

In the second phase, measures were consolidated and the relevant federal departments identified financial and legislative requirements. In February 2015, due to the complexity and broad implications of some of the proposed measures, the Federal Council decided that cantons needed to be further consulted and involved in the finalisation of the plan (FOEN, 2016b). The Federal Council finally approved the plan in September 2017. Financing of the action plan was approved in a context of limited access to new sources of funds, both at the federal and cantonal levels, which may result in incremental implementation of the plan.

Other policy frameworks

In addition to the Swiss Biodiversity Strategy and action plan, a few other policy frameworks and strategies on related environmental areas could benefit the state of biodiversity in Switzerland.

For instance, in May 2016 the Federal Council adopted an Invasive Alien Species Strategy (FOEN, 2016c) setting out principles, goals and measures to prevent and control such species, which are becoming a growing problem (Section 2.3). The strategy identifies knowledge and regulatory gaps and proposes measures that need to be taken to harmonise domestic and international action. The strategy reinforces the Confederation's intention to address the issue, which the biodiversity strategy lists as its third strategic goal (Table 5.3).

To address threats to species caused by a changing climate, the Federal Council approved a strategy, Adaptation to Climate Change in Switzerland, in 2012 and a 2014-19

action plan in 2014. This two-part national adaptation strategy identifies areas for action in various policy sectors, including biodiversity management. It calls for increasing monitoring of climate-sensitive species and habitats, expanding forest cover to minimise the impact of flooding and rockfalls, controlling the spread of the built-up area and rehabilitating watercourses (Federal Council, 2015).

4. Policy instruments for biodiversity conservation and sustainable use

The Confederation has implemented a number of instruments over the years to ensure biodiversity conservation and sustainable use. Over and above traditional regulatory approaches, economic instruments can provide alternative incentives and financing for programmes that benefit biodiversity and contribute to the inclusion of biodiversity in economic sectors.

4.1. *Direct regulatory instruments*

Protected areas

Habitat protection instruments are the main tool used to protect biodiversity (FOEN, 2017a). The protection level varies with the designation provided to a certain area. Taking only nationally protected areas into account, Switzerland has 6.2% of its territory protected under federal law. This is a low level by international comparison (Figure 5.7) and far from Aichi Target 11: adequate protection of at least 17% of terrestrial and inland water areas by 2020. Some 58% of the area under protection is in game reserves, a lower protection category originally intended to limit excessive hunting (FOEN, 2015b). The total area of nationally designated biodiversity areas increased from 29 449 ha in 1991 to 258 008 ha in 2011 but has since remained essentially constant. The types of ecosystem protected have evolved with time, however, with the addition of biotopes of national importance such as raised bogs, alluvial zones, fens, amphibian spawning sites, and dry meadows and pastures (Figure 5.8).

In addition to these formally protected national sites, there are other conservation areas that are not accounted for in the 6.2%, either because they overlap with nationally protected sites or because of missing data on the biodiversity protection level they offer. Adding in areas of international importance such as Emerald Network and Ramsar sites, regional and local conservation areas, forest reserves and biodiversity promotion areas on farmland would increase the share of the national territory designated for biodiversity conservation to around 12.5% (Figure 5.9) (FOEN, 2017a).

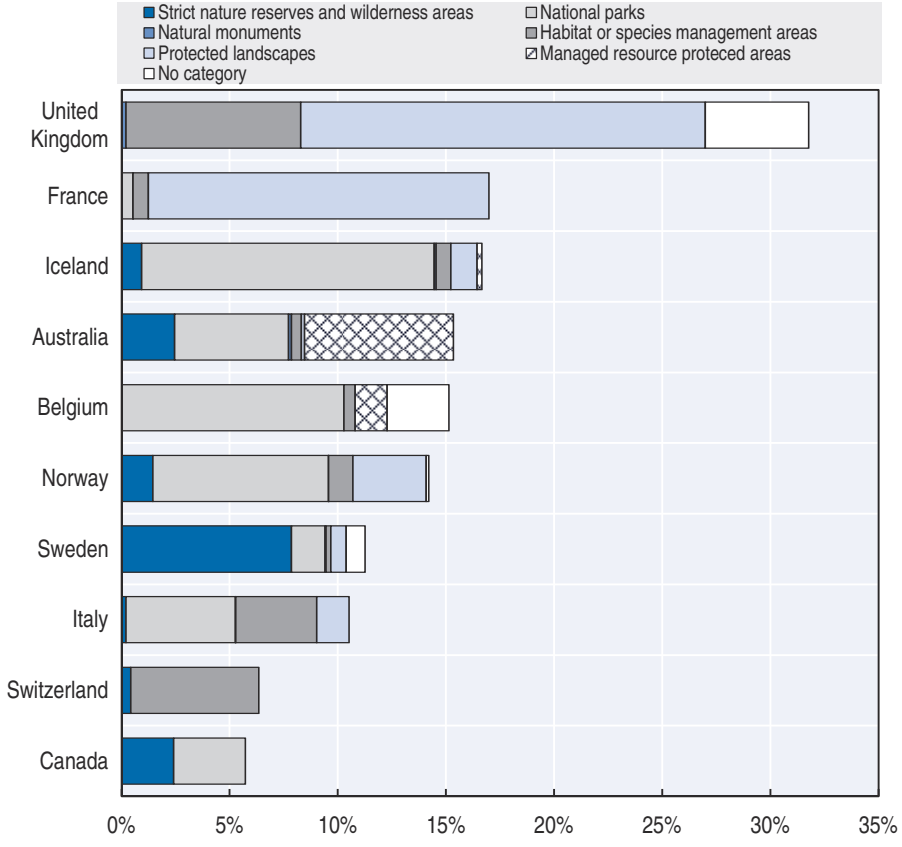
In addition to the issue of quantity, quality of protected areas is a challenge. The protected areas that do exist are often too small and poorly interconnected, and do not fully meet conservation objectives (FOEN, 2017a). Around 23% of protected areas lack a management plan (FOEN, personal communication). In 2014, only 58% of biotopes of national importance had protection and conservation measures in place (FOEN, 2017a).

Swiss parks

In 1914, Switzerland was one of the first European countries to create a national park. To this day, however, that remains the country's only national park, which is unusual for an OECD country (PNS, 2016). In November 2016, after 16 years of work with local authorities and conservation experts, voters rejected the creation of a second national park. A referendum on a smaller proposed national park is to be held in 2017. Plans for further national parks are being re-evaluated (Swiss Parks, 2016).

Figure 5.7. **Switzerland has lower levels of strict protected areas than other OECD countries**

Terrestrial protected areas by IUCN category, selected OECD countries, 2013 (% total area)

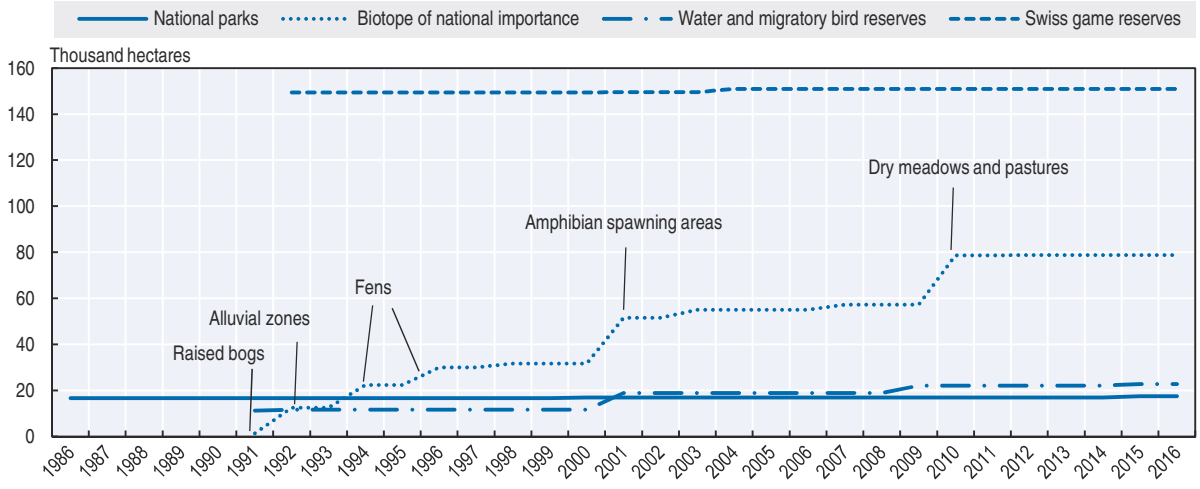


Source: OECD (2015a), Environment at a Glance 2015: OECD Indicators.

StatLink http://dx.doi.org/10.1787/888933571891

Figure 5.8. **Most protected area categories have seen little progress since 1990, except for biotopes of national importance**

Area of nationally protected sites, 1986-2016

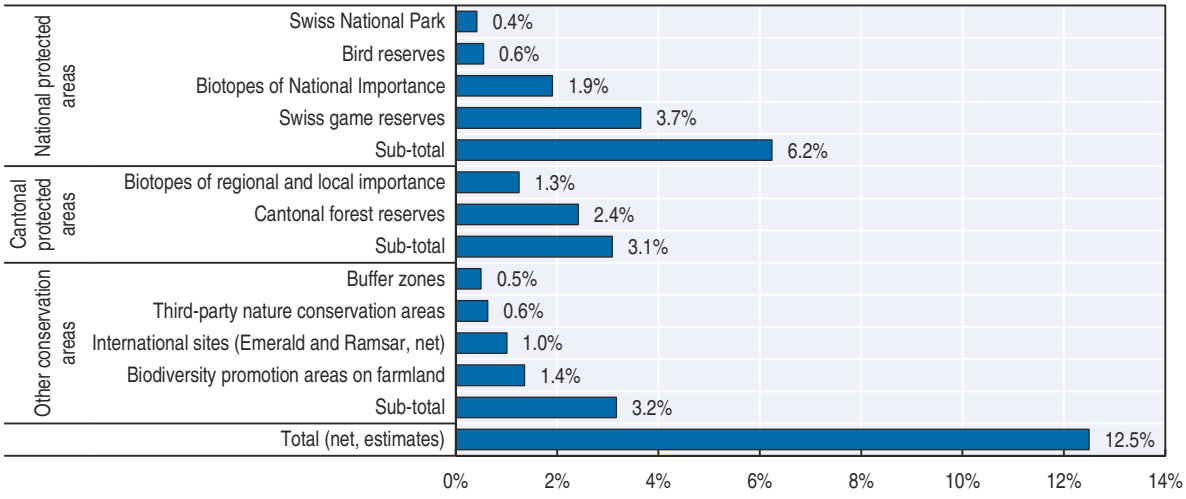


Source: FOEN (2017), State of Biodiversity in Switzerland, Results of the Biodiversity Monitoring System in 2016, State of the Environment N 1630.

StatLink http://dx.doi.org/10.1787/888933571910

Figure 5.9. **Designated areas for biodiversity have varying levels of protection**

Share of the territory protected, by category



Note: Adjustments have been made to account for estimated overlaps

Source: FOEN (2017), State of Biodiversity in Switzerland, Results of the Biodiversity Monitoring System in 2016, State of the Environment N 1630.

StatLink http://dx.doi.org/10.1787/888933571929

In response to a recommendation in the previous EPR, a legal framework for the creation of parks of national importance was adopted in 2007. It provides for park categories offering lower habitat protection than national parks: regional nature parks and nature discovery parks. Since then, 16 such parks have been established and 4 are being considered.

Emerald Network

As a party to the Bern Convention on the Conservation of European Wildlife and Natural Habitats, Switzerland is committed to protecting valuable natural environments through the Emerald Network, which applies to EU and non-EU countries alike. In 2009, the Confederation announced a first set of 37 candidate sites for the Swiss Emerald Network. However, all except on were already protected by federal or cantonal law (SVS/BirdLife Suisse, 2017).

The incremental conservation benefit of naming sites as part of the Emerald Network lies in ensuring connections between them. In this regard, Switzerland should ensure coherence between the network and river rehabilitation efforts undertaken since 2011 as water policy measures (Chapter 4). Connections also need to be improved with the Natura 2000 network in neighbouring EU countries. The EU and Council of Europe are co-operating towards concerted site conservation to develop Emerald and Natura 2000 into a pan-European ecological network with aligned standards by 2020.

4.2. Landscape management policies

Landscape management policies are an important tool to protect biodiversity and reduce habitat fragmentation, particularly where there are competing demands for land use. A study by the Biodiversity Forum of the Swiss Academy of Sciences estimated that one-third of the country's surface area should have conserving biodiversity and ecosystem services as its primary objective, and further efforts should be put into rehabilitation and restoration, in order to support long-term conservation (FOEN, 2014b). Switzerland has been making progress in integrating nature protection objectives into landscape management, but still

relies largely on subsidies, rather than regulations or economic instruments, for implementation at the cantonal and municipal levels.

Swiss landscape concept and Landscape 2020

In 1998, Switzerland developed the Swiss Landscape Concept to better consider the protection of nature, landscape and cultural heritage by integrating landscape policy into sectoral policies (FOEN, 1998). At the time of its publication, the concept was an innovative way to foster a dialogue between landscape users and conservationists. It helps mainstream landscape preservation in policies for sectors such as tourism, agriculture, nature protection, land use planning, transport and forestry. The concept is supported by the Swiss Landscape Fund, which provides funds for the protection and management of traditional landscapes, including enhancement of rural and urban landscapes, along with information sessions and training activities.

The Swiss Landscape Concept was a milestone in that it marked the beginning of an all-inclusive landscape policy in Switzerland. Landscape issues have since been increasingly considered, and legally binding instruments are available at the national level to require better and more effective actions in sectoral decision making. However, legally binding instruments are not yet used at the cantonal and municipal levels, where better alignment with federal objectives is needed (Jørgensen et al., 2016).

Switzerland signed the European Landscape Convention in 2000 but only ratified it in 2013 following years of political debate. Nevertheless, in 2003 Switzerland published Landscape 2020, a document that explicitly refers to the convention's definition of landscape and acts as a complement to the Swiss Landscape Concept. Landscape 2020 presents guiding principles to help federal agencies comply with the convention (Jørgensen et al., 2016).

Spatial planning, strategic environmental assessment and environmental impact assessment

Spatial planning, strategic environmental assessment (SEA) and environmental impact assessment (EIA) help in implementing policies related to landscape management and biodiversity conservation. The biodiversity strategy includes a commitment to improve co-ordination of sectoral policies relevant to spatial planning and integrate biodiversity into infrastructure policies and the planning, development and implementation of building projects (FOEN, 2012a). Because spatial planning mostly takes place at subnational levels, the Swiss Spatial Concept was developed jointly by the Confederation, cantons and municipalities as a policy framework to guide spatial development (Federal Council et al., 2012). One of its main objectives was to conserve and create space for biodiversity through spatial planning. The Spatial Planning Act was amended in 2013 to provide greater guidance for cantonal land use planning that supports biodiversity, seeking to reduce oversized development zones and better allocate reserves of development land (Federal Council, 2015). There is also a legal obligation to restore and provide compensation for degraded habitats deserving of protection under the NCHA (FOEN, 2012a). The federal inventories of mires, landscapes and natural monuments of national importance help support land use decision making that weighs a range of interests appropriately (Federal Council, 2015).

SEA and EIA are also important tools for mainstreaming biodiversity and other environmental considerations into policy and project decision making. As Chapter 2 noted, Switzerland has made limited use of SEA, EIA only seeks to verify whether larger projects

comply with environmental law, and smaller projects usually undertake simplified preliminary assessment. Addressing the gaps and inconsistent regional application of the current system of project approvals will be a key step in improving the status of vulnerable ecosystems and species that may not be adequately protected in existing laws. An inventory of all high-value habitats and ecosystems would help support improved spatial planning and EIA.

Urban development

Increased densification of built-up areas and the development of more protected areas in regions at risk of urban sprawl will be important to limiting impacts on biodiversity while not hindering economic growth on the Swiss Plateau. A commitment of the biodiversity strategy is to promote biodiversity within settlement areas so as to improve habitat interconnection, local species conservation and the public's ability to experience nature. One way to achieve this is through urban land use planning that designates green and open spaces in a multifunctional network (FOEN, 2012a). Swiss governments could look to examples such as France, which developed the Green and Blue Infrastructure initiative to reconstitute a network of corridors for animal and plant species (TVB, 2017). Yokohama in Japan uses a green tax on residents and corporations to pay for protection and expansion of green spaces (CY, 2013). A tax on building permits could also be considered as a source of funding.

Switzerland's decentralised governance model acts to encourage urban sprawl. The mix of federal and cantonal tax systems has repercussions on use of the territory as it influences land users and developers to assign a certain activity to the land, a multi-agency study found (Waltert et al., 2010). Its authors proposed a few minor changes to the tax system, including additional taxes on soil sealing and greenfield developments. Such taxes have been shown to be effective elsewhere to slow urban sprawl.

In contrast to countries such as the UK that contain urban growth with stringent land use restrictions and subject each planning application to review, Switzerland automatically allows developers to proceed as long as the land is zoned for that purpose. The fiscal system, which finances local goods provision through progressive income taxes, also provides strong incentives for municipalities to allocate large plots of land on the outskirts of the urban boundary to attract high-income taxpayers. Concerns related to the impact of urban sprawl on nature led to a ban on construction of new second homes in tourist areas. It was determined, however, that the policy had a negative impact on local economies, implying that alternative measures to limit urban sprawl may be preferable (Blöchliger et al., 2017).

Mountain development

Some 70% of Switzerland is mountainous. For decades, the policy has been to avoid widespread depopulation of the mountains, where dry grassland habitats are being lost due to abandonment of pastures and associated forest encroachment. Public financial support promotes sustainable development in the mountains. In particular, farmers in mountain areas receive significantly higher agricultural income support than their lowland counterparts. In addition, the fiscal equalisation system requires financially strong cantons to support financially weaker cantons, to the benefit of many mountainous cantons.

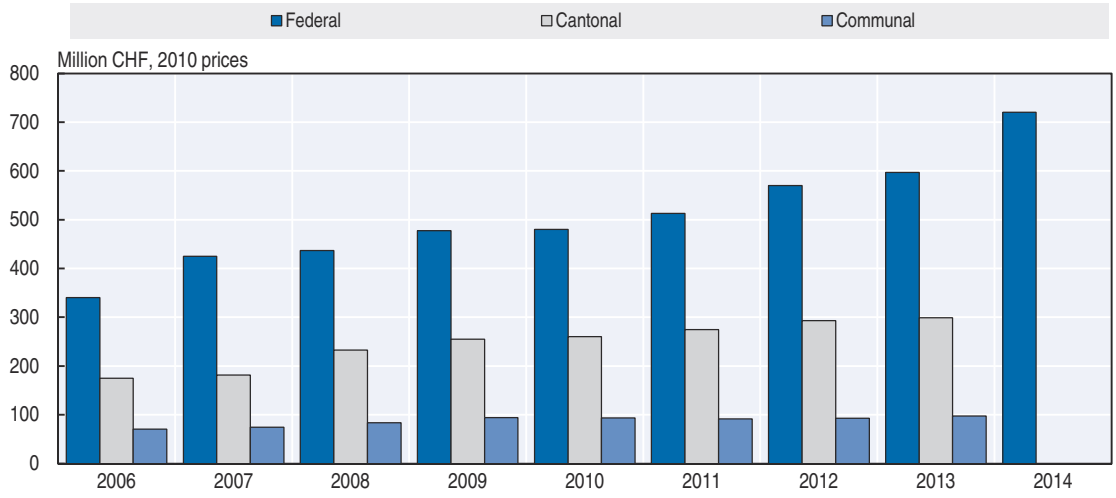
Switzerland is part of the world's only legally binding regional agreement for mountain protection, the Alpine Convention, along with Austria, France, the European Community, Germany, Italy, Liechtenstein, Slovenia and Monaco. Nine protocols detailing the requirements of the framework agreement have been developed, concerning mountain

agriculture; nature protection and landscape conservation; land use planning and sustainable development; mountain forests; tourism; soil conservation; energy; transport; and dispute settlement. While Switzerland signed the protocols, it is the only country not to have ratified them (AC, 2017). The Federal Council submitted the protocols to the parliament in 2001, but after years of consultation, ratification was rejected. Nevertheless, Switzerland adheres to the protocols in practice, and has incorporated the requirements into law (ARE, 2017).

4.3. *Public financial support*

Public expenditure on biodiversity by all three levels of government increased significantly in the past decade; it exceeded CHF 1 billion in 2013 (Figure 5.10). In particular, federal public expenditure more than doubled over the period, reaching CHF 700 million in 2014. Public expenditure included here consist of biodiversity-related budgets for ministries and research organisations, and the biodiversity-relevant share of agricultural direct payments (Sections 4.4, 5.1), which explains the large federal contribution.

Figure 5.10. **Public expenditure on biodiversity increased significantly over 2006-14**



Note : Cantonal and municipal data are not available for 2014.
Source: CDB (2017), Financial Reporting Framework Clearing-House Mechanism.

StatLink http://dx.doi.org/10.1787/888933571948

Nevertheless, current financial resources, despite the increase, remain insufficient to ensure protection and restoration of important ecosystems and species. The shortfall in resources may partly explain the failure to meet biodiversity targets. In 2013, FOEN estimated that implementing measures to meet the objectives of the biodiversity strategy would lead to an annual funding gap of CHF 182 million to CHF 210 million by 2040 (CBD, 2017). This situation led to a Federal Council decision in May 2016 to invest CHF 135 million – an additional CHF 55 million, plus CHF 80 million through repurposing from the FOEN budget – in urgent biodiversity measures over 2017-20.

In 2008, a fiscal equalisation reform introduced requirements for federal budgetary transfers to the cantons. Since then, the Confederation and cantons have had to prepare joint programme agreements describing, among other matters, environmental challenges in the cantons and measures to address them. FOEN then determines the amount of federal transfer for a particular cantonal nature conservation programme, based on goals

and targets as well as indicators to monitor progress (SIB, 2014). Confederation support to cantonal biodiversity activities is expected to double compared to 2008-11 levels, reaching up to CHF 60 million per year between 2016 and 2019.

4.4. *Economic instruments*

Economic instruments, such as environmentally related taxes and charges, payments for ecosystem services and biodiversity offsets, can be a cost-effective way for governments to address environmental issues, including threats to biodiversity and ecosystems. They can offer economic agents greater flexibility than regulations (e.g. command-and-control approaches) in the way they respond to environmental objectives, thus enabling objectives to be attained at lower total economic cost. Some – such as taxes, charges and user fees, and tradable emission permits that are auctioned – can also generate revenue that can be earmarked for further biodiversity conservation and sustainable use measures.

Switzerland makes little use of economic instruments in its efforts to protect biodiversity, with the noticeable exception of agricultural direct payments for biodiversity promotion areas (Section 5.1), which can be likened to payments for ecosystem services. Few other examples exist in Switzerland, which puts greater reliance on regulatory measures to meet challenging biodiversity objectives. Numerous opportunities exist for expanding the use of economic instruments, such as taxes on pesticides and ammonia emissions in agriculture, payments for ecosystem services in the forestry sector (Section 5.2), access fees in tourism and urban taxes to finance additional green spaces (Section 4.2).

Biodiversity offsets

Biodiversity offsets, also known as conservation offsets, are economic instruments (based on the polluter-pays approach) whereby developers must compensate for unavoidable biodiversity loss when projects of overriding public interest are allowed to go ahead. Good practice requires such offsets to be the final step of a mitigation hierarchy: first, avoiding or minimising negative impacts on biodiversity; then restoring unavoidable impacts at the site; and finally, as a last resort, offsetting residual impacts elsewhere. This should ensure no net loss of biodiversity, but can also require net gain. The NCHA requires reconstitution or replacement of protected biotopes where impacts are unavoidable. If, after all factors are taken into consideration, it is impossible to avoid harm to protected biotopes, the developer must take special measures to ensure the best protection possible, reconstitution, or, if this is not possible, adequate replacement (ten Kate et al., 2004). A compensation site must be in the same area and be equivalent (i.e. have the same ecological function). Metrics for compensation are published and the cantons are responsible for ensuring long-term quality. Finding suitable areas for compensation is becoming increasingly difficult and pools of areas where compensation could take place are being considered (habitat banking). Some cantons and authorities have the expertise to oversee these processes well, while others lack the human and financial capacities. Biodiversity offsets' most common application is in the extractive industries, of which Switzerland has few, but other applications could be imaginable and desirable (e.g. ski resorts, infrastructure) (Sections 5.4 and 5.5) (OECD, 2016b).

Taxes

Governments can use environmental taxes or tax exemptions to promote desirable environmental practices while raising revenue. Biodiversity-related taxes or charges could

include, for instance, entrance fees to protected natural areas and taxes on fertiliser and pesticide use (OECD, 2013).

One biodiversity-related tax exemption was applied by the Federal Council in 2008. A hefty oil tax (above the OECD average) is applied to petrol, diesel fuel and heating oil imported to Switzerland. The Confederation passed an exemption for fuel produced from renewable feedstock (biofuel) provided that biofuel suppliers can demonstrate a positive overall environmental impact and socially acceptable production standards. Three ecological requirements must be met to qualify for the exemption, including one specific to biodiversity: the cultivation of raw materials must not jeopardise tropical forest preservation and biological diversity (OECD, 2013).

4.5. *Subsidies harmful to biodiversity*

Switzerland has recognised the challenge posed by environmentally harmful subsidies and has committed to look into it as part of its biodiversity strategy goals for 2020 (Strategic Goal 5). An initial study (Rodewald and Neff, 2001) estimated that one-third of all federal financial measures potentially qualify as environmentally harmful. In 2013, in the course of work to develop the Agriculture Policy 2014-17, a study commissioned by FOEN identified a set of such subsidies and recommended further work on incentives, such as support for tourism infrastructure (Ecoplan, 2013).

4.6. *Information measures*

A recent poll showed that a large majority of Swiss believe nature is doing very well and the country is past the degradation stage and into recovery (FOEN, 2017a, Schaub and Welte, 2017). This misperception of the risks facing biodiversity may contribute to biodiversity protection being given low priority vis-à-vis economic development objectives.

Both NGOs and governments have a role to play in informing and educating the population. For instance, Info Species is a network of Swiss data centres to document biodiversity for fauna, flora, lichens and fungi. Through this network, researchers, cantonal and federal agencies, and the public have easy and efficient access to over 15 million observations stored in a single database (Info Flora, 2017).

5. Mainstreaming biodiversity into economic sectors

Many pressures on biodiversity result from activities influenced by sectoral or other policies that do not have biodiversity as their primary focus. Overall, Switzerland has made progress in mainstreaming biodiversity at the level of strategies and federal policies, but needs to do more to translate general declarations of intent into concrete measures at all levels of government, particularly in relation to pesticides and ammonia emissions from agriculture, forest conservation and mitigating the impact of tourism and transport infrastructure.

5.1. *Agriculture*

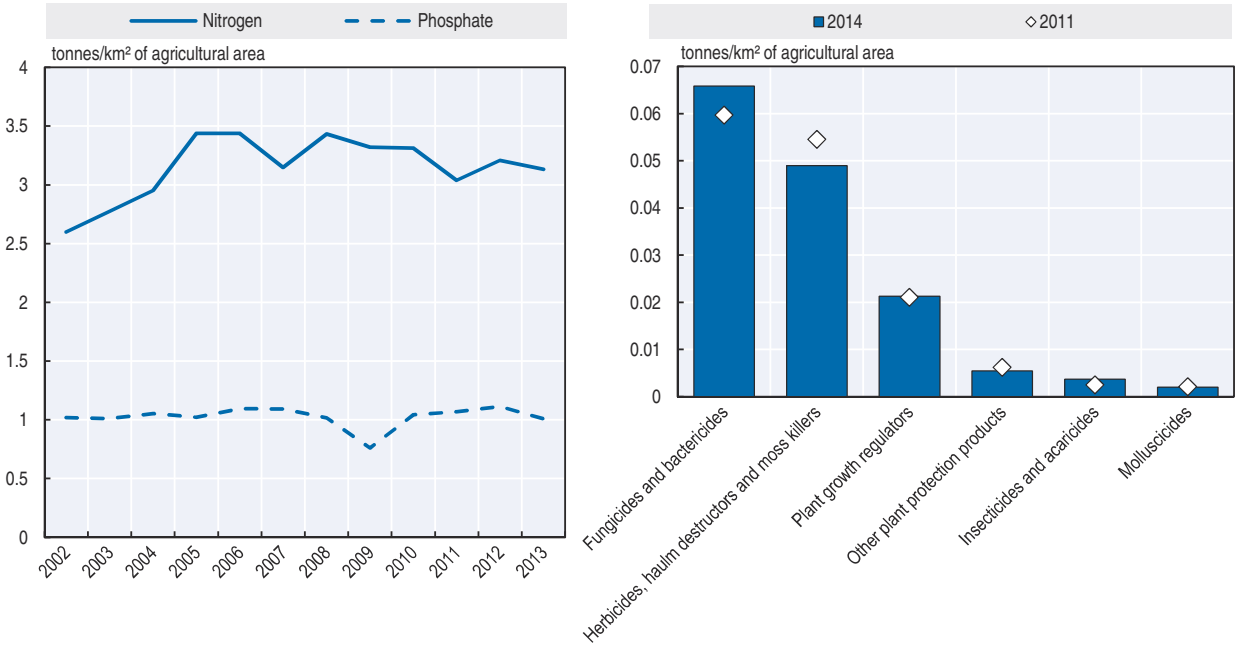
Trends relevant to biodiversity

Over the years, intensive agricultural practices have greatly affected habitat diversity on agricultural land. To facilitate industrial farming, biodiversity-friendly structures have been removed, wetlands have been drained or filled in, nutrient-poor land has been fertilised and dry sites have been irrigated. All this has been devastating for habitat diversity. It has been

estimated that 35% of the habitat types in agricultural areas are assessed as threatened (FOEN, 2017a).

The agriculture sector is a significant contributor to water, soil and air pollution, which is a risk to both terrestrial and aquatic biodiversity. Pesticide sales in Switzerland, currently ranking in the middle of OECD countries, remained stable between 2011 and 2014, despite a decrease in hectares used for agriculture (Figure 5.11) (FOEN, 2014b). Nitrogen fertiliser use remained high between 2002 and 2013, keeping pressures on water quality in agricultural areas (Figure 5.11). As a result, nitrate levels continue to be elevated in groundwater of the Swiss Plateau (SCNAT, 2016b). Agriculture is also responsible for around 20% of consumptive water use even though only 3.4% of the agricultural area is irrigated (SCNAT, 2016b).

Figure 5.11. **Nitrogen fertiliser use remains high while pesticide use has stabilised**



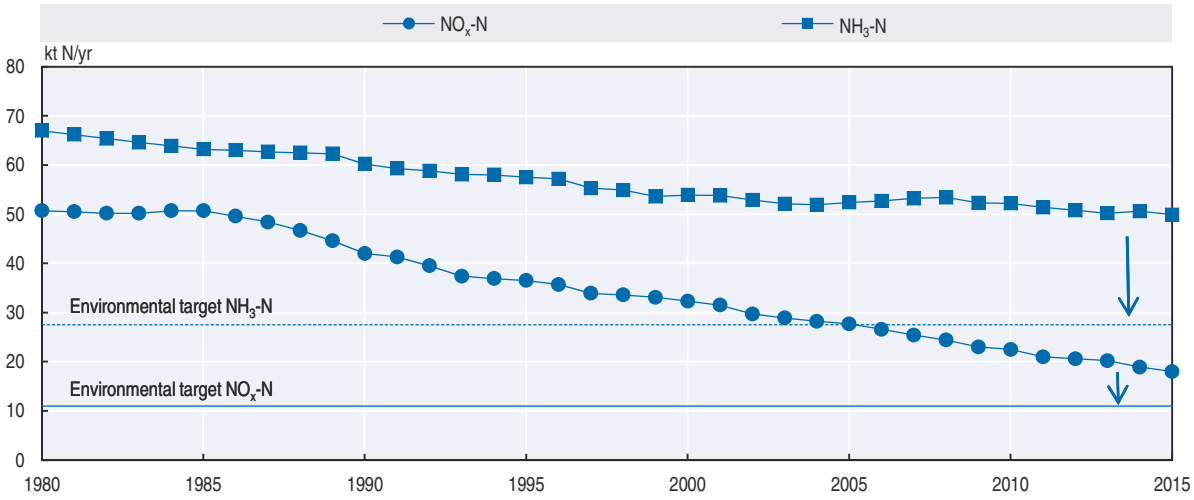
Source: EUROSTAT (2017), *Pesticide sales* (database) ; EUROSTAT (2017), *Consumption of inorganic fertilizers* (database); FAO (2016), *FAOSTAT* (database).

StatLink http://dx.doi.org/10.1787/888933571967

Agriculture is the main contributor to ammonia emissions: it is responsible for 92% of them, and the level is relatively little improved over the past two decades (Figure 5.12) (ES, 2015). Combined with high levels of NO_X, ammonia pollution in the air is causing eutrophication of many ecosystems. In particular, the impact is felt on the Swiss Plateau on 100% of all raised bogs, 84% of fens and 42% of dry meadows and pastures (Federal Council, 2015). No less than 90% of the forest area is adversely affected by excessive nitrogen loads (FOEN, 2014b). Ammonia comes primarily from agricultural livestock waste management and fertiliser use, while NO_X emissions come from fossil fuel combustion (FOEN, 2014b). Soils highly loaded with nutrients such as nitrogen result in less diversity (homogenisation) of local plant communities (FOEN, 2014b).

However, agriculture can also be beneficial to biodiversity, with grazing cows, sheep or goats slowing down the loss of biodiversity-rich grasslands to forest (BDM, 2016). As Section 1 noted, biodiversity-rich dry meadows and pastures lost around 95% of their area between 1900 and 2010 (FOEN, 2017a). In 2011, Switzerland averaged 1.2 head of livestock per hectare

Figure 5.12. **Ammonia emissions have declined more slowly than NO_X emissions**



Source: OFEV / IIR (2016) ; SLPA (2009).

StatLink http://dx.doi.org/10.1787/888933571986

of utilised agricultural area, but in some central and eastern cantons livestock numbers exceed 1.5 head per hectare, which is rather high by European standards (BMD 2016).

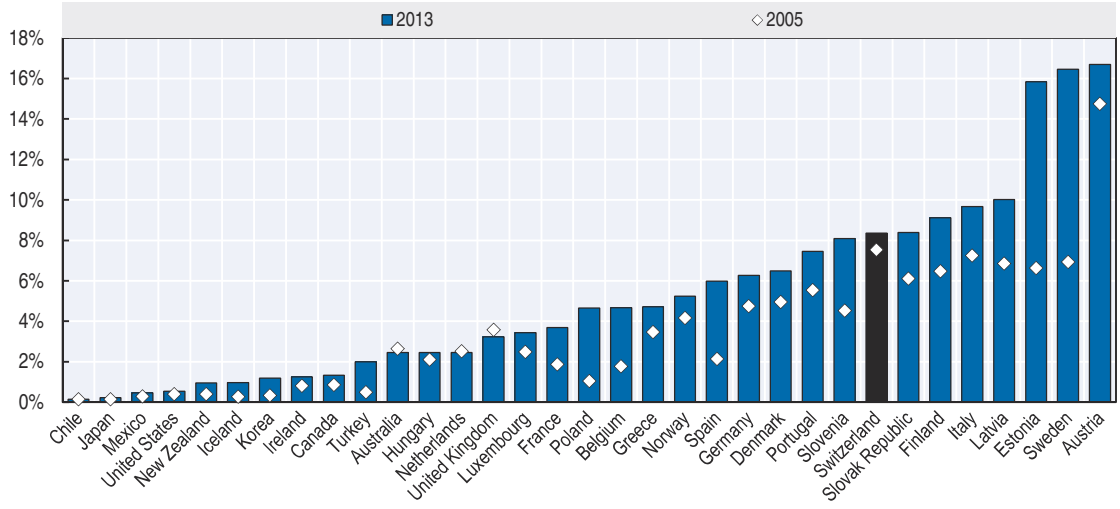
An increasing trend towards organic farming has the potential to be beneficial to biodiversity by limiting use of chemical or synthetic fertilisers or pesticides as well as limit livestock density (though in some cases it may increase ammonia emissions and nitrate leaching from manure). In 2014 Switzerland had strong demand, with the world's highest per capita organic food consumption (OE, 2014). However, while organic farming increased significantly between the early 1990s and 2005, growth has since slowed, allowing countries such as Sweden to surpass Switzerland's previous high levels (Figure 5.13). Mountain cantons are leaders in organic farming, with the largest areas in Graubünden and Bern. In 2015, 13% of Swiss agricultural land was farmed organically (FOEN, 2017a). Organic farming is easier in the mountains, where there is primarily grassland, than on lower altitude farms that cultivate cereal or specialised crops (BDM, 2016).

Agricultural policy

Environmentally responsible farmers use a private eco-labelling initiative, IP-SUISSE, to attract consumers increasingly demanding environmental accountability. IP-SUISSE is an association of over 20 000 farmers who produce food using environment-friendly processes. To be certified, farmers must demonstrate that their production is free of genetically modified organisms and produced with limited and controlled amounts of fungicides and pesticides. One study showed that farmers following IP-SUISSE's guidelines had seen increases in species on their land of 33% for plants, 20% for butterflies and 12% for birds (Zellweger-Fischer and Birrer, 2015).

Switzerland reformed its agricultural support in the 1990s to reduce production distortions from market price support and require proof of ecological performance. While the level of farm support has gradually fallen, producer support remains among the highest in the OECD. However, the reforms have allowed for targeting certain regions, such as mountainous areas losing biodiversity-rich grasslands (OECD, 2015b; OECD, 2017b).

Figure 5.13. **Switzerland, an early leader in organic farming, has been overtaken by other OECD countries**



Note: 2005 and 2013 or closest available years.
Source: FAO (2016); *FAOSTAT* (database).

StatLink http://dx.doi.org/10.1787/888933572005

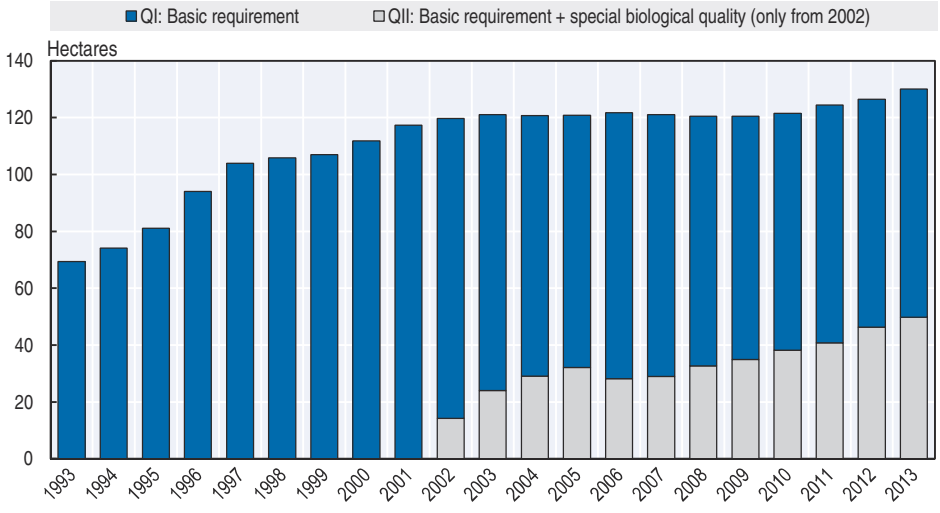
Environmental cross-compliance (direct payments to farmers tied to ecological performance) was introduced in 1993 and strengthened in 1999 to encourage, among other things, conservation and promotion of biodiversity in agricultural areas (OECD, 2010). To be eligible for direct payments, farmers must provide evidence of good ecological performance, including allocating at least 7% of agricultural land (3.5% for special crops) as biodiversity promotion areas (which until 2014 were called ecological compensation areas). Between 1993 and 2013, such areas increased in total size from 70 000 to 130 000 ha, accounting for 12.4% of the utilised agricultural area (Figure 5.14). In 2015, they covered around 15% of the utilised agricultural area, which demonstrates the incentive effect of the payments.

The strong participation of Swiss farmers in the biodiversity promotion areas programme reflects significant demand for this type of policy incentive. Two case studies conducted in the early 2000s by the Swiss Federal Research Station for Agroecology and Agriculture revealed that species diversity is higher on such areas than on intensively farmed land (FOEN, 2012b). However, a survey of compliance with agri-environmental targets set since 2008 showed that the sector had not attained the majority of objectives relevant to biodiversity, particularly in terms of quality and interconnection of habitats and ecosystems. The review highlights the need for greater efforts to maintain biodiversity in mountain regions and improve it at lower elevations (FOEN and FOAG, 2016).

Agriculture Policy 2014-17 reallocates direct payments to more closely align them with specific objectives, including biodiversity conservation. It also eliminates payments per head that had encouraged intensification of cattle farming (FOEN, 2014b). Agricultural direct payments totalled CHF 2.8 billion in 2015, of which payments for activities that explicitly support biodiversity conservation reached CHF 396 million, or 12% of all direct payments (OECD, 2016c). Additional work is needed to ensure that the remaining 88% have no harmful biodiversity effects.

Control of ammonia emissions falls under air policy. There are no specific agricultural payments to tackle ammonia pollution from agriculture, but many agricultural payments

Figure 5.14. **Biodiversity promotion areas (formerly ecological compensation areas) are eligible for direct payments**



Source: OFEV (2016b), Stratégie et plan d'action pour la biodiversité.

StatLink http://dx.doi.org/10.1787/888933572024

implicitly address it. There are technical regulations for manure storage and treatment (Federal Council, 2015). Pesticide use can also be subject to restrictions, such as maintaining a certain distance from surface water bodies. The Federal Council is considering a broader action plan to minimise pesticide risk to water bodies (Federal Council, 2015).

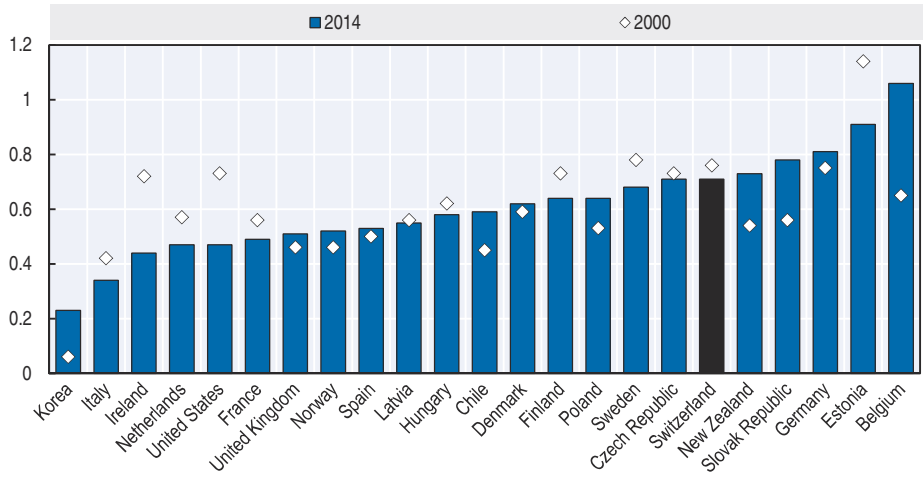
While agricultural policy reforms are moving in the right direction, more effective policies are needed to limit pesticide use and ammonia emissions in the sector, such as more directly tying of support payments to environmental performance and introducing regulations or taxes to control pesticides and ammonia (OECD, 2015a), something the government seems to be considering through an introduction of taxes on pesticides and farm nitrogen surpluses as of 2021 (Chapter 4).

5.2. *Forestry*

Trends relevant to biodiversity

Swiss forests are particularly important to biodiversity. Around 60% of the over 50 000 plants, animals, fungi and bacteria in the country rely on forest ecosystems (FOEN, 2013b). The forest area was reduced over the 19th century to a low of 0.7 million ha, but forests now represent 31% of Switzerland's surface area, or 1.28 million ha (FOEN, 2014b). Pressures on forests continue on the Swiss Plateau as a result of increasing population and infrastructure development as well as pollution and invasive species. Switzerland has higher levels of threatened forest-occurring mammals and fungi than other European countries but similar levels of other species (FAO and EFI, 2015). In general, the trend is towards forest regrowth at higher altitudes and forest loss at lower altitudes (FOEN, 2014b). Between 1995 and 2013, an average of 7.3 million m^3 was harvested annually, and an additional 1.8 million m^3 was lost to natural hazards (Federal Council, 2015). The Confederation is looking to increase the annual wood harvest, encouraging wood use as a low-carbon alternative to concrete, steel and fossil fuels (Federal Council, 2015). Switzerland already has one of the OECD's highest levels of forest resource use intensity (Figure 5.15). The total length of forest roads travelled by trucks

Figure 5.15. **Intensity of forest resource use is relatively high**



Note: 2000 and 2014 or closest available years. The indicator is a ratio of actual fellings to annual productive capacity (i.e. gross increment).
Source: OECD (2016a), "Depletion and growth of forest resources in terms of volume", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933572043

has increased by 969 km since 1995, contributing to landscape fragmentation (Section 1) (FOEN, 2017a).

Swiss forests are coming closer to natural regeneration, however, with 90% of mature timber established by natural seeding and a growing share of fallen and standing deadwood (largely a result of the 1999 "Lothar" windstorm) that provides species habitat. As a result, breeding birds relying on forest habitat are increasing in numbers and some larger predatory mammals such as wolves and bears are returning. The proportion of endangered species in forests is lower than in other ecosystems (FOEN, 2014b). While the situation has improved, there are not enough old forests, forests with high levels of deadwood, highly structured forest edges and young well-lit young forests to support biodiversity (Federal Council, 2015).

Forestry policy

The 1876 Forest Inspectorate Act prohibiting clear-cutting was a turning point in reducing forest loss (FOEN, 2014b). While it does not allow for a decrease in forest area, it does allow options for compensation of forest losses, such as offsets (FOEN, 2014b). The 1991 Forest Act required increased standardisation of all cantonal regulations (Angst, 2012). Forest Policy 2020, adopted by the Federal Council in 2011, includes biodiversity conservation and improvement as an objective. The policy is founded on the principle of near-natural silviculture, which promotes natural regeneration where possible, tailors tree species to local conditions, conserves and promotes forest habitat diversity and protects the natural soil fertility. It also promotes interconnection of forest ecosystems, with each other and with other ecosystems, to improve biodiversity conservation (FOEN, 2012a; Angst, 2012). Over 50% of the Swiss forest area is certified through harmonised criteria of the Forest Stewardship Council and the Programme for the Endorsement of Forest Certification (FOEN, 2017a).

National forest policy implementation was initially supported by subsidies for afforestation and promoting the use of wood as a building material. In the 1980s, support was extended to include mountain forest management. Financial support to the forestry sector is around CHF 135 million per year. When cantonal contributions are included, the

amount increases to about CHF 230 million. Around 46% of federal funding is for forest protection, 30% for protection against natural hazards, 10% for forest management and 7% for forest biodiversity. An additional CHF 20 million was added in 2016 for adaptation to climate change. Forest Policy 2020 recommended increasing biodiversity-related payments in the forest sector from the current CHF 10 million a year to about CHF 38 million. The cantons vary in terms of how they distribute their contributions across categories. Implementing the forestry components of the biodiversity action plan will require an increase in subsidies or other measures (FOEN, 2015c).

Subsidies also exist for protection of mountain forests, which provide important ecosystem services, such as natural habitat for many species and a barrier against avalanches and other hazards. Half the Swiss forest area has protective functions whose maintenance costs are a fraction of what construction of hazard protection structures would cost taxpayers. Forest managers are obligated to monitor and improve forest structure, with costs covered by a mix of funding from all three government levels. The amount of assistance is determined by the protective area to be maintained, the risk to be avoided and the impact of the measures, leading to a large variation in the amounts – from CHF 3 000 to CHF 43 000 per hectare (Losey, 2014). On average, the Confederation allocates CHF 60 million per year for protective forest.

While subsidies encourage forest protection, the policy of increasing annual wood harvesting rates is potentially inconsistent with the biodiversity objectives in Forest Policy 2020 and commitments to protect 8% of forest by 2020 and 10% by 2030. Careful policy implementation is required to ensure coherence, protecting areas of high value to biodiversity while maintaining harvest rates at sustainable levels. Only 5.6% of the forest area is protected as forest reserves, and Switzerland has among the lowest levels of forest protection in Europe (FAO and EFI, 2015). Further effort beyond subsidies is needed to increase protection of forested areas, particularly those that are of high biodiversity value, and to minimise forest landscape fragmentation and species habitat disturbance while increasing elements beneficial to biodiversity, such as deadwood volumes. Expanding protected areas in forest ecosystems is important, but Switzerland could also consider fees and payments for ecosystem services (paid by forest users) reflecting forests' value in terms of CO_2 removal, oxygen production, water purification, climate modification, soil stabilisation, water regulation and wind breaks. Such a regime could discourage harvesting in high-value ecosystems while raising revenue for additional conservation programming.

5.3. Energy

Trends relevant to biodiversity

The planned shift away from nuclear power towards hydropower, other renewables, cogeneration and gas-fired power could harm biodiversity if not managed carefully. Hydropower generation can significantly affect aquatic ecosystems and water use, and wind turbines may pose a threat to birds. Irregular water discharges from hydropower plants (hydropeaking) disrupt aquatic organism habitats downstream (BDM, 2016). Hydroelectric plants account for 50% to 60% of the electricity produced in Switzerland. Some experts say that more than 90% of watercourses that can be exploited are already used for hydropower production. Others contend that only about 30% of the total energy contained in Swiss rivers is currently used to generate electricity, and it may be possible to increase the share without relaxing environmental and water protection laws. All in all, the more informed estimates concur that there is about a 10% hydropower production increase potential by 2050

(SCNAT, 2016b, Chapter 4). Wind represents a relatively small share of electricity production but there is potential to increase it, with attractive sites in the Jura and Alps (SFOE, 2016).

Hydropower stations cause insufficient residual water volumes in many locations and affect natural conditions with their alteration between water surge and low flow. While newly licensed hydropower plants must meet tight minimum flow requirements, much less stringent requirements apply to existing plants (Federal Council, 2015).

Energy policy

Energy Strategy 2050 requires minimisation of conflict between energy projects and biodiversity through guidelines for energy project development on top of EIA requirements (Section 4.10) (FOEN, 2012a). For example, any hydropower expansion must take valuable water bodies into consideration and have capacity greater than 1 MW so as to limit the number of facilities (Federal Council, 2015). The 2011 amendments to the Water Protection Act also require reduction of hydropeaking, sediment transport changes and fish migration obstacles by 2030, with provision for compensation for rehabilitation costs (paid via a surcharge on high-voltage power transmission networks) (Federal Council, 2015) (Chapter 4).

5.4. Tourism

Trends relevant to biodiversity

Tourism is an important sector of the economy, providing 4.6% of export revenue in 2013 (FST, 2014). Biodiversity is a key factor in the tourist industry; for instance, monetary estimates of the recreation value of forests are around CHF 10 billion (FOEN, 2014b). Ecosystem deterioration can pose a risk to tourism. In Lake Zurich, for example, warming waters combined with excess nutrients led to an explosion of algae, including a cyanobacterium that can harm humans, fish and wildlife (Rex, 2013). Tourism can also hurt biodiversity, with sport and recreation in alpine and subalpine regions being a particular risk (Box 5.4) (Fischer et al., 2015).

Box 5.4. **Outdoor snow sport affects black grouse in the Alps**

In 2013, the University of Bern published a case study on the impact of snow sport on black grouse in the Alps. The Alps, which form part of nearly a dozen European countries, are the top global destination for winter activities such as skiing and snowboarding, with the number of ski resorts and off-trail backcountry activities continuing to grow.

The black grouse was selected as an indicator species to demonstrate the impact of sport on alpine wildlife. The bird is an ideal species to assess, since it inhabits the treeline ecosystems where most outdoor winter sport takes place and is highly dependent on the habitat for reproduction.

Researchers measured the birds' stress hormone in faeces collected from snow burrows to assess their stress response to human disturbance. They found that black grouse living in natural treeline habitats had significantly lower concentrations than those in ski resort areas or areas with backcountry activities. The findings imply that the birds need areas with almost no disturbance to avoid negative effects.

They also found that the black grouse moved away from areas with snow sport, using them less frequently or abandoning them altogether. While the impact was lower with backcountry activities, the activities covered a larger area than ski resorts.

Box 5.4. **Outdoor snow sport affects black grouse in the Alps** *(cont.)*

The authors identified 31 critical conflict zones in Switzerland's Valais canton that should be priorities for wildlife refuges free of disturbance, such as those established near ski resorts in Germany's Bavarian Alps. They recommended refuges of about 40 ha that are clearly marked, combined with information provision and education as well as fines for not respecting the boundaries. The creation of refuges would benefit not only the black grouse, but also other alpine wildlife threatened by the expansion of snow sport.

Source: Arlettaz et al. (2013), *Impacts of Outdoor Winter Recreation on Alpine Wildlife and Mitigation Approaches: A Case Study of the Black Grouse, www.researchgate.net/publication/258689301_Impacts_of_Outdoor_Winter_Recreation_on_Alpine_Wildlife_and_Mitigation_Approaches_A_Case_Study_of_the_Black_Grouse.*

Tourism policy

The Swiss Biodiversity Strategy includes a commitment to integrate biodiversity into sport and tourism policy, promoting nature-compatible services and infrastructure. It also calls for more controls on tourism, sport and leisure activities by setting conditions and limiting visitors in ecologically sensitive areas. A further commitment in the strategy is to protect remote areas from large visitor volumes by conserving and creating attractive local recreational areas as alternative destinations (FOEN, 2012a). Commitments to reconcile tourism with nature protection are also included in the FOEN sport and tourism strategy (2010-12), the Landscape Concept (Goal 3) and the Federal Council's growth strategy for Switzerland as a tourist destination (2010). However, none of the strategies provide details on actions, other than provision of working groups and educational material.

More specific and targeted efforts will be needed to protect biodiversity from expanding tourism, particularly in previously undisturbed areas, as well as to reconcile tourism development ambitions with biodiversity protection (a shortcoming in the recent referendum on a second national park). The German approach of establishing wildlife refuges on the margins of ski resorts could be considered, for example, if biodiversity were adequately integrated into land use planning and EIA processes. There is also scope to introduce or increase fees for tourism operators in biodiverse (often remote) mountainous areas.

5.5. *Transport infrastructure*

Transport infrastructure, including roads and railways, is a significant contributor to landscape fragmentation, which limits the freedom of movement of wild animals, amphibians, reptiles and small mammals, increases the risk of accidents from traffic and reduces habitat size (BDM, 2010). Air pollutants, noise and light disturbances can also harm biodiversity (ARE, 2016). Swiss transport infrastructure covers around 952 km^2, up roughly 16% over three decades, and transport demand is expected to continue to rise significantly to 2040 (Federal Council, 2015, ARE, 2016).

While measures such as heavy vehicle charges and road tolls encourage use of Switzerland's high-quality rail system to reduce road demand, fragmentation remains a concern for biodiversity (Sections 1 and 3) and environmental externalities are not yet fully accounted for in transport costs. One study estimated the cost of fragmentation and habitat loss from the Swiss transport system at CHF 1 billion, and biodiversity loss from traffic-related air pollution at nearly CHF 140 million (ARE, 2016).

The biodiversity strategy aims to avoid additional fragmentation by favouring further development of existing transport infrastructure over new construction. It also aims to improve interconnection of habitats and species populations through new or improved wildlife corridors that are incorporated into master plans and zoning plans (FOEN, 2012a). As Section 1 noted, however, wildlife corridors are currently inadequate and require significant investment to improve their functionality.

Recommendations on biodiversity conservation and sustainable use

Status, trends and pressures on biodiversity

- Create a national ecosystem map that identifies priorities for action in terms of protection, pressures and corridors, considering threatened ecosystems and species, as a basis for establishing a more formal and legally binding tool for spatial planning.

Institutional, legal and strategic framework

- Move forward with implementation of the action plan for the Swiss Biodiversity Strategy, pursuing measures with quantified objectives, clear indicators to measure progress and adequate human and financial resources for implementation.
- Work with NGOs, the private sector and education systems to raise biodiversity awareness, engage further with local communities through dialogue on sustainable local development, and develop tools and guidelines for reporting their impact and contributions to biodiversity conservation.

Instruments for biodiversity conservation and sustainable use

- Develop policies, programmes and action plans to meet Switzerland's commitment to protect at least 17% of its territory by 2020, and increase the volume and quality of ecosystem and species protection, by expanding protected areas and other area-based conservation measures to address gaps and improve connectivity within Switzerland and with neighbouring countries; for instance, the Emerald Network should be expanded and co-ordination with Natura 2000 strengthened.
- Increase federal, cantonal and communal funding consistent with the Swiss Biodiversity Strategy and action plan, either through larger public appropriations or by finding alternative sources of revenue, such as economic instruments, which could include taxes on pesticide use and farm nitrogen surpluses and charges for use of ecosystem services; the complete system of agricultural direct payments should be focused so as to holistically optimise biodiversity-related incentives.
- Dedicate resources towards identifying and phasing out subsidies and tax incentives with harmful effects on biodiversity, and redirect tax instruments towards behaviour favouring the conservation and sustainable use of biodiversity, including for landscape management, where incentives within the fiscal system encourage urban sprawl.

Mainstreaming biodiversity into economic sectors

- Pursue efforts to strengthen the potential of the agricultural sector to support biodiversity by selecting biodiversity promotion areas based on environmental objectives (e.g. ecological infrastructure) rather than agricultural objectives.
- Ensure that forestry policy is consistent with biodiversity objectives, and with the national goal of protecting 8% of forest area by 2020 and 10% by 2030; explore opportunities to use economic instruments for forest conservation, such as fees and payments for ecosystem services paid by forest users, while promoting increased private certification.

Recommendations on biodiversity conservation and sustainable use *(cont.)*

- Pursue measures to mitigate the impact of tourism and transport infrastructure on biodiversity, such as improving wildlife corridors, introducing fees for tourism operators and developing biodiversity refuges adjacent to ski resorts.

References

AC (2017), *Alpine Convention: State of Ratifications,* Alpine Convention, *www.alpconv.org/en/convention/ratifications/default.html*.

Angst, M. (2012), *Integration of Nature Protection in Swiss Forest Policy,* Country report for the research project INTEGRATE (Integration of nature protection in forest management) of the Central European Office of the European Forest Institute (EFICENT), Swiss Federal Research Institute for Forest, Snow and Landscape, *www.wsl.ch/publikationen/pdf/11873.pdf*.

ARE (2017), *The Alpine Convention,* Federal Office for Spatial Development, Bern, *www.are.admin.ch/are/en/home/laendliche-raeume-und-berggebiete/internationale-zusammenarbeit/alpine-convention.html*.

ARE (2016), *External Costs and Benefits of Transport in Switzerland; Road, Rail, Air and Waterborne Transport from 2010 to 2013*, Federal Office for Spatial Development, Bern, *www.are.admin.ch/dam/are/en/dokumente/verkehr/publikationen/externe_kosten_undnutzendesverkehrsinderschweiz.pdf.download.pdf/external_costs_andbenefitsoftransportinswitzerland.pdf*.

Arlettaz, R. et al. (2013), *Impacts of Outdoor Winter Recreation on Alpine Wildlife and Mitigation Approaches: A Case Study of the Black Grouse*, University of Bern, *www.researchgate.net/publication/258689301_Impacts_of_Outdoor_Winter_Recreation_on_Alpine_Wildlife_and_Mitigation_Approaches_A_Case_Study_of_the_Black_Grouse?enrichId=rgreq-87fca207cdf5e958e7ec506ff9af9746-XXX&enrichSource=Y292ZXJQYWdlOzI1ODY4OTMwMTtBUzo5OTgxMTQ0NTQ0NDYxNkAxNDAwODA4MzExMzEz&el=1_x_2&_esc=publicationCoverPdf*.

BDM (2016), *Biodiversity Indicators*, Biodiversity Monitoring Switzerland, *www.biodiversitymonitoring.ch/en/home.html*.

BDM (2010), *Landscape Fragmentation,* Biodiversity Monitoring Switzerland, *www.biodiversitymonitoring.ch/en/home.html*.

Blöchliger, H. et al. (2017), *Local Taxation, Land Use Regulation, and Land Use: A Survey of the Evidence*, OECD Economics Department Working Papers, N° 1375, OECD Publishing, Paris, *http://dx.doi.org/10.1787/52da7c6a-en*.

Bontadina et al. (2001), *The Lesser Horseshoe Bat Rhinolophus hipposideros in Switzerland: Present Status and Research Recommendations,* Swiss Coordination Centre for the Study and Protection of Bats, Zürich and Geneva, *www.researchgate.net/publication/228083819_The_lesser_horseshoe_bat_Rhinolophus_hipposideros_in_Switzerland_Present_status_and_research_recommendations*.

CBD (2017), *Financial Reporting Framework of the Clearing-House Mechanism* (database), Secretariat of the Convention on Biological Diversity, Montreal, *https://chm.cbd.int/database/record/30F64DF1-7937-75AD-24D0-AE53B6FADD46* (accessed May 2017).

CBD (2016a), *Country Profile: Switzerland*, Secretariat of the Convention on Biological Diversity, Montreal, *www.cbd.int/countries/?country=ch*.

CBD (2016b), *Financial Reporting Framework* (database), *https://chm.cbd.int/fr/database/record/206788* (accessed March 2017).

CY (2013), *The Yokohama Green-up Plan,* City of Yokohama, *www.city.yokohama.lg.jp/kankyo/midoriup/english/images/the-yokohama-green-up-plan.pdf*.

Dictionnaire historique de la Suisse (2015), *Forêt, www.hls-dhs-dss.ch/textes/f/F7849.php?topdf=1*.

European Commission (EC) (2015), "The State of Nature in the European Union", Report on the status of and trends for habitat types and species covered by the Birds and Habitats Directives for the 2007-2012 period, Report from the Commission to the Council and the European Parliament, COM(2015) 219 final, Brussels, *http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0219&from=EN*

Ecoplan (2013), *Finanzielle Anreize bezüglich Biodiversität optimieren,* Economic Research and Policy Consultancy, Bern.

EDA (2016), *Geography*, Federal Administration of Switzerland, *www.eda.admin.ch/aboutswitzerland/en/home/umwelt/geografie.html*.

EEA (2015), *State of Environment (SOE)*, European Environment Agency, Copenhagen, *www.eea.europa.eu/soer-2015/countries/switzerland*.

EEA (2013), *The European Grassland Butterfly Indicator: 1990-2011*, Luxembourg, *www.eea.europa.eu/publications/the-european-grassland-butterfly-indicator-19902011/at_download/file*.

EEA and FOEN (2016), *Urban Sprawl in Europe,* EEA Report N° 11/2016, European Environment Agency and Federal Office for the Environment, Copenhagen and Bern, *www.eea.europa.eu/publications/urban-sprawl-in-europe*.

ES (2015), *Rapport du Conseil fédéral,* Environnement Suisse, *www.bafu.admin.ch/dokumentation/15710/15711/index.html?lang=fr*.

Eurostat (2017a), Pesticide sales (database), *http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tai02&plugin=1* (accessed April 2017).

Eurostat (2017b), Consumption of inorganic fertilizers (database), *http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=aei_fm_usefert&lang=en* (accessed April 2017).

FAO (2016), *FAOSTAT* (database), Food and Agriculture Organization of the United Nations, Rome, *www.fao.org/faostat/en/#home* (accessed April 2017).

FAO and EFI (2015), *State of Europe's Forests 2015,* Ministerial Conference on the Protection of Forests in Europe, Madrid, Food and Agriculture Organization of the United Nations and European Forest Institute, *www.foresteurope.org/docs/fullsoef2015.pdf*.

Federal Council, KdK, BPUK, SSV and SGV (2012), *Raumkonzept Schweiz*, Bern, *www.are.admin.ch/are/fr/home/media-et-publications/publications/strategie-et-planification/raumkonzept-schweiz.html*.

Federal Council (2015), *Environment Switzerland 2015, www.bafu.admin.ch/dam/bafu/en/dokumente/allgemein/uz-umwelt-zustand/umwelt_schweiz_2015.pdf.download.pdf/environment_switzerland2015.pdf*.

Fischer, M. et al. (2015), *État de la biodiversité en Suisse en 2014 : Une analyse scientifique,* Forum Biodiversité Suisse et al., Bern, *www.sciencesnaturelles.ch/organisations/biodiversity/publications/35223-etat-de-la-biodiversite-en-suisse-en-2014---une-analyse-scientifique*.

FOEN (2017a), *Biodiversity in Switzerland: Status and Trends – Results of the Biodiversity Monitoring System in 2016,* State of the Environment N° 1630, Federal Office for the Environment, Bern.

FOEN (2017b), *Switzerland's Informative Inventory Report 2017 (IIR)*, submission under the UNECE Convention on Long-range Transboundary Air Pollution, March 2017, Federal Office for the Environment, Bern, *www.bafu.admin.ch/dam/bafu/fr/dokumente/luft/fachinfo-daten/switzerland_s_informativeinventoryreport2016iir.pdf.download.pdf/switzerland_s_informativeinventoryreport2017iir.pdf*.

FOEN (2016a), *Indicator Wildlife corridors, www.bafu.admin.ch/bafu/en/home/themen/thema-biodiversitaet/biodiversitaet--daten--indikatoren-und-karten/biodiversitaet--indikatoren/indikator-biodiversitaet.pt.html/aHR0cHM6Ly93d3cuaW5kaWthdG9yZW4uYWRtaW4uY2gvUHVibG/ljL0FlbURldGFpbD9pbmQ9QkQwNjcmbG5nPWVuJlN1Ymo9Tg%3d%3d.html*.

FOEN (2016b), *Stratégie et plan d'action pour la biodiversité*, Federal Office for the Environment, Bern, *www.bafu.admin.ch/bafu/fr/home/themes/biodiversite/info-specialistes/mesures-de-conservation-de-la-biodiversite/strategie-et-plan-daction-pour-la-biodiversite.html*.

FOEN (2016c), *Stratégie de la Suisse relative aux espèces exotiques envahissantes*, Federal Office for the Environment, Bern, *www.bafu.admin.ch/dam/bafu/fr/dokumente/biodiversitaet/fachinfo-daten/strategie_der_schweizzuinvasivengebietsfremdenarten.pdf.download.pdf/strategie_de_la_suisserelativeauxespecesexotiquesenvahissantes.pdf*.

FOEN (2015a), *Assessing Private Sector Investments for Biodiversity*, presentation in Mexico City, Federal Office for the Environment, Bern, *www.cbd.int/doc/meetings/fin/rmem-2015-01/other/rmem-2015-01-presentation-05-en.pdf*.

FOEN (2015b), *Forest and Wood in Switzerland*, Federal Office for the Environment, Bern, *www.bafu.admin.ch/bafu/en/home/topics/forest/publications-studies/publications/forest-and-wood-in-switzerland.html*.

FOEN (2015c), *Forest Report 2015: Condition and Use of Swiss Forests*, Federal Office for the Environment, Bern, *www.bafu.admin.ch/bafu/en/home/topics/forest/publications-studies/publications/forest-report-2015.html*.

FOEN (2014a), *Swiss Biodiversity Monitoring BDM, www.bafu.admin.ch/bafu/en/home/topics/biodiversity/publications-studies/publications/biodiversity-monitoring.html*.

FOEN (2014b), *Switzerland's Fifth National Report under the Convention on Biological Diversity*, Federal Office for the Environment, Bern, *www.cbd.int/doc/world/ch/ch-nr-05-en.pdf*.

FOEN (2013a), *Swiss Environmental Law*, Federal Office for the Environment, Bern, *www.bafu.admin.ch/bafu/en/home/topics/law/publications-studies/publications/swiss-environmental-law.html*.

FOEN (2013b), *Forest Policy 2020*, Federal Office for the Environment, Bern, *www.bafu.admin.ch/bafu/en/home/topics/forest/publications-studies/publications/forest-policy-2020.html*.

FOEN (2012a), *Swiss Biodiversity Strategy*, Federal Office for the Environment, Bern, *www.bafu.admin.ch/ud-1060-e*.

FOEN (2012b), *Basic Data from Biodiversity Monitoring Switzerland (BDM) – Ecological Compensation Areas*, Federal Office for the Environment, Bern, *www.biodiversitymonitoring.ch/fileadmin/user_upload/documents/daten/basisdaten_en/1180_M4_Basisdaten_2012_V1_En.pdf*.

FOEN (2010), *Switzerland's Fourth National Report under the Convention on Biological Diversity*, Federal Office for the Environment, Bern, *www.cbd.int/doc/world/ch/ch-nr-04-en.pdf*.

FOEN (1998), *Swiss Landscape Concept*, Federal Office for the Environment, Bern, *www.sib.admin.ch/fileadmin/_migrated/content_uploads/VU-8004-F_2010_01.pdf*.

FOEN and FOAG (2016), *Objectifs environnementaux pour l'agriculture, Rapport d'état 2016*, Federal Office for the Environment and Federal Office for Agriculture, Bern, *www.bafu.admin.ch/uw-1633-f*.

FSO (2016), *Environment: Pocket Statistics 2016*, Federal Statistical Office, Neuchâtel, *www.bfs.admin.ch/bfs/fr/home/statistiques/espace-environnement.assetdetail.530973.html*.

FST (2014), *Swiss Tourism in Figures 2014*, Fédération Suisse du Tourisme, *www.swisstourfed.ch/files/infothek/Vademecum/2015/STiZ_2014_en.pdf*.

GISD (2016), *Harmonia Axyridis*, Global Invasive Species Database, *http://iucngisd.org/gisd/species.php?sc=668*.

Info Flora (2017), *www.infoflora.ch/en/* (accessed March 2017).

IUCN (2011), *The Business Case for Biodiversity: Switzerland*, Briefing document, International Union for Conservation of Nature, Gland, *http://cmsdata.iucn.org/downloads/the_business_case_for_biodiversity_1.pdf*.

Jørgensen, K. et al. (2016), *Mainstreaming Landscape through the European Landscape Convention*, Routledge.

Losey, S. (2014), "Protection Forest Management in Switzerland", presentation to the European Foresters' Orienteering Championships, *www.nouvelleforet.ch/efol/EFOL_forest_seminar_Losey_OFEV.pdf*.

OE (2014), *Country Report – Switzerland*, Organic Europe, *www.organic-europe.net/country-info/switzerland/country-report.html*.

OECD (2017a), *OECD International Development Statistics* (database), *http://dx.doi.org/10.1787/dev-data-en* (accessed May 2017).

OECD (2017b), *The Political Economy of Biodiversity Policy Reform*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264269545-en*.

OECD (2016a), *OECD Environment Statistics* (database), *http://dx.doi.org/10.1787/env-data-en*.

OECD (2016b), "Biodiversity Offsets: Overview and Insights for Good Practice", in *Biodiversity Offsets: Effective Design and Implementation*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264222519-4-en*.

OECD (2016c), *Agricultural Support Estimates* (database), *http://dx.doi.org/10.1787/83ff9179-en* (accessed 25 November 2016).

OECD (2015a), *Environment at a Glance 2015: OECD Indicators*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264235199-en*.

OECD (2015b), *OECD Review of Agricultural Policies: Switzerland 2015*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264168039-en*.

OECD (2013), *Scaling-up Finance Mechanisms for Biodiversity*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264193833-en*.

OECD (2010), "Environmental Cross Compliance in Agriculture", background report for the Joint Working Party on Agriculture and the Environment, Paris, *www.oecd.org/tad/sustainable-agriculture/44737935.pdf*.

OECD (2007), *OECD Environmental Performance Reviews: Switzerland 2007*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264030541-en*.

OECD (2003), *OECD Environmental Indicators: Development, Measurement, and Use*, Reference Paper, Paris, *www.oecd.org/env/indicators-modelling-outlooks/24993546.pdf*.

ÖSL (2016), Berücksichtigung von Ökosystemleistungen in der Planung – Eine Arbeitshilfe *(Consideration of Ecosystem Services in Planning – A Work Aid)*, Ökosystemleistungen, Zürich, *http://oesl-check.ethz.ch/index.php*.

PNS (2016), *Switzerland,* Parc Naziunal Svizzer, *www.nationalpark.ch/en/about/about-us/other-protected-areas/switzerland*.

Pro Natura (2017), "*Allegra Pierre le Chevrier": des chèvres, ânes et autres bovins paissent pour la biodiversité ("Allegra Peter the Goatherd": goats, donkeys and bovines graze for biodiversity*), Cheseaux-Noréaz, *www.pronatura.ch/allegra-pierre-le-chevrier*.

Pro Natura (2016), *Réserves naturelles – plus de 600 cadeaux pour vous*, *www.pronatura.ch/reserves-naturelles*.

Rex, E. (2013), "Harmful Algal Blooms Increase as Lake Water Warms", *Scientific American*, *www.scientificamerican.com/article/harmful-algal-blooms-increase-as-lake-water-warms*.

Rodewald, R. and C. Neff (2001), *Bundessubventionen – landschaftszerstörend oder landschaftserhaltend? Praxis-analyse und Handlungsprogramm?*, Stiftung Landschaftsschutz Schweiz, Bern.

Roth, T. et al. (2014), "Plants, Birds and Butterflies: Short-Term Responses of Species Communities to Climate Warming Vary by Taxon and with Altitude", *PLoS ONE*, 9(1), *http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0082490*.

Schaub, A. and S. Welte (2017), UNIVOX Umwelt 2016, gfs-zürich, *http://gfs-zh.ch/wp-content/uploads/2017/03/Univox-Umweltbericht-2016.pdf*.

SCNAT (2016a). *Engaging Politics with Science,* Swiss Academy of Arts and Sciences, *www.academies-suisses.ch/fr/dms/publikationen/10/report1005e.pdf*.

SCNAT (2016b), *Water Exploitation, Water Use, Water Consumption, www.naturalsciences.ch/topics/water/water_exploitation*.

SIB (2014), *NFA Manual Regarding the Environment*, Swiss Information System Biodiversity, Bern, *www.sib.admin.ch/en/documentation/publications-addressing-biodiversity/2008/nfa-manual-regarding-the-environment/*.

SFOE (2016), *Renewable Energy,* Swiss Federal Office of Energy, Bern, *www.bfe.admin.ch/themen/00490/index.html?lang=en*.

SVS/BirdLife Suisse (2017), *www.birdlife.ch/fr/content/emeraude%20* (accessed January 2017).

SVS/BirdLife Schweiz (2013), *Biodiversität und Ökosystemleistungen*, *www.birdlife.ch/birdlife_shop&func=view&itemid=758*.

Swiss Parks (2016), *Closer than you Think, www.swiss-parks.ch/en/swiss-parks*.

ten Kate, K. et al. (2004), *Biodiversity Offsets: Views, Experience, and the Business Case,* IUCN and Insight Investment, Gland and London, *www.iucn.org/content/biodiversity-offsets-views-experience-and-business-case*.

Trame verte et bleue (2017), *Centre de ressources pour la mise en œuvre de la trame verte et bleue*, *www.trameverteetbleue.fr*.

Universitat Bern (2016), *Conservation Biology: Lesser Horseshoe Bat, www.cb.iee.unibe.ch/research/lesser_horseshoe_bat/index_eng.html*.

Vittoz, P. et al. (2012), "Climate Change Impacts on Biodiversity in Switzerland: A Review", *Journal for Nature Conservation*, 21(3), *www.sciencedirect.com/science/article/pii/S1617138112001215*.

Waltert, F. et al. (2010), *Fiskalische Instrumente und Flächeninanspruchnahme,* Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), FOEN, ARE, Bern, *https://biblio.parlament.ch/e-docs/353580.pdf*.

WSL (2017), website of the Swiss Federal Institute for Forest, Snow and Landscape Research, *www.wsl.ch/index_EN* (accessed 1 June 2017).

Zellweger-Fischer, J. and S. Birrer (2015), *Système à points biodiversité d'IP- SUISSE – Évolution des exploitations label 2015,* Station ornithologique suisse, Sempach, *www.vogelwarte.ch/assets/files/publications/upload2016/Zellweger-Fischer_Birrer%202015%20-%20Systeme%20a%20points%20biodiversite%20d%20IP-SUISSE%20-%20Evolution%20des%20exploitations%20label%202015.pdf*.