Maintaining the genetic diversity of wild species in Scotland

Case Study Database

A compilation of good practices and lessons learned to bring innovative subnational solutions to global problems

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Chanterelle fungi and moss, Glen Affric National Nature Reserve, East Highland Area. ©Lorne Gill/SNH

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Introduction

Genetic diversity is key to the resilience of species and habitats, and thereby underpins the ecosystem services we gain from them. It allows biodiversity to adapt in the face of pressures, including climate change.

At a global level, we are losing biodiversity at an unprecedented rate.

However, we have little understanding of how much genetic diversity we are losing, how this might affect us and what is being done to halt that loss. Since most actions to safeguard biodiversity occur at a regional or subnational scale, there is a clear need for a tool to assess the status of genetic diversity and thus focus efforts at that level.

Author

NatureScot & Royal Botanic Garden Edinburgh

Summary

A partnership including the Royal Botanic Garden Edinburgh, NatureScot and other Scottish Government agencies, research bodies, universities, and NGOs developed a regional approach for the conservation of genetic diversity suited to Scotland and applicable internationally. To achieve this, a set of criteria was identified for defining terrestrial and freshwater species of socio-economic importance in Scotland, and an initial list of species was selected.

A simple, readily applicable Scorecard method was created for assessing risks to the conservation of genetic diversity in these species and the effectiveness of conservation measures in place. The Scorecard approach is not dependent on prior genetic knowledge, technology or expensive resources, and instead uses structured expert opinion assessments. This was originally designed for reporting under the Aichi Framework but has wider applicability. The list is currently being expanded to include marine species and a local-scale version of the Scorecard is being developed for use by local communities and land managers.

Key Information

Location: Scotland, UK

Areas of interest: Genetic diversity, conservation, adaptation, environmental protection

Founded in: 2018

Investment: Amount of investment per year or per project in US$: <$20,000

Aichi Biodiversity Targets addressed:

Aichi target 13 "By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socioeconomically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity."

Sustainable Development Goals addressed: "Genetic resources are contributing to poverty alleviation (SDG 1), food security (SDG 2), good health and wellbeing (SDG 3), gender equality (SDG 5), innovation (SDG 9) and life on land (SDG 15)."[1]

Kunming-Montreal Global Biodiversity Framework Targets addressed: KM-Goal A "The genetic diversity within populations of wild and domesticated species, is maintained, safeguarding their adaptive potential."

[1] https://www.undp.org/publications/abs-genetic-resources-sustainable-development

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BACKGROUND AND CONTEXT

Genetic diversity is the differences among individuals due to differences in their DNA sequence. This concept encompasses genetic variability, which pertains to the number and characteristics of different types of organisms, and genetic distinctiveness, which indicates how different and unique an organism is compared to others.

- Genetic variability relates to the presence of different genetic types, with the focus being on the number and characteristics of different genetic types.
- Genetic distinctiveness relates to the degree of difference between entities, including factors such as evolutionary divergence in wild species —where lineages that have been isolated for extended periods become genetically distinct—and genetic purity, as seen in domesticated entities bred to conform to specific standards, like rare livestock breeds.

Studies have shown that genetic diversity has been lost at a global and European scale. This loss can reduce fitness and elevate extinction risks of varieties, populations and species. In turn this can impede future adaptive responses to environmental change, such as to climate change or new pest and pathogens. As a result, ecosystems become less resilient to change and may become unable to provide us with the goods and benefits we currently receive. Nature supports humanity through the provision of food and materials, regulating and mediating natural flows, and the cultural and spiritual value people gain from nature. Collectively these valuable functions are known as ecosystem services, which in turn lead to the public goods and benefits we derive from them. Genetic diversity loss also reduces the genetic resources available to enhance species traits for human use.

The Convention on Biological Diversity had from its inception recognised the essential role of genetic diversity but even as late as the Aichi targets (2010), reporting remained largely focussed on domesticated species and their wild relatives. This project sought to foster the safeguarding of genetic diversity in Scotland's wild species, both for its own sake and for the benefits that accrue to people.

Biodiversity is devolved within the United Kingdom to the four countries and the Scottish Government had committed to an independent report on progress against the Aichi targets. As part of this process, a group of scientists from Scottish Government's Environment, Natural Resources and Agriculture Research Portfolio came together under the auspices of the Scottish Environment, Food and Agriculture Research Institutions (SEFARI) to design and implement a new approach to reporting on genetic diversity.

The working group had the benefit of the UK Strategy for Forest Genetics Resources, which was launched in 2019. However, the methods and key issues for genetic conservation vary markedly for other plants and for animals and fungi. Thus, the group had to pioneer a completely new approach.

The group was keen to develop a framework that could be used in any region or country, regardless of development level. The pressures that have led to loss of genetic diversity are not confined to Scotland: they are global. Indeed, regions closer to the equator tend to be home to greater diversity and thus have potentially more to lose. The group aspired to make it easier to assess threats and opportunities without the use of expensive technologies that might be prohibitive for species-rich economically poor regions. This in turn could help such regions maximise the ecosystems services that genetic diversity underpins.

Promotion of pollinator-friendly management provides an opportunity for lowland populations of raspberry (Rubus idaeus) to increase.

KEY ACTIVITIES AND INNOVATIONS

The project began with a workshop hosted by the Royal Botanic Garden Edinburgh with support and funding from SEFARI. They identified that whilst there were good data and existing assessment methods for species of agricultural and horticultural importance, there was no strategy to cover wild species. However, since producing assessments for every living species in Scotland was clearly not feasible, the workshop had to develop a selection process to focus on representative species to add to those already reported upon from domesticated species. The group built upon the wording of the Aichi Targets: "...other socioeconomically as well as culturally valuable species..." to develop selection criteria.

Cultural and economic valuation is clearly subjective. It depends on whom one asks and what is taken into account. The group looked at five categories that could cover aspects of societal value, but recognised that other criteria might also be useful in other regions and that there should be flexibility to refine or change these categories. The agreement was that as long as the selection method was transparent, other users could modify it to suit their needs. The five categories are:

- **Conservation priorities**
- **Culturally important**
- **Regulating Ecosystem Services provider**
- **Food/Medicines**
- **Meat/Game**

The group then sought information on species that best exemplified these categories. Conservation priorities were selected from NatureScot's Species Action Plan, with an effort to ensure that a wide taxonomic range of species was included: fungus, plants, vertebrate and invertebrate animals. Culturally important species were taken from the most popular species identified in a public survey. Regulating ecosystems services providers were plants which form the bases of widespread habitats important for carbon capture and flood amelioration, along with a widespread predator of invertebrate pests. Whilst the collection of wild plants and fungi for food and medicine is not an economically important activity, it is still an important tradition both in rural areas and amongst urban dwellers wishing to spend time in nature, so the most frequently gathered species were collated under this category.

Finally, species hunted for game that contribute to rural economies were included based on data from hunting organizations. It should be noted that some species can be classed in more than one category, for example heather is both culturally important and an ecosystem service provider.

The project coordinators approached an expert for each species and asked them to assess the current threats and likely future issues for the next 25 years. The assessment also included the importance of the species' genetic diversity on an international scale and conservation measures in place. This information formed the basis of an overall 'traffic light' score of genetic risks and whether current conservation actions are effective, with a statement on the level of confidence in the score.

Where there was direct genetic data, it was combined with information on species biology, abundance and distribution. This was not possible for some species and in those cases risk assessment was based on species biology, abundance and distribution only.

The initial Scorecard was published in 2020 and included five species from each category plus a species of wider concern, the European ash tree, which is suffering global decline due to disease.

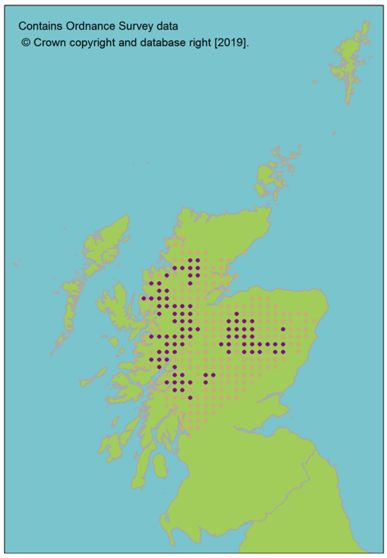
One of the selected species was Scots pine (*Pinus sylvestris*). This shows how the threats and conservation measures can be clearly presented.


Red deer. Forsinard Flows National Nature Reserve.©Lorne Gill/SNH

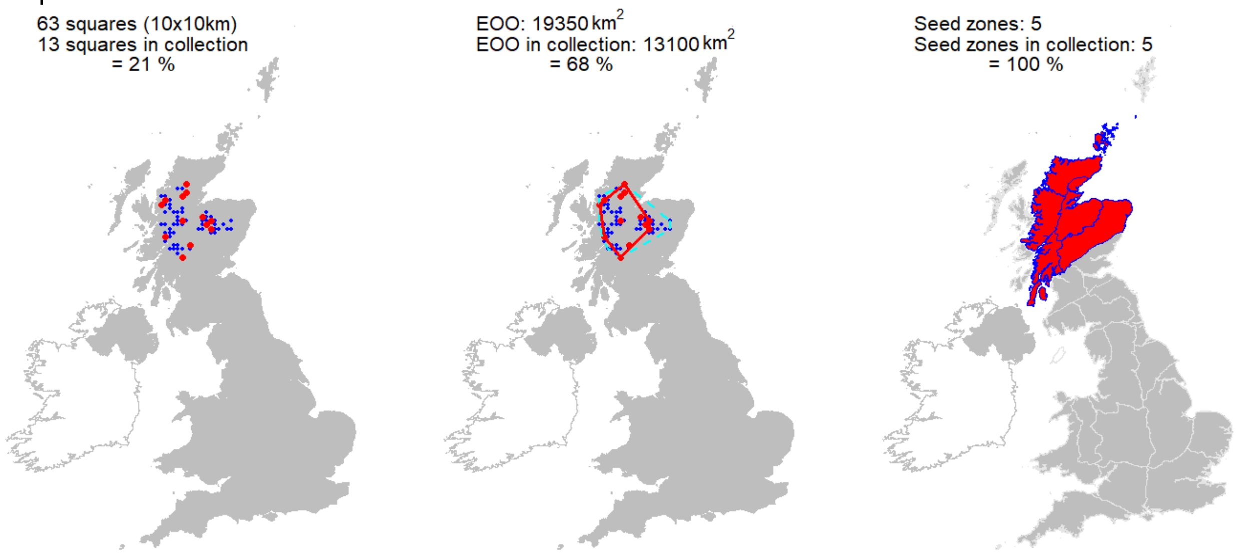

Scots pine (*Pinus sylvestris*)

Example of Scorecard (Scots pine):

Scientific name	*Pinus sylvestris*	**Common Name**	Scots pine
GB IUCN Category	LC	**T13 Status**	Moderate risk Mitigation effective



Context	**Background**	Hermaphrodite, wind pollinated, widely distributed tree. Present in 84 natural stands, often small and fragmented (dark circles on map, light circles are plantations). Natural stands represent only 10% of trees in Scotland. Genetic marker studies show large amounts of neutral genetic diversity. Some evidence of adaptive differentiation in Scotland from west to east (Salmela, 2011; Donnelly *et al*., 2018).
Context	**Current threats**	Plant pathogens represent the major emerging threat (*Dothistroma septosporum* races introduced on Corsican and lodgepole pine) (Piotrowska *et al*., 2018).
Context	**Contribution of Scottish population to total species diversity**	Molecular evidence for putative separate lineage in north western Scotland, although nuclear markers indicate very low differentiation, even from continental Europe (Ennos *et al*., 1997). Scotland does, however, contain a uniquely oceanic adapted population (Ennos *et al*., 1997; Donnelly *et al*., 2018).
Genetic risks	**Diversity loss: population declines**	Multiple small populations with no regeneration coupled with a biased age-structure towards older trees compromises the sustainability of many populations. However, there is limited risk of imminent genetic diversity loss due to high levels of standing variation in adult trees (assuming no catastrophic population losses due to pathogens).
Genetic risks	**Diversity loss: functional variation**	The general persistence of the species across its range in Scotland is not threatened, which minimises likely loss of adaptive variation. There are risks to loss of high elevation populations across its range which may lead to some loss of adaptive variation.
Genetic risks	**Diversity loss: divergent lineages**	Limited divergence from European populations precludes loss of major divergent lineages. The most genetically distinct populations are in the north west of Scotland around Shieldaig. These populations are not currently threatened.
Genetic risks	**Hybridisation/ introgression**	Buffer zones in which planting of non-local seed is prohibited around existing native stands limit risk to loss of integrity from exotic stands.

<table>
<tr><td></td><td>Low turnover/ constraints on adaptive opportunities</td><td colspan="5">Deer grazing is a major limitation on turnover and regeneration, but the risk is mitigated in c. 20% of populations where active management is in place.</td></tr>
<tr><td rowspan="8">Cumulative risk summary</td><td>In situ genetic threat level</td><td colspan="5">Moderate (in the face of emerging pathogen threats, major limitations to regeneration present a moderate risk of genetic variation loss and constraints to adaptation).</td></tr>
<tr><td>Confidence in in situ threat level</td><td colspan="5">High (assessment based on good demographic data and direct data on genetic variation, population differentiation and biology).</td></tr>
<tr><td>Ex situ representation</td><td colspan="5">Seeds from 13 10km squares held at the Millennium Seed bank, including all 5 UK ‘standard’ tree seed zones in which native stands occur, with 68% ex situ coverage of its wild extent of occurrence.</td></tr>
<tr><td colspan="6">Representation in seed bank collection

</td></tr>
<tr><td rowspan="3">Current conservation actions</td><td colspan="5">Grazing controls at c. 20% of sites promote regeneration providing adaptive opportunities. Establishment of Gene Conservation Unit at Beinn Eighe National Nature Reserve safeguards some variation.</td></tr>
<tr><td>Ex situ</td><td>Translocation</td><td>Habitat management</td><td>Legal protection of habitat or species</td><td>Control of INNS/pests/ pathogens</td></tr>
<tr><td>X</td><td></td><td>X</td><td>X</td><td></td></tr>
<tr><td>Overall T13 status</td><td colspan="5">Moderate risk; Mitigation effective</td></tr>
<tr><td></td><td>Overall T13 status explanation</td><td colspan="5">Despite the fragmented nature and small size of many populations, longevity of individual trees minimises imminent loss of genetic diversity. Management to promote regeneration supports some ongoing evolutionary processes, and wide representation of all seed zones in seed banks likely catches main adaptive variation.</td></tr>
<tr><td></td><td>Assessor</td><td colspan="5">Richard Ennos, University of Edinburgh</td></tr>
<tr><td></td><td>Reviewer</td><td colspan="5">Stephen Cavers, Centre for Ecology and Hydrology
Peter Hollingsworth, Royal Botanic Garden Edinburgh</td></tr>
</table>

ENVIRONMENTAL IMPACTS

The assessment found that:

- 14 species were classed as being at negligible genetic risk
- Eight species were classed as being at moderate risk, with effective mitigation in place for five of these
- Four species were classed as being at risk of severe genetic problems

Work was already underway to incorporate genetic diversity in recovery plans for the species at serious risk, and the leads for these projects contributed to the Scorecard assessments. Of the four species classified as being at serious risk, two (Scottish wildcat [*Felis silvestris*] and European ash [*Fraxinus excelsior*]) are primarily threatened by non-native species. In the case of the Scottish wildcat, the primary threat is extinction-by-hybridisation from feral domestic cats, with the small number of remaining pure Scottish wildcats being vulnerable to further loss of genetic integrity. In the case of ash, although there are millions of ash trees still present in the UK, there is a serious risk of genetic diversity loss due to large-scale mortality from the introduced ash-dieback pathogen, and the potential for further pressures from the introduced emerald ash borer.

In the case of the great-yellow bumblebee (*Bombus distinguendus*), land-use change leading to sub-optimal habitat management has resulted in population declines, and this, coupled with the short-life cycle of the species, creates a risk of further rapid decline in genetic diversity. Likewise, the freshwater pearl mussel (*Margaritifera margaritifera*) is experiencing continued population declines with the associated risk of genetic diversity loss.

Many of the species at moderate risk of genetic problems are relatively widespread species facing acute pressures from pests/pathogens and/or non-native species. For instance, closely related non-native species are a source of pressure for both the British bluebell (*Hyacinthoides non-scripta*) and the red squirrel (*Sciurus vulgaris*), farmed salmon is a pressure for Atlantic salmon (*Salmo salar*), and risks of population declines due to pests and pathogens are important for Scots pine, Atlantic salmon, sea trout/brown trout (*Salmo trutta*), red grouse (*Lagopus lagopus*) and red squirrel. The primary threat to the woolly willow (*Salix lanata*) in contrast, is its rarity, occurring in just 12 populations, many with very few individuals, with only the longevity of individual bushes acting as a buffer against immediate serious genetic diversity loss.

Of the eight species classed as being at moderate risk, effective mitigation is not yet in place for sea trout/brown trout and Atlantic salmon, or for the Scottish bluebell (*Campanula rotundifolia*), also known as harebell.

The project has provided an impetus for genetic conservation in Scotland. For example, it was an important factor in getting resources for the creation of Scotland's first Gene Conservation Unit (GCU) at Beinn Eighe in the Highlands. Beinn Eighe is home to a unique population of Scots Pine that are genetically distinct due to having adapted to the wet conditions there. GCUs are forest areas which contain sufficient numbers of individuals to retain high genetic diversity, and which receive gene flow from other sites. They are managed to encourage natural regeneration and the action of natural selection so that there is ongoing adaptation to changing environmental conditions. Crucially the GCUs are compatible with economic land use, such as forestry, and as such represents a win for biodiversity, rural economies and the regulating ecosystems services that well managed forests can provide. The Scorecard allows us to assess the effectiveness of such approaches and helps us prioritise species for future GCUs.

Following on from the success at Beinn Eighe, a further eight GCUs have been established across Scotland. The suite now covers 24 species including all the forest trees assessed in the Scorecard.

Scottish wildcat (*Felis silvestris*)

Great-yellow bumblebee (*Bombus distinguendus*)

Red squirrel (*Sciurus vulgaris*)

Ash (*Fraxinus excelsior*) woodland at Cragbank wood SSSI near Hawick ©Lorne Gill/SNH

Scottish bluebell (*Campanula rotundifolia*), also known as harebell.©Lorne Gill

Red grouse (*Lagopus lagopus*)

Sea trout/brown trout (*Salmo trutta*)

Woolly willow (*Salix lanata*)

Atlantic salmon (*Salmo salar*)

SOCIOECONOMIC IMPACTS

It is too early to quantify the impacts to society from this project as its effects will be over the long-term. While genetic diversity may seem removed from the lives of ordinary people, this is not the case, since it provides a wide range of benefits. This is recognised in the Sustainable Development Goals which list genetic resources are contributing to poverty alleviation (SDG 1), food security (SDG 2), good health and wellbeing (SDG 3), gender equality (SDG 5), innovation (SDG 9) and life on land. The decision to include species in the Scorecard based on multiple categories aimed to capture some of this breadth and relevance across all sections of society. The benefits of the increased resilience that will accrue from reporting on and safeguarding genetic diversity are many.

Species of conservation concern vary in their socioeconomic value. All have what are termed existence values, that is an intrinsic worth and with it a non-monetary value to people just from knowing that the species exists, even without seeing or using it. Many also bring wellbeing to people who experience them and economic benefit via tourism. The same is also true of the species of cultural importance covered in the Scorecard. It has been calculated that wildlife tourism is worth over £1.5 billion per year.

Species providing regulating ecosystems services were selected because of the benefits from carbon capture, flood alleviation and mitigation, and pest control. All of these species are widely distributed. Papillose bog-moss (*Sphagnum papillosum*) was selected as Scotland's most important moss for ecosystem services. It is a major force in carbon capture, through the formation of peat. By absorbing water, it reduces flood risk, and it also reduces the amount of sediment entering watercourses, thereby enhancing the quality of rivers for fish and as an ingredient in whisky production. Common frog (*Rana temporaria*) was included as the most widely distributed vertebrate on mainland Scotland. As a predator it is a major consumer of invertebrates including economically important pests.

Whilst foraging for food and traditional medicines are not as important to people in a post-industrial nation like Scotland, it is still of cultural value. We included this category in recognition of its greater importance in countries with less disturbed ecosystems and a greater reliance on wild food sources.

Hunting and recreational fishing are important contributors to the rural economy, generating approximately £340 million and over £100 million respectively each year, though the latter figure is almost certainly an underestimate. Game fish in particular are vulnerable to climate change and novel pests and pathogens. Understanding the threats to genetic diversity is key to understanding how to manage these stocks and is being increasingly recognised by fisheries managers.

The socioeconomic value of the Scorecard will be increased when it is expanded to marine species and when the site-based version is deployed more widely. Its impact will also be much greater when its use is extended to other regions, particularly those hosting greater genetic diversity.


Papillose bog-moss (*Sphagnum papillosum*)


Common frog (*Rana temporaria*) in a garden pond.©Lorne Gill

GENDER IMPACTS

The Scotland Act (1998) **enshrined** equal opportunities as: “the prevention, elimination or regulation of discrimination between persons on grounds of sex or marital status, on racial grounds, or on grounds of disability, age, sexual orientation, language or social origin, or of other personal attributes, including beliefs or opinions, such as religious beliefs or political opinions.”

The importance of genetic resources to gender equality is recognised in Sustainable Development Goal 5. At a global and a regional level, women along with other groups subject to discrimination, are more likely to suffer from declines in ecosystem services. Since genetic diversity is the base from which ecosystems services ultimately flow, information that facilitates the protection of genetic resources can also safeguard these services and hence enhance the well-being of the most vulnerable in society.

POLICY IMPACTS

The potential of the Scorecard has been recognised in IUCN guidance for “Selecting species and populations for monitoring of genetic diversity”. This document explains the importance of genetic diversity as the foundation for resilience of populations, species and ecosystems. It targets practitioners which includes those most likely to be able to influence on the ground conservation through policy and land management. The document takes the reader through the Scorecard approach and the rationale behind it. It also describes the wider societal benefits from structured monitoring of genetic diversity. The use of the Scorecard in Scotland is highlighted as a case study. The ease of transfer to other regions and the low cost of the Scorecard are emphasised and the section closes with a note on further collaboration between the Scottish team and the University of Benghazi to produce a version for Libya. Libya faces many challenges when it comes to biodiversity conservation but it can also reap rewards, especially when it comes to endemics such as Cyrenaican wild artichoke (*Cynara cyrenaica*). Similarly to Scotland, the Libyan Scorecard will also include economically important species, in this case including the Aleppo pine (*Pinus halepensis*), which is important for timber, as a source of pinenuts and for ameliorating extreme weather.

The Scorecard was selected as a “Complementary Indicator” for the Kunming Montreal Global Biodiversity Framework (KMGBF). While complementary indicators are optional, inclusion in the KMGBF shows an appreciation of the Scorecard’s potential to improve understanding of how biodiversity is fairing and the effectiveness of conservation measures. It also recognises the robustness of the methods used and its applicability in any region or country in the world. This bridgebuilding between science, policy and practice is at the heart of both the Scorecard rationale and the KMGBF. The Scorecard will continue to play a part in reporting Scotland’s progress in biodiversity conservation through the safeguarding of genetic resources.

Domestically, the Scorecard was recognised at Nature of Scotland Awards 2020 where it won the Innovation Category. The award ceremony included a short film about the Scorecard entitled “Conserving genetic diversity – helping nature to help itself” (available at: https://www.youtube.com/watch?v=Y-z-ufUO_uA) which guided the audience to understand its wider relevance. The Nature of Scotland Awards aim to highlight the very best in Scottish nature conservation and attendees include politicians, media figures, businesspeople, community leaders and senior conservation managers. The awards were reported on in mainstream channels, including the BBC and national press, and in social media. The exposure beyond the core research and conservation communities that this event brought has helped ensure the Scorecard is seen as a useful pragmatic tool.

SUSTAINABILITY

The Scorecard was conceived as a simple low-cost approach. Costs were limited to running the workshops, which were funded by SEFAI and RBGE, and staff time which in most cases was paid for by the employing institution. This ethos was in line with the aspiration that that Scorecard should be a tool available to any region or country without cost being a barrier. The use of proxies and data from pre-existing studies has also minimised cost. Gathering and analysing genetic data are becoming much cheaper, and in many cases are now less expensive than species and habitat surveys. This should mean that more data become available, thus increasing the range of species that can be covered and the depth of understanding of the threats and opportunities facing them.

The original project managers are now working on an updated Scorecard which will allow comparison with the original assessment and bring in some new metrics recommended in a review of the method in 2022. This work is being funded by SEFARI, though again many partners will give staff time without passing on the costs. The update is also incorporating marine and coastal species for the first time.

The original Scorecard had confined itself to terrestrial and freshwater species, in part due to the expertise of the working group. Bringing marine specialists on board not only adds to the representativeness of the Scorecard for a new realm, it also brings new ecosystem services, many of which, such as protection from extreme weather, are becoming of increasing importance and all of which are underpinned by genetic diversity. For example, seagrasses act as nurseries for a wide range of species including commercially important fish. They also trap carbon and protect soft coasts from storm surges. Historically seagrasses have been vulnerable to pressures including pollution and disease. Genetic diversity is key to resilience to such threats and so by monitoring and acting to safeguard it, both biodiversity and human coastal safety and livelihoods can be supported.


Shallow water seagrass (*Zostera marina*) bed with bivalve shells and native oysters (*Ostrea edulis*) in Loch Sween.©Ben James/SNH


A shallow Zostera marina bed

ASSOCIATIONS

The project is led by staff from the Royal Botanic Garden Edinburgh, the University of Edinburgh and NatureScot, the Scottish Government's statutory nature conservation agency. The partners include research bodies, universities, and Non-Governmental Organisations. Having the different perspectives ensured that the Scorecard would be based on sound science and would be useful for policy makers and practitioners. The workshop format of the original meetings encouraged debate and the exchange of ideas. Preparation of the individual species accounts also benefitted from having reviewers who were knowledgeable on the species as well as an editorial team that were able to ensure a consistent style.

Going forward, one of the offsprings of the project is a local site-based assessment. In this case, development has been in partnership with land managers including farmers and foresters (Scotland), communities (Mexico and Libya), conservation managers (Australia) and fishers (Sweden). This approach is seen as key to ensuring the product meets the needs of as wide a range of stakeholders as possible. In each case the lead scientist is local to the project, and as such should be seen as an ally rather than an outsider trying to impose alien values and ways of working.

Golden eagle (*Aquila chrysaetos*)

REPLICATION AND APPLICABILITY

The Scorecard design brief was to develop an indicator that is fully replicable regardless of the economic status of the country or region where it is used. The Scottish experience shows that this has been the case. Because assessments can be carried out using proxies, there is no need for expensive technology. However, Scorecard can also use direct genetic data where these are available, which will allow regions and countries to grow their reporting capacity alongside their technological development. This will support them in their efforts to maintain genetic information within the country to maximise the benefits to their citizens.

Although the Scorecard was initially developed for the terrestrial realm, its methods are equally applicable for marine species. This offers an opportunity to focus on species of concern to a wide range of stakeholders including fishers and coastal communities.

More specifically, the elements that should be considered for its successful replication are the following:

- **Partnerships:** The initiative benefited from a diverse set of partners, including NGOs, research organizations, and government agencies. For successful replication, it is suggested to bring together a variety of stakeholders with different expertise (e.g., biodiversity, policy, and local communities) to ensure scientific robustness and policy relevance.
- **Adapting Selection Criteria for Species:** The five categories (conservation priorities, culturally important, ecosystem services, food/medicine, and game species) should be revisited for local relevance. Different regions might prioritize species differently based on their biodiversity or local uses.
- **Use of Pre-existing Data:** Using existing studies and data (e.g., species surveys, ecological assessments) is critical for reducing costs. Any replication would benefit from leveraging available local or national databases to build a foundation.
- **Inclusion of Public and Cultural Perspectives:** The project incorporated public input, such as surveys on culturally significant species. It is suggested that the replicated initiative promotes meaningful engagement with local communities and stakeholders to identify species of cultural importance and to ensure societal integration into the project.
- **Interdisciplinary Workshops:** The use of workshops to bring together experts and stakeholders for discussion and decision-making is a key replicable element. Such participatory approaches could foster collaboration and ensure diverse perspectives are included.
- **Alignment with International Frameworks:** The project was recognized by the Convention on Biological Diversity (CBD) and linked to international biodiversity goals like the Aichi Targets and the Kunming-Montreal Global Biodiversity Framework (KMGBF). Replication efforts should ensure alignment with global biodiversity commitments like the SDGs and KMGBF.
- **Policy Uptake and Use as a Tool:** The Scorecard became a policy tool that informed conservation decisions and resource allocation. Replication efforts should aim to create a tool that is useful for policymakers and land managers, ensuring it can guide action and resource prioritization.
- **Socioeconomic Relevance:** Genetic diversity impacts economic activities like forestry, agriculture, and tourism. Demonstrating how the project contributes to long-term socioeconomic benefits (e.g., food security, ecosystem services) is important for gaining political and public support.

It is relevant to consider that the Scorecard was conceived in response to a gap in reporting under the Aichi Targets of the Convention on Biological Diversity. However, it has been accepted as a complementary indicator for the Kunming-Montreal Global Biodiversity Framework and can be a useful component of any regional, national or international approach to biodiversity. Enabling local communities and managers to assess genetic diversity will allow them to manage biodiversity in a way that will enhance the resilience of nature and the benefits it can bring

FOR MORE INFORMATION

To obtain more information about this project, visit https://www.nature.scot/doc/scotlands-biodiversity-progress-2020-aichi-targets-aichi-target-13-genetic-diversity-maintained#serious-risk-species

You can also contact us via email at info@regions4.org to schedule an informational meeting, address your questions, and receive support for the implementation of similar projects.

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ABOUT REGIONS4

Regions4 (formerly known as nrg4SD) is a global network that exclusively represents regional governments (states, regions, and provinces) in UN processes, European Union initiatives, and global discussions on climate change, biodiversity, and sustainable development. Regions4 was established in 2002 at the World Summit in Johannesburg and currently represents over 40 members from 20 countries across 4 continents. Through advocacy, cooperation, and capacity building, Regions4 empowers regional governments to accelerate global action.

For more information, visit: www.regions4.org
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Chaussée d'Alsemberg 999 - B-1180, Brussels, Belgium

www.regions4.org

info@regions4.org

@Regions4SD

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