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SPIRAL

Science-Policy Interfaces for Biodiversity: Research, Action and Learning

Attributes of Science-Policy Interfaces and their Linkages to Instruments and Mechanisms for Encouraging Behaviour that Reduces Negative Human Impacts on Biodiversity

Simo Sarkki , Jari Niemelä, Rob Tinch, and the SPIRAL team

SEVENTH FRAMEWORK PROGRAMME

SPIRAL Interfacing Biodiversity and Policy

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Executive Summary

Science-policy interfaces (SPIs) play a vital role in addressing the great environmental challenges of our time. Better connectivity between science and policy can influence policymakers' and scientists' behaviour and decisions, leading to more policy-relevant research and to better-informed policies that in turn encourage behaviours that have positive impacts on biodiversity. We need to understand how SPIs work and how to improve their performance.

The SPIRAL project aims to help improve the design and effectiveness of biodiversity SPIs, in particular regarding their ability to influence human behaviour with impacts on biodiversity. The aim of this report is to synthesise work done in SPIRAL Work Package 3 to develop attributes for describing and assessing science-policy interfaces and their linkages to instruments and mechanisms for encouraging behaviour that reduces negative human impacts on biodiversity. The work included a literature review, two workshops with stakeholders, and interviews of eight experts with experience of biodiversity science-policy interfaces. The resulting set of 18 attributes developed are presented in this report.

Complex interactions involving many factors affect the connectivity between science, policy-making and behaviour. A linear conception of communication of scientific knowledge to policy makers is too simplistic: if we are to improve SPI performance, we have to recognise and understand the many complex factors and processes involved in real SPIs, how the interactions occur, and how they can influence policy mechanisms that impact on behaviour and ultimately biodiversity.

SPIs use various tools for carrying out their work, and have influence on various policy instruments that are used to change human impacts on biodiversity. Part of SPIRAL seeks to understand and enhance the role of SPIs in supporting these mechanisms. Policy instruments are used to influence human behaviour, and SPIs play important roles in supporting the design and implementation of instruments. We consider these roles, using case studies, and draw conclusions on features of SPIs that improve their support for policy instruments and effect behavioural change. The policy instruments considered are:

- Market-based instruments that modify prices, information or market rules to change incentives and behaviour of actors in society, including the private sector and individuals. SPIs need to provide information for designing instruments, setting targets monitoring and evaluating impacts.
- Targets and indicators can help to drive major changes if they are properly integrated in policy across sectors. SPIs play important roles in developing indicators, promoting them, building capacity to use them, integrating them into policies and measuring progress.
- Scenarios can help policy makers and other actors to understand the importance and implications of environmental trends and changes under various possible future conditions. SPIs may use scenarios to raise awareness, highlight the consequences of different courses of action, encourage stakeholders to reflect on policy and behaviour changes that may be needed in order to avoid negative outcomes. Scenarios may also be used by SPIs to support policy design.

The impacts of SPIs on behaviour depend on many features within and outside the SPI. Empirical material for researching these features was collected in two workshops (March and December 2011) with over 20 external participants, through eight in-depth interviews with additional experts, and through extensive literature review. We analyse the

characteristics of SPIs that are most associated with success and develop a set of attributes that can be used to help design, implement, assess and improve SPIs.

The 18 attributes developed here, and associated 'lessons learned', provide a valuable resource for those working with SPIs, pinpointing important issues that affect the ability of SPIs to influence the behaviour of their target audiences. Use of the attributes can help to improve biodiversity SPIs, thereby enhancing their impacts on policy, on wider behaviour and ultimately on biodiversity itself. Our results also feed in to SPIRAL case studies, SPI mapping and test cases that will further enhance our understanding of SPIs, leading to refined proposals for their improvement.

We also identify potential trade-offs and conflicts among the SPI success attributes: their relative importance is heavily context-dependent, varying according to the type of problem, the stage in the policy cycle, and various other factors. Considering these factors helps to determine which attributes to emphasise. There is not a single recipe for success, but rather a suite of features that need to be taken into account in a context-dependent way.

1. Introduction

Science policy interfaces play a vital role in addressing the great environmental challenges of our time: we need to understand how they work and how to improve their performance.

Environmental governance faces great challenges, in particular associated with climate change, chemical and radiobiological contamination, overexploitation of natural resources, biodiversity loss, and the deterioration of ecosystem services vital for human well-being. Various environment-related science-policy interfaces (SPIs) have been established as ways to better connect science and policy. SPIs can be broadly defined as relations between scientists and other actors in the policy process which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making.[1] Important examples of global environment-related SPIs include the Intergovernmental Panel on Climate Change (IPCC), The Economics of Ecosystems and Biodiversity (TEEB) initiative, the emerging Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), and the scientific advisory board (SBSTTA) of the Convention on Biological Diversity (CBD).

There are many other SPIs at global, regional, national and sub-national scales. Some address specific aspects of biodiversity, e.g. the International Council for the Exploration of the Seas (ICES). They aim to ensure that the latest, highest quality and most relevant scientific evidence can be effectively integrated in policy processes, and that the needs of policy can be integrated in research funding and programmes. To enhance the execution of these vital tasks, it is important to study and understand how SPIs work, and explore ways in which their performance and influence can be enhanced.

Science Policy Interfaces in the SPIRAL project

The SPIRAL project aims to help improve the design and effectiveness of biodiversity SPIs, in particular regarding their ability to influence human behaviour that impacts on biodiversity.

The SPIRAL project is based on the premise that more effective interfaces between science and policy are urgently needed in order to support more effective policies, better institutional interrelations and changed social behaviour of policy makers and political institutions, individual citizens, civil society organisations, scientists and research organisations, and business actors.

An important part of the SPIRAL project therefore focuses on how science-policy interfaces (SPIs) can influence the behaviour of a wide range of actors. Human impacts on biodiversity are the result of decisions and behaviours by these actors; policy mechanisms are employed to influence these behaviours in various ways, encouraging beneficial behaviours and discouraging or inhibiting damaging behaviours. This can include policies to restrict certain behaviours, targets, indicators, voluntary agreements, and market-based instruments to create (dis)incentives for behaviours with (negative) positive impacts on biodiversity. The design and implementation of these mechanisms are themselves functions of the decisions and behaviour of policy makers and other stakeholders involved in policy processes. These behaviours depend in large part on knowledge and information held and exchanged by actors in those processes. And this knowledge depends on those actors and also on the behaviours of scientists and science funders who may or may not be directly involved in the policy processes.

Science-policy interfaces involve complex interactions

A linear conception of communication of scientific knowledge to policy makers is too simplistic: if we are to improve SPI performance, we have to recognise the many complex factors and processes involved in real SPIs.

The traditional linear model of communication of scientific knowledge to policy makers – 'truth' speaking to 'power' – is too simplistic to deal with complex processes and interactions between science and policy domains that are inescapably intersecting, with multiple relations and reservoirs of knowledge, and a host of other actors, including intermediaries and policy-brokers.[2]

SPIs therefore play a vital role in a complex chain linking knowledge creation to policy and onwards to behaviour and biodiversity impacts. Many factors affect these connections between science, policy-making and behaviour. Failure to take account of these complexities in the design and operation of SPIs can lead to disconnections and frustrations: scientific output mismatched to user requirements, stakeholders feeling excluded, and so on.

Our understanding of how to enhance interactions between science and policy in the existing and emerging interfaces is limited. Improved understanding is needed as this interaction is vital for effective evidence-based policy and ultimately to changing behaviours in ways that lead to effective sustainable use and conservation of biodiversity. Studying established SPIs can help us to understand the processes and to draw conclusions about effective SPI design and operation.

SPIRAL research on SPI tools and mechanisms

SPIs use various tools for carrying out their work, and have influence on various policy instruments that are used to change human impacts on biodiversity. SPIRAL seeks to understand and enhance these mechanisms.

Different policy instruments have different knowledge requirements, and understanding these needs can be important for effective SPI operation. Thus, one aim of the SPIRAL project is to carry out research into the ways in which different science-policy interfaces can support different forms of policy development and implementation, which ultimately aim at influencing human behaviour impacting on biodiversity and ecosystems. Our focus here is in human behaviour in the very broad sense of decisions and actions that affect biodiversity – not primarily the behaviour of 'the person in the street', but the behaviour of policy makers, scientists, business actors and other actors in policy, civil society, research and private institutions, with the understanding that this behaviour will affect that of the individual citizen.

This interest intersects with a focus on tools and instruments that may reduce negative impacts or enhance positive impacts on biodiversity conservation. We seek to understand how SPIs can be designed in order to support the development and implementation of appropriate policy instruments, and how the SPIs can use different tools to implement this support. We are looking, therefore, at two quite different kinds of 'mechanisms' through which SPIs influence behaviour: (i) **tools** for review, assessment and communication; and (ii) **policy instruments** used by policy makers and supported by SPIs. These two types have different rationales, influence different actors and operate differently: see Figure 1, and the summary in table 1.

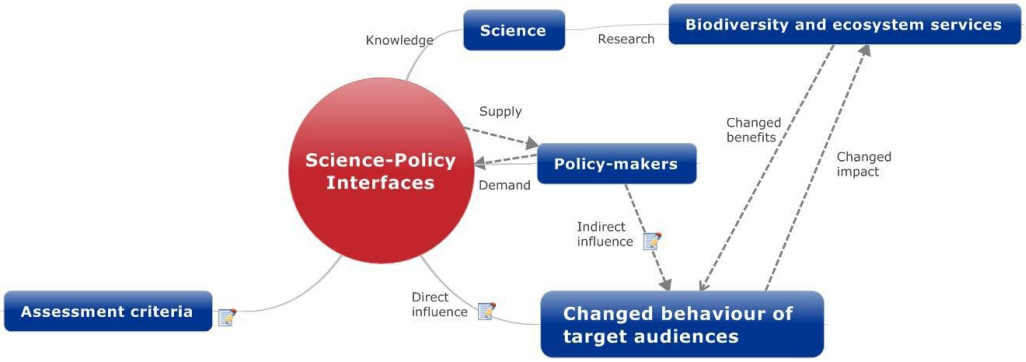

Figure 1. SPIs' influence on human behaviour and biodiversity

Table 1. Two types of mechanisms through which SPIs can influence behaviour

Mechanisms to influence behaviour	**Tools** for review, assessment and communication of the SPI	**Policy instruments** used by policy makers and supported by SPIs
What?	Literature reviews, reports, policy briefs, indicators, charts, figures, pictures, narratives or scenario storylines, …	Various market-based instruments, regulatory policies, and policy targets and indicators
Why?	Used to enhance interactions and knowledge flows between knowledge creators, policy makers and other stakeholders	Used to create/modify incentives and disincentives for different behaviours.
Who is influenced?	Policy makers and other target audiences (involved in the SPI, or communicated with). Their behaviour is ***directly*** influenced by SPI activities and information.	Wide range of actors outside the SPI. Their biodiversity-related behaviour is ***indirectly*** influenced by the SPI, via the influence of the SPI on instrument choice, design and implementation
How?	Behavioural change happens through learning, awareness raising, access to information.	Behavioural change happens through awareness, information provision, incentives, coercion, direct regulation.

So the research in SPIRAL has a dual focus on tools and instruments to change behaviour and on how to enhance science-policy interfaces The main output of the work is the development of a set of attributes than can be used to enhance the design, implementation, assessment, and revision of SPIs, with the ultimate aim of contributing to the development of 'better' SPIs in terms of their ability to influence the behaviour of policy makers and other stakeholders. Some of the attributes apply quite generally to the smooth and effective operation of an SPI; others relate to external perceptions of its credibility, legitimacy and relevance; still others relate to tools used to change policy makers' (and other target audiences') behaviour directly. The link from the attributes to policy instruments is often more indirect, reflecting the fact that SPIs' influence over policy instruments is often indirect (i.e. via policy-maker behaviour), though this is not necessarily the case: for instruments such as certification labels or indicators, many of the attributes are directly relevant.

Objectives and roadmap

Analysis in this report leads to attributes for improving SPIs, especially regarding their impacts on behaviour. The results feed in to SPIRAL case studies, SPI mapping and test cases.

To improve SPIs, we need to understand better how interactions between science and policy occur, and how they can influence policy mechanisms that impact on behaviour and ultimately biodiversity.

The aims of the SPIRAL work package on SPIs and mechanisms are as follows:[3]

1. To identify the main mechanisms designed to encourage (discourage) decisions and behaviours that have positive (negative) impacts on biodiversity;
2. To examine how these mechanisms can improve integration of scientific, economic, ethical, moral and stewardship principles into policy making;
3. To identify the types and features science-policy and science-society interfaces that promote the development and implementation of these mechanisms;

4. To identify the strengths and weaknesses of these mechanisms and the interfaces that support their development and implementation;
5. To draw conclusions about possible steps to improve science-policy and science-society interfaces.

During our research in interviews and workshops, a key concern of participants was the identification of features associated with success and failure in influencing behaviour of target audiences.

Reflecting this demand from *our* target audience, the focus of this report is the presentation of attributes for designing, implementing, assessing, and improving SPIs in the context of their ability to influence the behaviour and decisions of policy makers and other audiences, in particular regarding the use of policy mechanisms for encouraging (or discouraging) behaviour that may reduce (or increase) negative human impact on biodiversity.

The focus on assessment attributes for SPIs is also important for other work in the SPIRAL project. The attributes contribute to the development of categories for mapping the science-policy landscape, and help guide the topics and analysis of interviews on EU projects and NBSAPs (Work Package 1). The attributes also constitute a tool for assessing and supporting the SPIRAL test cases (WP4).

The remainder of the report is structured as follows. The next section discusses the links between SPIs and policy instruments, drawing on case studies of SPIs particularly active in three types of instruments: market-based instruments, biodiversity targets and indicators, and scenarios. Following that, we draw on the cases discussed, on wider literature and on the results of our interview and workshop research to develop assessment attributes for SPIs. The attributes are classified according to whether they relate to structures, objectives/functions, processes, outputs or outcomes (see discussion below), although these categories overlap to some extent. We discuss how the attributes could be used, including consideration of potential context-dependent trade-offs among certain attributes. More detailed factsheets on each attribute are presented in an annex. The final section of the main report draws conclusions on how the attributes can contribute to steps to improve science-policy and science-society interfaces to develop mechanisms for encouraging behaviour that may reduce negative human impact on biodiversity.

2. Science-policy interfaces, policy instruments and behaviour

Policy instruments are used to influence human behaviour, and SPIs play important roles in supporting the design and implementation of instruments. We consider these roles, using case studies, and draw conclusions on features of SPIs that improve their support for policy instruments and effecting behavioural change.

Human behaviour related to biodiversity can be influenced through various governance instruments: regulations, market-based instruments, targets and indicators, scenarios and so on. SPIs have a variety of roles in developing, supporting, implementing such mechanisms, depending on the instrument in question. Analysis of how SPIs act to support instruments helps to understand the requirements for SPI design and operation, and what makes SPIs succeed or fail in their objectives. Drawing on a number of case studies, we outline relationships between instruments and SPIs, illustrating how the instruments can influence biodiversity-related behaviour and how SPIs can work to enhance this influence. This leads on to the development of attributes for SPIs in the next section. The main categories of instrument considered are market-based instruments, targets and indicators, and scenarios.

Market-based instruments

Market-based instruments modify prices, information or market rules to change incentives and behaviour of actors in society, including the private sector and individuals. SPIs need to provide information for designing instruments, setting quantities, monitoring and evaluating impacts.

Biodiversity loss can be viewed as a problem of market failures: individuals and organisations do not face the full costs of their actions (the problem of external costs), receive inappropriate subsidies for activities that damage biodiversity[4], may not even be aware of the damages caused (information failure), may discount future impacts (much) more highly than is socially desirable, and so on.[5]

'Command and control' instruments have traditionally been used to address environmental problems, for example through setting restrictions on what can and cannot be done in land management, and quota-based controls for resource use and pollution emissions. Such approaches tend to be inflexible and do not take into account differences in costs and benefits of actions for different stakeholders, but can give more direct control over outcomes than instruments that try to influence behaviour through incentives.

Market-based instruments such as taxes or tradable permits instead use prices to change the incentives for different behaviours. This allows similar physical outcomes to be achieved in lower cost ways, and provides clearer dynamic incentives for technological improvements. Instruments such as labelling and information provision also tap in to the power of markets by allowing buyers to express preferences they previously could not – for example, labelling FSC timber (see Box 1) allows buyers to express their desire for biodiversity conservation by selecting the less-damaging, labelled product. However market-based instruments offer policy-makers less direct control than regulations, and in some cases can have undesirable impacts on the distribution of wealth.

The potential of market-based instruments for encouraging biodiversity-sensitive behaviour has evoked increasing interest over recent decades.[6] The design and implementation of market-based instruments requires scientific and socio-economic knowledge of various

kinds, and SPIs play important roles. These are illustrated by the examples presented below of timber certification (Box 1), biodiversity offset/banking schemes (Box 2), and wildlife damage compensation schemes (Box 3).

Science underpins the principles and criteria used by certifications, the calculation of equivalence in biodiversity offset schemes, the modelling and monitoring of animal populations, the damages they cause and the costs and effects of measures to conserve them. The social science knowledge to understand behaviours and economic processes is also essential. The science is not generated or used in 'stand-alone' format, but rather alongside policy and management considerations. SPIs often play a core function in supporting the necessary interactions between knowledge generation and policy processes

Some SPIs play wider roles regarding market-based instruments. TEEB[7] in particular highlights the role of economic valuation of ecosystem services and aims to bring the current and future potential values of ecosystem services and biodiversity into policy decisions, encouraging a progressive shift from 'recognising' value, to 'demonstrating' and measuring it, and ultimately to 'capturing' value through market-based instruments for management. The Business@Biodiversity platform[8] aims to establish partnerships among various kinds of private and public stakeholders to promote and raise awareness about potential synergies between business and biodiversity. The function of this platform is to support market-based instruments for biodiversity via partnerships and networks consisting of business actors as well as NGOs[9].

General points arising from the consideration of SPIs to support the deployment of market-based instruments include:

- **Ensuring adaptive capacity / flexibility within the SPI is important**. Biodiversity problems, and market-based solutions, are inherently dynamic. Both SPIs and the instruments need to be able to respond to new knowledge and changing conditions, and structures that lead to inertia can be problematic. *Attributes identified below include: people, resources, horizon scanning, capacity building, adaptability.*
- **Involvement of local stakeholders and knowledge is often important**, from an equity and buy-in perspective, but also for the day-to-day running of schemes and provision of management information and practical knowledge. SPIs can play an important facilitating role here, and foster communication between local and national management structures. *Attributes identified below include: people, trust building, translation, capacity building.*
- **Market-based instruments can be seen as complementary to regulatory mechanisms**: some regulatory structures are necessary to frame the broad lines of behaviour impacting biodiversity, while market-based mechanisms can achieve certain outcomes in more cost-efficient and flexible ways. SPIs have a role to play in linking science (what is known, what is feasible) and stakeholder views to the policy development process in striking a balance between regulation and market solutions. *Attributes identified below include: people, balancing supply and demand, relevant outputs.*
- **In policy design, the devil is often in the details**. Market based instruments will require specific information in certain legal formats, that may be hard to alter once established. SPIs are important in ensuring that the uncertainties, costs, and time constraints of knowledge provision are taken into account during instrument design and review. *Attributes identified below include: quality assessment, relevant outputs, translation.*

Box 1: Forestry Stewardship Council

The Forestry Stewardship Council (FSC) is a SPI that directly supports an instrument: FSC certification. Forest and timber certification aims to influence the behaviour of timber purchasers (giving them the option of buying certified wood, and educating them on the reasons for doing so) and of timber producers (helping them modify practices to achieve certification). Globally, only 9.3% of forest area is certified, though 25.3% of roundwood production is from certified sources. These figures are much higher in Western Europe and North America (50.8% and 32.7% of area). Around 2/3 of the certified area is PEFC (Program for the Endorsement of Forest Certification), 1/3 FSC (Forest Stewardship Council). About 1% of certified area is certified under both schemes.[10]

The FSC was established in the wake of the Rio 1992 Summit as an independent, non-governmental, not-for-profit organisation promoting the responsible management of the world's forests. Environmental NGOs were instrumental in establishing the FSC, which enshrines equal voting rights of economic, social and environmental actors to avoid business dominance in its processes, and actively seeks to network with a wide range of actors including scientists and experts. Governmental bodies are excluded from membership. The FSC has general principles and attributes,[11] though these are not applied identically at heterogeneous locations. Standards are written by experts in an open process including extended peer review processes[12] and wide consultation. Third-party verification is used to give objective and independent accreditation.

Although the FSC principles are widely agreed to be appropriate, there is criticism of the way they have been applied. Independence is clouded by the financial relationship between the certification body and the timber producer paying for the certification. An alternative approach would be for the FSC to act as an intermediary, removing any direct contract between the industry actors and the verification bodies, and facilitating FSC quality control of the process. There has been criticism that the FSC has "bowed to pressure from big logging companies"[13] Though some concerns are recognised, the consensus-based process has been criticised for creating inertia preventing the FSC from making major changes. Nevertheless, the area of land and production under FSC certification has grown rapidly.

In 1999 the PEFC was established by European landowner organisations. The PEFC leaves the development of certification rules and procedures to national initiatives, approved or rejected by the PEFC Secretariat and Council, which is dominated by landowners and representatives of industry. The role of the social and environmental stakeholders is much weaker in the PEFC than in the FSC. The PEFC can be viewed as an industry backlash against the FSC's inclusive process and tighter certification attributes, and even as a deliberate attempt to confuse consumers with less rigorously enforced, competing standards.[14]

The FSC is a 'boundary organisation' combining various groups of people and knowledges to create credible certification, seeking to foster trust, to build consensus or compromise on difficult areas, and to do this in a transparent and visible process. The approach taken by the FSC is designed to enhance its legitimacy (independent of other groups, inclusive, participatory processes) and credibility (transparent use of best science advice, third party verification). The FSC case illustrates some trade-offs in success attributes: legitimacy and credibility have been enhanced by approaches that, while partly successful in preserving the FSC against the threat of being crowded out of the market by the less-demanding PEFC, have left it unable to make big changes such as adoption of a fully independent third party verification scheme.

Box 2: Business and Biodiversity Offsets Programme

The Business and Biodiversity Offsets Programme (BBOP) defines biodiversity offsets as "measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken." The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity, with a wide interpretation covering not only species composition and habitat structure, but also ecosystem function and human use and cultural values associated with biodiversity.[15]

BBOP is a partnership of some 40 organisations and individuals including companies, governments, conservation experts and financial institutions. Initiated in 2004, BBOP's expectation is that biodiversity offsets will become a standard part of the development process when projects have a significant residual impact on biodiversity. BBOP is in effect a SPI supporting implementation of biodiversity offset schemes.

For offsets to work, biodiversity outcomes have to be quantifiable: it is necessary to demonstrate the balance between a project's impacts on biodiversity and the benefits achieved through the offset. This is a major SPI challenge, because significant scientific uncertainty and data gaps hinder this quantification.

The USA has a system of wetland banking whereby anyone wishing to dredge or fill a wetland must apply for a permit from US Army Corps of Engineers. Permits are usually granted, but compensatory mitigation can require the applicant to create at least as much wetland function as it destroyed through the permitted action. Wetland credits must be certified as providing wetland functions and monitored to guarantee on-going provision of the functions. This requirement exceeds the capacity of science to provide robust measurements. Rapid assessment methods are used that can be heavily dependent on individual impressions during site visits. Scientists are required to produce results in a certain legal format, and with limited time and resources, and it may not be possible to do this in a robust and uncontroversial way.[16]

BBOP campaigns for sustained public and private sector commitment to address key areas of scientific uncertainty to fill the data gaps and realise the long-term potential of biodiversity offsets. Alongside this research, BBOP seeks to develop verification and auditing protocols for biodiversity offsets. But biodiversity and ecosystem function are complex and it is questionable whether scientific uncertainty can be overcome by increasing quantification efforts.[17] There is likely to be significant residual uncertainty that cannot be reduced. Designing a system in such a way as to match legal requirements for measurement and monitoring to feasible, robust and affordable science protocols is a major challenge for SPIs.

Offsets need to operate in the real world, where information is not perfect. To some extent, concerns here can be assuaged by including safety margins, built-in adaptability, and including requirements for stakeholder participation in knowledge production and other processes, incorporation of traditional knowledge in the design of biodiversity offsets, transparency, and inclusion of equity considerations.[18] Although certainty may be elusive, there can be agreement on the credibility, legitimacy and reliability of processes designed to operate in an uncertain world. Capacity building for independent third-party verification and monitoring methods would be one way for BBOP to support offset instruments.

Box 3: Wildlife damage compensation schemes

Compensation for biodiversity schemes aim to encourage pro-biodiversity behaviour by compensating actors for the damages caused by biodiversity and/or the additional costs of acting to conserve it.

In Scotland, goose management schemes including compensation for farmers have been used in several locations. On Islay, the Islay Voluntary Goose Management Scheme (IVGMS), set up in 1992 with a view to allowing all farmers the opportunity to receive payment in return for allowing geese to graze undisturbed, is generally considered successful. Payments were linked to the number of geese counted on individual farms and crofts. The initial scheme worked but Islay farmers and crofters did not feel that the level of compensation available was a true reflection of their economic losses. The Islay Local Goose Management Group, formed in 2000, now links the local community to government bodies and NGOs involved in managing the scheme. A revised scheme was introduced in 2000, with a further revision in 2005. Payments depend on the goose density and consequent allocation of land to 'feeding', 'buffer' or 'scaring' zones, as well as on land type (rotational arable or permanent pasture). Day-to-day delivery of the scheme is provided by local Scottish Natural Heritage and Scottish Government's Rural Payments and Inspections Directorate staff, but complex, contentious or strategic decisions are taken by the group, which maintains a working relationship with the UK's National Goose Management Review Group. Goose numbers have increased on Islay, and there are now suggestions that the population of Greenland Barnacle goose might be too large, and that payment rates may be too high in comparison with the actual costs to farmers.

Across the nation, the Scottish Government is seeking to reduce costs by 25%, through stopping funding of scaring and focusing on priority species.[19] It considers that the local approach has worked well and should be continued, including facilitation for crofters and farmers to organise the control of geese locally, but looks for improvement in governance and eligibility arrangements. In particular, equity problems with goose damage occurring in areas not covered by schemes, and the inflexibility of schemes to changing populations and pressures, are highlighted. There is support for development of sport shooting where appropriate, to safeguard conservation goals while also bringing more benefits to rural local communities, and more generally for development of an adaptive management approach. This would require the robust collection of hunting bag returns and would permit agreed levels of local population management and willingness to license control measures where supported by good data. Such an approach will clearly require further science involvement in the measurement and modelling of goose populations.

In Finland predators pose challenges for profitable reindeer herding. Land predator damages are compensated on a basis of damage proven to municipal officers on the basis of found carcasses. For golden eagles, however, herders do not have to prove damages, but receive compensation based on the number of nesting eagles within a given reindeer herding district. Currently, herders themselves inform the Ministry about nest locations, in order to receive compensation. With the land predators, there are constant accusations that herders kill predators illegally. However, the new compensation system for eagles has given herders incentives to report the nests in contrast to previous incentives to destroy the nests.[20]

Biodiversity targets and indicators

Targets and indicators can help to drive major changes if they are properly integrated in policy across sectors. SPIs play important roles in developing indicators, promoting them, building capacity to use them, integrating them into policies and measuring progress.

Targets and indicators are used in many policy areas at a strategic level, setting broad aims and performance measures that can be used to shape and evaluate policy. Clear, outcome-oriented targets can help to reformulate expectations and create conditions in which actors (governments, private sector and civil society) have the confidence to develop solutions for common problems, such as biodiversity loss. However, setting targets is not enough: they must be widely accepted and adopted at appropriate scales, and then integrated into policies and actions.

SPIs can contribute to the development and implementation of targets and indicators at all stages. At the design stage, SPIs can foster the development and communication of measurable and robust indicators, and promote policy evaluations for setting and justifying targets. Indicators play a dual role: (1) they are necessary for monitoring progress against targets; and (2) they help to raise awareness and understanding of biodiversity among policy-makers and others, and can communicate new concepts and emerging issues, perhaps leading to the development of new targets.

Indicators and targets have played an important role in biodiversity policy, in particular through the CBD 2010 Biodiversity Target (see Box 4) and associated indicator framework. SPIs supporting work towards the target include the CBD Secretariat (Box 4), the BIP 2010 partnership (Box 5) and the Countdown 2010 initiative (Box 6). In Europe, the SEBI2010 indicators[21] were developed to monitor progress towards the target. Towards the end of 2010, the CBD adopted an updated Strategic Plan, the Aichi biodiversity targets[22], which includes 20 headline targets under five themes. Most are to be achieved by 2020, but three specify 2015.

Despite the global target setting, biodiversity state indicators (such as species' population trends, extinction risk, habitat extent and condition, and community composition) still show decline, and pressure indicators (such as human resource consumption, invasive alien species, nitrogen pollution, and climate change impacts) are still increasing. There have been some local successes, but overall the rate of biodiversity loss does not appear to be slowing, and "none of the national reports to the CBD claims that the 2010 target has been met at the country level".[23]

There is therefore wide consensus that the 2010 Biodiversity Target has not been met[24], and the CBD recognised this in its revised strategy, stating that "The 2010 biodiversity target has not been achieved, at least not at the global level. The diversity of genes, species and ecosystems continues to decline, as the pressures on biodiversity remain constant or increase in intensity, mainly as a result of human actions."[25] But, it is also clear that biodiversity targets and indicators have created some progress. Without them, the state of biodiversity today would be much worse. According to GBO-3, the existence of biodiversity 2010 target has stimulated important actions for biodiversity: indicators show increasing policy responses including extent and biodiversity coverage of protected areas, sustainable forest management, policy responses to invasive alien species, and biodiversity-related international aid. Internationally, financial resources have been mobilized, and there have been developments in mechanisms for research, monitoring and scientific assessments

of biodiversity. Around 170 countries have developed national biodiversity strategies and action plans.[26]

The requirement to report progress towards the 2010 biodiversity target, and now Aichi targets, has been a major driver in promoting biodiversity indicator development. The international indicator frameworks, offered for example by CBD and BIP 2010, and adapted for use in specific countries, have in turn resulted in increased capacities to monitor biodiversity and establish nationally relevant targets. The use and profile of biodiversity indicators have increased considerably since the adoption of the 2010 target.[27] This should lead to increasing awareness of biodiversity, threats to it, and the consequences for humans, at least among policy makers.

SPIs have played important roles in the successes and failures of the global biodiversity target. The main SPI activities are knowledge brokerage, awareness raising and promotion of targets and indicators, and capacity building and support for developing and using indicators in policy. In particular, SPIs have worked on the development of improved indicators and on integrating indicators into National Biodiversity Strategies and Action Plans (NBSAPs). These are closely related: a key driver for developing more holistic, clear and policy-relevant indicators is to facilitate their understanding and use by policy makers, and their 'mainstreaming' in policy across all sectors.

Partner networks have been a vital resource for SPIs in carrying out this work. In a rapidly developing field, tools to collect new developments and experience, and facilitate widespread learning from them, are essential. Outreach activities for widespread promotion of SPI goals can be carried out by partners and ambassadors. This may be essential where central SPI resources are limited, and also offers advantages associated with partners' closer knowledge of, and involvement with, local/national policy processes and actors. It is important that the partners understand the clear vision of the SPI - first the partners have to learn in order to diffuse learning further - and are motivated and empowered to carry out the dissemination activity. Central SPI publications, web-tools and other resources can help here; clarity of vision and messages are vital. TEEB is a good example, achieving strong recognition and impact through the combination of a charismatic ambassador with outstanding 'translation' and communication skills, Pavan Sukhdev[28], a wide range of important and active partners in both policy and science communities,[29] and a clear approach to communication, including tailored publications for different audiences, newsletters, a press centre, presentation tools, videos, an interactive map of case studies, and so on, available via the website.[30]

Even though the 2010 target has not been met, many instruments and capacities to combat biodiversity loss in the future have been set in place. The role of SPIs has been important in contributing to the target setting, creation of new knowledge, and building capacity. However public knowledge of biodiversity remains limited,[31] and there remains much to be done in communicating biodiversity issues to a wider audience. Progress is also needed in integrating biodiversity indicators and targets in policy across all sectors of government – transforming knowledge into action. SPIs will again need to play a major role, and can learn from the experiences of the 2010 biodiversity target outlined in the boxes below.

Box 4: Convention on Biological Diversity 2010 Target and the Aichi Biodiversity Targets

The Convention on Biological Diversity (CBD) is an international treaty address biodiversity loss at the global level, one of the main achievements of the UN 'Earth Summit' in Rio, 1992.[32] A major CBD objective agreed in 2002 by all 193 parties to the convention was the 2010 Biodiversity Target, "To achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth."[33] This has now been replaced by an updated and revised strategy, including the Aichi Biodiversity Targets, which are much more detailed, split into five themes with 20 specific targets.[34]

The CBD Secretariat plays the role of a science-policy interface aiming (inter alia) to support the biodiversity targets and associated CBD indicators framework. The indicators for the Aichi targets are under development and are to be discussed at the 11th Conference of the Parties in October, 2012. In particular, the Secretariat fulfils two key SPI roles, knowledge-brokerage and capacity building, through which it attempts to change policy maker and other behaviour to the benefit of biodiversity conservation.

Knowledge-brokerage involves gathering, processing and disseminating knowledge on biodiversity problems, consequences and possible solutions. The CBD Secretariat houses 70 experts performing this role, monitoring implementation, and giving technical and administrative support. They maintain close links to the scientific communities, participating in scientific programmes (such as the Millennium Ecosystem Assessment and DIVERSITAS) and relevant symposia and conferences. In 2007, it was noted that, while some specific target groups used knowledge from CBD sources regularly (notably national delegates to negotiation bodies and NGO representatives), the information was little used by the science and business communities, and generates limited media coverage.[35] With the help of external experts, the Secretariat established a communication strategy for bridging the gap between its products and the wider public. The strategy stresses the importance of reaching very different audiences, via publication in several languages, use of policy briefs, assessments and scenarios, the periodic "Global Biodiversity Outlook" (GBO) reports, and multiple channels for dissemination.[36] GBO 3 (2010) received much wider media attention.

Capacity building is a second major role for the CBD Secretariat. The Secretariat has supported national governments' development, implementation and revision of National Biodiversity Strategies and Action Plans (NBSAPs, the primary tool for achieving the CBD goals), through regional and sub-regional capacity-development workshops, with emphasis on incorporation of the 2010 target into NBSAPs and mainstreaming biodiversity issues in sectoral policy.[37] The Secretariat also provides training courses, best practice examples and guidelines for political, legal and administrative practices, and direct responses to practitioners in member states on how to develop capacities.[38]

Despite these efforts, the 2010 target was not met. Many NBSAPs are already dated, and capacity building has been more technical than political with limited influence over wider policy. Coordination structures often have limited political and cross-sectoral commitment, including insufficient resources for financing ambitious actions. The Secretariat cannot directly fund biodiversity projects, has no regulatory or sanctioning powers, and has limited resources for more extensive capacity building projects. Nevertheless, second generation NBSAPs are considered to be better in many respects than the previous ones[39].

The Aichi targets are more detailed and specific than the rather general 2010 target, and fit in to a strategic programme of actions. This more complex structure may appear harder to communicate easily. There is a simpler 'vision' statement, though even that is more complete and nuanced than the 2010 target. But, with the benefit of hindsight, the 2010 target seems too simple, and too overwhelming, to serve as a practical guide to policy. Breaking the overarching vision down into 20 strategic targets may in fact make it clearer to individual policy makers how they can contribute to achieving one or more of the targets through changes in policy in their areas of competence.

Box 5: Biodiversity Indicators Partnership 2010

The 2010 Biodiversity Indicators Partnership (BIP 2010) was established as a collaboration of various organisations with the aim to further develop and promote indicators for monitoring and assessment of biodiversity, promoting knowledge on biodiversity indicators, supporting their use in policy, and linking with regional and national biodiversity initiatives to build capacity and improve the delivery of biodiversity indicators.[40]

BIP 2010 is structured as a partnership with 'Indicator partners' and 'Affiliate partners'. Indicator partners (including NGOs, conventions, initiatives, research institutions and UN bodies) lead the development and implementation of individual indicators, with funding from the Global Environment Facility (GEF) via BIP2010. Efforts are made to 'package' indicators in ways that help politicians to see their relevance and potential uses.

Constraints identified by the Indicator Partners include

- poor and inconsistent data collection (availability, quality, and coverage),
- problems with unclear messages and communication,
- low profile of some indicators, and lack of understanding about the relevance of indicators among decision-makers,
- inadequate collaboration between the BIP Partners,
- uncertainty over continuity of funding for indicator work.

Possible solutions include capacity building (producing guidance on data collection, improving indicator expert network)), producing clear, tailored messages for target audiences and supporting uptake in key organisations, and reviewing/learning from other indicator initiatives such as SEBI 2010.

According to BIP 2010, the indicators in the CBD framework are isolated, which hinders understanding of policy relevance. This led them to develop 'linked indicators', with four types: Pressures (threats to biodiversity); State (the condition of biodiversity and how it is changing); Responses (policies or actions to prevent / reduce biodiversity loss); and Benefits (resulting changes in services that people derive from biodiversity).[41] This is an attempt to make indicators holistic, policy relevant, and easy to communicate and understand. Actual outreach and dissemination work is to take place through the work of BIP2010 partners, though the secretariat provides knowledge and documents for partners to draw on to reach a variety of audiences. In a few cases the secretariat is directly involved in external communication, in particular with international organizations, when representation of the BIP 2010 is needed to strengthen its legitimacy, and through participation in wider initiatives such as GBO 3 and other large scale assessments.[42]

BIP 2010 is also involved in a series of regional capacity building workshops in order to help countries in selecting and producing indicators for their NBSAPs and international reporting obligations. BIP2010 web pages link to regional and national indicator projects and initiatives and provide briefing about specific initiatives, supporting learning and awareness of developments in indicators. Feeding developments back to the BIP Indicator Partners helps them to continue development of global indicators:[43] capacity building and learning function in both directions.

Feedback from workshops highlights that national biodiversity indicators are often dependent on data availability and interest, and rarely linked to NBSAPs, policies or decision-making. In part this is because the 2010 Biodiversity Target and indicator framework were widely understood mainly as a reporting requirement. The BIP 2010 partnership is supporting governments and agencies in understanding a wider role for indicators, including by communicating the relevance and benefits of creation and implementation of NBSAPs.

Box 6: Countdown 2010

Countdown 2010 was an IUCN initiative financed by various Ministries of Environment and nature conservation agencies (mostly from Europe). The network of over 1000 partners from more than 60 countries and various sectors aimed to "mobilize action to ensure that all governments and members of civil society, at every level, have taken the necessary actions to halt the loss of biodiversity by 2010."[44]

It was a SPI promoting and building capacities for the 2010 biodiversity target. Key principles of the Countdown 2010 initiative included transparency, autonomy and independence, subsidiarity, and underpinning work with "sound science".[45] The three main objectives were to:

1. gain maximum public attention for the challenges of 2010 biodiversity target
2. encourage and support the full implementation of international commitments and necessary actions for biodiversity
3. demonstrate what progress the world makes in meeting the 2010 Biodiversity 2010 target.

Public attention was sought through wide networking, seeking new partners, recruiting high-profile 'ambassadors' committed to promoting the target, supporting outreach work at various scales, attending high-level meetings and making recommendations for decision makers. This 'awareness raising' strand of work aimed at fostering learning by various actors, encouraging buy-in for biodiversity targets, and generally enhancing commitment to biodiversity issues and solutions, changing the behaviour of people and their organizations.

Capacity building work focused on direct interventions to improve (national) capacities to develop and implement governance instruments for biodiversity. National implementations were supported through the IUCN/UNEP Tematea project, aiming to support better and more coherent national implementation of biodiversity related conventions through issue-focused web-based tools. Countdown 2010 also developed "multiregional hubs" for assessing biodiversity threats and possible solutions at regional scale. Countdown 2010's "Readiness Assessment" analysed the policy responses of national governments in the G8+5 countries. The Readiness Assessment helped countries in reviewing their own progress towards achieving the 2010 Biodiversity Target, and supported changes to biodiversity governance instruments.

It being 2012, the Countdown 2010 initiative is now finished. There is at present no direct equivalent focusing on the Aichi targets as a package; the IUCN works towards biodiversity conservation through a wide range of 'knowledge', 'action' and 'influencing policy' initiatives at various scales. The IUCN is playing an important role in key 2012 events including the Rio+20 conference in June 2012, the IUCN World Conservation Congress in September 2012, and the 11th CoP of the CBD in October 2012, and it remains to be seen if a 'Countdown 2020' or similar will be launched.

Scenarios

Scenarios help policy makers and other actors to understand the importance and implications of environmental trends and changes under various possible future conditions. SPIs may use scenarios to raise awareness, highlighting the consequences of different courses of action, encouraging stakeholders to reflect on policy and behaviour changes that may be needed in order to avoid negative outcomes. Scenarios may also be used by SPIs to support policy design.

Scenarios are used by various environment and biodiversity-related SPIs as tools to raise awareness, encourage discussion and learning, and influence behaviour and policy formation. They tend to focus on possible mid- to long-term outcomes, and the aim is not to predict, but rather to contrast different potential futures. Examples of major scenario exercises include CBD's Global Biodiversity Outlook[46] (Box 7), UNEP's Global Environmental Outlook[47] (Box 8), the scenarios of the Millennium Ecosystem Assessment[48] and the IPCC scenarios[49]. At smaller scales, various research projects (e.g. SCENES, Box 9) and national initiatives use scenarios as tools to initiate learning and change in biodiversity related behaviour.

By focusing on possible future conditions, expressed in familiar terms, scenarios make current issues in environmental change more meaningful and understandable for various actors. Qualitative storylines can incorporate diverse variables and issues, aiming to condense knowledge from various sources under one coherent story. The information is made more accessible, facilitating awareness raising, learning and behavioural change for various actors.

Scenarios have no direct environmental impacts and do not exert direct influence over behaviour in the way that market based instruments do. They do not set clear targets for policy, though 'backcasting' methods are used to determine how to achieve specific targets under different scenarios. Nevertheless scenarios do aim to influence behaviour of policy makers and other stakeholders by narrowing down choices and by enabling policy makers to chose between alternatives. Scenarios do this by alerting various audiences to the possible consequences of different courses of actions, to possible future events and dangers, and to the existence of 'points of intervention' where their decisions could make a difference.

Large scale scenario-based assessments can even spread new concepts and tools for thinking about a problem. For example, the Millennium Ecosystem Assessment (MA) played a key role in promoting the concept of ecosystem services. Environmental and ecological economists had been working with this concept for some years, but the way the MA introduced the concept to large audiences has led to an explosion in use of this conceptual framework, now adopted by many organisations. The new way of thinking has proven to be a powerful communication tool, and forms a key plank of further SPI initiatives such as TEEB (The Economics of Ecosystems and Biodiversity). There have been practical policy and behaviour implications, with widespread interest policy and science interest in the development of Payments for Ecosystem Services (PES), a branch of market-based instruments[50]. Assessments of ecosystem services, and their value to humans, have become common components of policy appraisals and in justifying expenditures.

The SPIs behind scenario exercises can enhance their success by focusing on the potential to introduce new ideas and new ways of thinking and influence and behaviour. Learning is especially likely for actors directly engaged in the scenario development process. However the end products, reports and policy briefs directed at different audiences can also foster

learning, through discussions and deliberations about different future paths, and potential points of intervention for different actors seeking to influence these.

Scenarios are diverse and do not aim to predict, so they are not expected to be 'right' or 'wrong', but must be based on credible knowledge and be plausible if they are to be considered useful. Often, scenarios will combine knowledge on a wide range of factors and processes, and attempt to consider quite remote time horizons (by human policy standards). This means that knowledge synthesis and review are important parts of the process, requiring strong science involvement. But the ways in which organisations and individuals might react to changing conditions is also central, so participation by the full range of stakeholders involved in the policies and actions shaping the future of the area of interest – for example policy makers, industry, agriculture and so on – is essential to the development of successful scenarios. An example of such a participatory approach to scenarios is the "Positive Visions for Biodiversity" meeting that took place in 2010, where 230 participants developed a "Vision Framework" composed of goals and top changes that should occur by 2050 to create a sustainable relationship between nature and human beings (http://www.positivevisionsforbiodiversity.org/). This participation will enhance the credibility, legitimacy and relevance of the work.[51]

Box 7: Global Biodiversity Outlook

Global Biodiversity Outlook (GBO) is the flagship publication of the Convention on Biological Diversity (CBD). It summarizes knowledge on the latest status and trends of biodiversity, and forms the basis for developing the future strategy of the Convention.[52] The GBO uses scenarios as an instrument to raise awareness and alert policy makers and other stakeholders to the loss of biodiversity and ecosystem services and the consequences for human populations.

GBO 3 notes that, although instruments to halt the loss of biodiversity exist, their usage requires more political will than is currently shown. Through scenarios, GBO aims to help policy makers and stakeholders to think about and discuss where different future paths might lead – demonstrating how "business as usual" will lead to serious losses of biodiversity and ecosystem services, with severe consequences, while alternative development paths could reduce or avoid these costs.

Scenarios can also highlight issues which are important but neglected in current policies. For example, GBO 3 notes that most responses to biodiversity loss have focused either on decreasing direct pressures on biodiversity or on preservation of biodiversity in protected areas; it is becoming increasingly urgent that the underlying drivers and causes should be addressed, through new governance instruments and 'mainstreaming' biodiversity concerns across all policy areas.

GBO 3 drew on a wide knowledge base, including over 110 fourth national reports provided by the Parties of the CBD, status and trends from the Biodiversity Indicators Partnership, and some 500 peer-reviewed articles and assessments from intergovernmental and non-governmental bodies. Many scientists, working for example in the DIVERSITAS network and UNEP-WCMC, were involved in reviewing this information and drafting the biodiversity scenarios for the 21st century.

GBO 3 also went through a "transparent and rigorous review process" involving scientists and stakeholders. An initial internet draft drew comments from some 200 reviewers. The revised draft was subjected to scientific review by a panel including scientists, intergovernmental bodies and non-governmental organisations. Decision makers and governmental actors were particularly encouraged to participate in the review process, and NGOs, institutions and universities could also submit comments. The width of the knowledge base, use of respected scientists and extensive quality control with wide participation act to enhance the credibility, legitimacy and relevance of the product.

Box 8: Global Environment Outlook

The Global Environment Outlook (GEO) is "a consultative, participatory, capacity building process for global environmental assessment and reporting on the state of the environment, trends and future outlooks".[53] It is led by UNEP's Division of Early Warning and Assessment, and aims to make the state and trends of the global environment clearly visible, and to foster linkages between science and policy. Various science-policy related issues can be identified from the GEO processes.[54]

The process involves a strong 'demand-side' element, via participation of governments, regional bodies and other stakeholders. The stakeholders also bring in specialized knowledge on certain subjects. This inclusivity makes the assessment more relevant, directly addressing policy and stakeholder needs from the start, and also more legitimate through the inclusion of many perspectives and interests. The integrated approach also helps in the identification of opportunities or 'intervention points' for policy makers to address priority environmental issues.

The GEO process has contributed to capacity building in monitoring and evaluating mechanisms, drawing on stakeholders' feedback on the GEO process and outputs. Iterative evaluation processes identify what works and what needs to be changed, and when stakeholders have a say in the methods of knowledge production, they are more likely to accept the process and its outputs.

GEO has used a collaborative approach, developing processes of information and data gathering and knowledge sharing that engage scientific and policy actors and other stakeholders at multiple scales. Networks are used for stakeholder consultations inviting various stakeholders to comment draft materials and also scientific reviews. Wide networks enhance the credibility and legitimacy of knowledge, and also facilitate knowledge sharing and diffusion. The collaboration and partnership approach gives an expanded sense of ownership of the process and its products, among the same actors who have the power to use the knowledge in their work, thereby enhancing the likelihood that the GEO outputs will actually be used in policy making aiming to protect biodiversity.

This is further supported by GEO's capacity building programme, which provides governments and partners with the tools and methods to implement integrated environmental assessments – leading to improved national and regional reports, more useful to the national actors, and feeding back to enrich the global assessment process.

Box 9: EU project SCENES

With funding from the European Commission's 6th framework programme, SCENES[55] (Water Scenarios for Europe and for Neighbouring States) aims to build participatory freshwater scenarios for Europe and nine pilot areas up to 2050. In each area, a scenario panel produces water scenarios, via three iterative workshops. Participation is built around deliberation with an aim of supporting planning: open discussion of various interests, identification of problems, and production of scenarios for the future of the water use and quality. The project has also established a further process to address cross-scale issues, and for linking the scenarios and impacts with environmental, agricultural and other relevant policy processes in Europe.

SCENES used backcasting methods at the workshops.[56] While descriptive scenarios tell us where we might be heading under different assumptions, backcasting scenarios tell us "how to get to where we want to be". It helps to identify measures and decisions that are needed in order to move towards desired future.[57] In SCENES, the backcasting and identification of necessary decisions are carried out under different storylines; the identified policies are then compared across the scenarios. Common findings across different scenarios can be seen as robust decisions, which are needed regardless how the future will unfold, helping to identify key actions for various policy makers and stakeholders.

Various lessons from SCENES highlight ways to improve knowledge dissemination and effectiveness in multi-scale scenario exercises:[58]

- translate results to national languages for knowledge diffusion at pilot area and national scales
- make proactive use of various media and methods for visualization of results, and encourage media participation at stakeholder workshops.
- arrange focused meetings with policy makers, in addition to more general workshops. A round table with high level politicians was especially effective in reaching high-ranking decision makers, giving workshop participants a sense that their work was important, and the opportunity to ask questions of politicians, and in gaining media attention.
- select relevant stakeholders carefully: are all the relevant sectors and factors represented? A common problem for the pilot area and pan-European workshops was that actors from industry were absent or under-represented.

3. Developing attributes for SPIs

The impacts of SPIs on behaviour depend on many features within and outside the SPI. Drawing on literature, workshops and interviews, we analysed the characteristics of SPIs that are most associated with success and developed a set of attributes that can be used to help design, implement, assess and improve SPIs.

In SPIRAL, SPIs are being analysed within a framework based on a distinction between *structures, objectives, processes, outputs*, and *outcomes*.[59]

- **SPI structures:** institutional arrangements used to achieve the goals of the SPI. Many different SPI structures can be identified, ranging from very formal, institutionalised bodies to informal and flexible relationships, and from one-off or time-bound exercises to on-going, semi-permanent institutions. SPIs can operate at different political levels, closer to policy or to scientific processes, and may focus on one or more stages of the policy cycle (early warning, issue identification, policy design, implementation, assessment, review).
- **SPI objectives:** the stated (or sometimes implicit) aims of the SPI. Objectives address one or more policy or societal needs by fulfilling a role in the interaction between science and policy. In practice SPI objectives may be flexible, and in some cases participants may not agree on details or have hidden agendas. We can also consider **SPI functions**, the roles that an SPI actually fulfils, which may differ from its objectives.
- **SPI processes:** the ways in which the SPI uses its structures to achieve its objectives and functions, via production of outputs. Processes will often be defined by procedural rules and guidelines, but there may be additions to or variations from 'official' codified procedures, and in some cases most interaction may be *ad hoc*.
- **SPI outputs:** the tangible products emerging from the process, for example reports, workshops, websites, indicators, policy briefs, declarations, press releases and so on.
- **SPI outcomes:** the direct and indirect impacts and effects that either the SPI process itself or the outputs have on behaviour and ultimately biodiversity. Outcomes are not controlled directly by the SPI, which can try to influence its outcomes only through changes in the other four categories (structure, objective, process, and/or output).

These categories are not fully distinct – for example there is fuzziness between 'processes', which relate to day-to-day operation of the SPI, and the 'structures' that create the framework. Some attributes could appear under more than one heading – for example 'Quality Assessment', which we have classified under 'Outputs', could also be considered under 'Processes'. The categorisation is a guide to help think about SPIs and attributes, but SPIs are complex entities, and their structures, objectives, processes and outputs are closely entwined in ways that it may be necessary to consider for any given case. For example, the 'people' and 'resources' elements of the 'structures' category will have implications for what is possible in terms of 'processes' and 'outputs': so identifying the need to improve some aspect of 'outputs' may lead back to the need to modify 'structures'.

SPIRAL also considers three important descriptors of SPI influence, outcomes and impacts: the SPI's *credibility*, *relevance* and *legitimacy* (CRELE)[60].

- **Credibility** refers to the (perceived) quality, validity and scientific adequacy of the evidence and arguments used by the SPI, including consideration of the

individuals/organisations involved, and the processes for generating and synthesising knowledge.
- **Relevance** (or saliency) refers to the responsiveness of the SPI to policy and societal needs, including the usefulness and timeliness of knowledge communicated.
- **Legitimacy** refers to the (perceived) fairness and balance of the SPI processes, covering transparency, inclusiveness of all stakeholders, conflict resolution and fairness in the treatment of divergent values, beliefs, opinions and interests.

There is some evidence that CRELE can help to explain the effectiveness and influence of SPIs, and suggestions that there may be minimum requirements for each as a necessary (but not sufficient) condition for an SPI to be effective,[61] though our results cast some doubt on this. There are also trade-offs where attempts to improve one aspect can result in losses elsewhere.[62]

To explore further the success attributes for SPIs, we classified the existing arguments found in previous research on science-policy interfaces based on the above framework. Our review focussed on the following main sources:

- **The "Assessment of Assessments"[63]:** launched in 2005 by the UN General Assembly, the AoA aimed at building foundations of a regular process of global reporting and assessment of the state of the world's oceans. It identified eight design principles for establishment and operation of an assessment process, focusing on structure, process and objectives.
- **The National Research Council[64]:** identified 11 elements for effective assessments, focusing on process, structure and objectives.
- **Lentsch & Weingart[65]:** examined various SPIs to draw conclusions on institutional design features for robust scientific advice, for three phases of 'preparation' (defining problems, setting objectives, establishing structures); 'working' (processes to synthesise knowledge); and 'impact' (publication, training, utilisation).
- **Wider research** considering the two-way interactions of SPIs and the efficiency of communication methods[66] and structures and processes that lead to knowledge being fully used in policy[67] (rather than ignored, or used strategically/selectively).

The main features identified from the literature formed the background for our research into attributes development using interviews and workshops (see Box 10). The attributes underwent several revisions during this process (also called communicative validation): the final set is presented in the following tables:

- Table 2: Attributes for SPI structures and institutional arrangements
- Table 3: Attributes for SPI objectives / functions
- Table 4: Attributes for SPI processes
- Table 5: Attributes for SPI outputs.
- Table 6: Attributes for SPI outcomes

The first four present attributes and the 'lessons learned' that motivate their selection: why it is that each attribute matters. Further details on each attribute, i.e. how to assess it, and the source evidence, are presented in factsheets at the end of this document.

The attributes for outcomes are a little different: they are not controlled by the SPI, which can try to influence its outcomes only through changes in the other four categories (structure, objective, process, and/or output). So there we focus on features by which the outcomes could be assessed.

The outcome attributes can be useful for assessing the performance of specific SPIs, and also for research seeking to analyse the effectiveness of SPI features generally (i.e. attempting to discover which (combinations of) features are strongly associated with achievement of SPI goals). However such evaluation can be difficult, for three main reasons.

- **Unclear objectives**: performance should be evaluated in relation to the SPI's goals, so if these are not clear, it is hard to know how the evaluation should be carried out.
- **Timing**: desired effects may occur with a significant time-lag, due to policy cycle delays, while the evaluation requirement may be more immediate (in order to feed back to change in the SPI). Here, effectiveness of outputs may be used as a proxy for outcomes/impacts.
- **Boundaries**: ultimate impacts depend on a complex network of policy and other events (international crises, environmental shocks…), only some of which are within the (partial) control of the SPI. And teasing out the exact contribution of an SPI to outcomes may be very difficult. Proxy measures may again be needed to assess whether the SPI has performed adequately.

Using the attributes

There are potential trade-offs and conflicts among the SPI success attributes, and their relative importance is heavily context-dependent, varying according to the type of problem, the stage in the policy cycle, and various other factors, such as personal perspectives. Considering these factors helps attributes users to determine which attributes to emphasise.

The attributes can be used to guide the design, implementation, assessment, and revision of SPIs. They provide a convenient checklist of items to consider and generally desirable features for SPIs. The relevance and relative importance of different attributes will of course depend on the SPI context (the policy, science and stakeholder environments in which it operates), and the attributes are not independent. In some cases, features under one attribute will determine what is most appropriate under another – for example, where a policy mandate and resources are specific and time-bound, horizon scanning and continuity are not relevant. Geographical scale, and the human and political cultures encountered, are likely to be important considerations.

There are also potential conflicts between some of the attributes – for example, emphasis on consensus building may conflict with delivery of timely advice. Previous research[68] on credibility, relevance and legitimacy has flagged possible problems enhancing all three dimensions, though the trade offs have not been fully explained. Through discussions at the SPIRAL workshops and interviews, and by comparing and contrasting the attributes developed, we have elaborated a number of trade-offs to consider (Table 7). These should be kept in mind when applying the attributes and considering changes to an SPI.

The relative importance of the attributes also varies according to the policy context, which may strongly shape the needs and requirements for science-policy interfaces.[69] For enhancing interactions between science and policy it is important to understand how policy processes work and how scientific expertise is treated in the policy cycle.[70] The policy process is cyclical and iterative and scientific input can be integrated at every stage of the cycle (see Figure 2) – problem identification and political agenda setting, defining targets, developing regulations and other policies, implementation, monitoring and evaluation – but in different ways and with different needs.[71] An assessment of how the relevance and applicability of the attributes vary through the policy cycle is presented in Table 8.

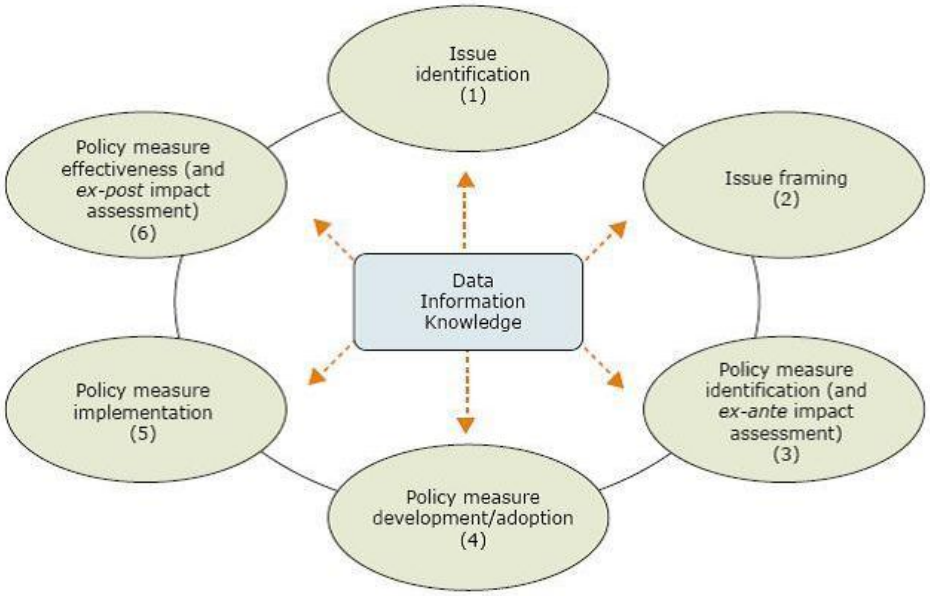

Figure 2: Main stages in the policy cycle, with SPIs at the core (Policy effectiveness evaluation report, EEA)

The type of policy problem is a central consideration. Policy problems vary according to their complexity, potential for political conflicts, and solutions available. Achieving coordination in cross-sectoral problems can be especially challenging; and this is often the case for biodiversity loss, where diverse threats impact on biodiversity. There may be need for a wider range of scientific expertise, and more attention to covering all views, presenting uncertainties, and resolving conflicts. The role of SPIs also differs according to how clearly structured the policy issue is,[72] and this has implications for the relative emphasis on different attributes (see Table 9). Badly structured or unstructured problems make it difficult to assess the success of an SPI dealing with that particular issue.

Different assessment attributes may be relevant for SPIs depending on their location in science-policy continuum. SPIs can act to sharpen or to blur the boundaries between policy and science.[73] With sharp boundaries, production of knowledge occurs in institutionally separate spheres: SPIs communicate scientific answers to policy questions. With blurred science-policy boundaries, science and policy actors are integrated within 'knowledge coalitions' (also called 'epistemic communities'[74] or 'advocacy coalitions'[75] (Sabatier 1988), often in competition with alternative coalitions making different knowledge claims. Here there is strong emphasis on maximising credibility, and often on discrediting alternative knowledge claims. SPIs may be representing, or having to deal with conflict between, vested interests.

For "near-science" SPIs, translation is a key issue, since heavily scientific formats are likely to be less useful for integration in policy. Independence, quality control and (extended) peer-review[76] are likely to be important. Efforts may also be needed to reach out to policy communities, understand their needs, and incentivise scientists to 'go the extra mile' in translating and communicating their knowledge. Capacity building may focus on enabling scientists to comprehend and respond to requirements of the policy process. Less emphasis may be placed on inclusivity of non-science stakeholders and on trust-building and conflict management strategies.

For SPIs that have blurred boundaries between science and policy, inclusivity, conflict management and trust building are all likely to be important. Capacity building may focus on increasing policy-makers' abilities to understand and use scientific evidence. Formal outputs may be of reduced importance, if the main impact is from participation in the SPI process itself.

The appropriate balance will therefore vary depending on objectives and policy context, and an interface could be successful without following our lessons learned in each attribute category. Or, an SPI could satisfy most of the attributes but still lack influence and impact because of external policy contexts. In many cases, relevance may be seen as the key feature – the goal of the SPI is to influence behaviour and policy, and ultimately improve biodiversity outcomes, and for this credibility and legitimacy may be of interest only as means to achieving the end of policy relevant influence.

So we are not proposing a 'one size fits all' approach to SPIs. The attributes should be seen as an aide memoire of features to consider, rather than a list of boxes to tick, and users of the attributes should carefully consider which attributes to emphasize based on the purpose and context of the given SPI.

Box 10: SPIRAL attributes workshops and interviews

Building on the review on literature on assessment attributes, we organised two workshops with over 20 external participants, and carried out interviews with eight additional experts to refine the assessment attributes for science-policy interfaces. The workshop participants and interviewees were scientists and policy makers with extensive involvement in science-policy work.

The first workshop[77] involved 'story telling' sessions, in which each invited participant briefly described their experience with a biodiversity-related science-policy interface. These were followed by group discussion exploring points of interest and lessons from the story. Stories covered major international initiatives drawing on multiple research and policy communities, specific national and local SPIs, individual projects, and SPIs focussing on a specific issue. This work led to a set of 44 attributes for explaining successes and failures of SPIs, categorised according to (1) CRELE (credibility, relevance and legitimacy) and (2) the SPI framework (structure, objectives/functions, processes and outputs).

The interviews sought to test the attributes matrix, as well as collecting further experiences regarding SPI success or failure to influence on policy. The attributes caused some confusion due to the classification according to both CRELE and SPI framework, and because of the large number of attributes. We simplified the attributes, reducing the number to 20, removing the CRELE classification (though CRELE remains a useful framework to keep in mind), and adding a distinction between 'outputs' (products) and 'outcomes' (impacts). The outcome section was added to facilitate analysis of the link between SPI characteristics and their impacts on policy, human behaviour and ultimately biodiversity.

The second workshop[78] focused on verifying the attributes. Before the workshop, participants prepared a story about an SPI they knew, linking this to the attributes set. They were asked to consider what attributes could be used to explain successes or failures of SPIs to influence policy, and what additional factors should be considered. The aim was firstly to provide examples of good/bad practice and explanatory factors to support the further development of assessment attributes, and secondly to comment, amend and verify a final set of attributes. Based on these discussions we revised the attributes again: the final list is presented in the tables below.

Table 2: Attributes for SPI structures and institutional arrangements

Attributes: what to assess	**Lessons learned: why to assess**
Independence (freedom from external control, 'neutral' position, balanced membership …)	Independence from external control: increases credibility
	Documentation and transparency of dependencies (e.g. funding links, underlying values and power structures): enhances credibility
	Neutral stance: partisan policy agendas may decrease credibility and lead to exclusion of SPI from some forums
	Balanced membership (e.g. geographical representation, interest groups): helps to maintain independence, neutral structure, credibility.
People (all relevant expertise and interests; competent participants; open to new participants …)	Wide coverage of expertise (range of experts, coverage of different views/paradigms, experience/competence, types of knowledge, multi-disciplinarity as needed): increases knowledge base, legitimacy and credibility of the SPI
	Open to new participants: increases legitimacy and can create 'buy-in' and 'ownership' of SPIs' messages for policy makers and stakeholders
	Competent participants (sufficient expertise, peer-group respect, ability to represent interests and people they are supposed to): increases credibility and also legitimacy
Resources (financial resources, human resources, networks…)	Participants are motivated: incentives, clear policy demand, or other mechanisms attract participation and action by relevant scientists, policy makers, and other stakeholders
	Good leadership: helps to move things forward (e.g. by drawing more resources to SPI, facilitating compromises, reaching out to policy side, providing expertise and credibility, motivating others)
	Key human resources such as 'champions' in strategic organisations, translators, charismatic 'ambassadors': well-respected and high-placed members improve visibility and credibility and facilitate access to other resources
	Adequate and sustained financing: enables the SPI to achieve objectives; inadequate funding endangers continuity and motivation

Table 3: Attributes for SPI objectives / functions

Attributes: what to assess	**Lessons learned: why to assess**
Vision (clarity, scope and transparency of the vision and objectives of SPI)	Clear and transparent strategic vision: helps to develop agreement on target scales, sectors and actors
	Choosing strategy between issue advocacy and honest broker[79]: lobbying may be efficient in some instances, while honest brokerage probably increases credibility, but generally better to pick one and stick with it.
	Ambitious goals: aiming to deal with large issues can motivate participants, and helps to see the relevance of the SPI in larger contexts
Balancing supply and demand (striking balance between meeting policy needs and ability to communicate emerging issues)	Aiming for policy relevance: Science / supply driven SPIs can create policy demand by addressing societal problem, gaps in knowledge and policies, topical concepts and by related awareness raising
	Policy mandate: SPIs with policy mandate cannot be easily ignored by policy makers
	Mandate seeking: SPIs may seek a specific mandate from policy makers to move from policy relevance to policy demand
	Room to take initiatives: In demand-led SPIs, sufficient room left for emerging issues to increase agility and long term policy relevance

Table 4: Attributes for SPI processes

Attributes: what to assess	Lessons learned: why to assess
Horizon scanning (procedures to anticipate science and policy developments)	Planning for appropriate time perspectives: is relevant for timely policy interventions, and for realistic scope for knowledge gathering
	Inclusive scoping processes: increase relevance and legitimacy
	Strategic scanning for potential collaborators (and opponents), opportunities, windows of opportunity, and threats: aids in strategic planning and maintaining relevance
	Filter new ideas: SPIs can be "gate keepers" making distinctions between crazy and useful new ideas in science and policy
	Access to latest policy and research knowledge: increases relevance and credibility
Continuity (continuity of SPI work with the same issues; continuity of personnel; iterative processes…)	Continuous and iterative policy support (e.g. periodic and regular policy advice): important for building efficient SPIs and well working interaction between science and policy
	Network building/maintenance: SPIs need to build and maintain collaboration networks to increase possibilities for continuity and establishment of SPI as an influential player in its domain
	Membership: some continuity in members of SPIs is useful to maintain relationships and trust
	Changing contexts: SPI's continuity may be challenged by changing policy priorities and funding situations
Conflict management (strategies may include third party facilitation; allowing sufficient time for compromise etc.)	Clearly stated and appropriate methods: needed to prevent and manage conflict and power plays.
	Recourse to external independent conciliation: may improve chances for reaching agreement
	Staged process and internal ombudsman: to ensure fair roles of involved parties
	Open scientific debate: constructive 'conflict' can also be seen as a healthy sign of open dialogue
Trust building (possibilities to participate in discussions, clear procedures, opportunities for informal discussions; transparency about processes and products…)	Regular opportunities for dialogue: (informal) multi-stakeholder dialogue including local communities as appropriate is needed for building trust and relationships
	Creating trust relationships for quick communications between scientists and policy makers (who can I call?): enhances relevance
	Understanding diverse cultural values of policy makers, scientists, member institutions and target audiences helps to create mutual trust
	Safe discussion arrangements (e.g. what is said in the meeting remains in the meeting): can build trust
	Defined contact points for participants to voice their concerns (e.g. in plenary) and agreed procedures for approving external statements: clarify possibilities for participation and thus can increase trust and create sense of commitment
	Open access to outputs and statements: increases transparency and also trust
Capacity building (helping policy makers to understand science and scientists to understand policy makers; building capacities for further SPI work…)	Build capacity with needs of SPI: Iterative and parallel processes of capacity building and SPI development increase SPI's possibilities to influence and create sense of continuity and commitment;
	Science training: training manuals and other tools used to build capacities for policy makers and stakeholders to understand science
	Sectoral integration by teaching and learning from other sectors can build capacities to mainstream biodiversity
	Enhance capacity for further work: for example by maintaining databases, training on data, availability and access
	Policy training: when scientists are trained to better understand policy processes connectivity between science and policy is enhanced

Attributes: what to assess	**Lessons learned: why to assess**
Adaptability (responsiveness to changing contexts; flexibility to change…)	Processes/ability to change previously agreed things or wordings, correct weaknesses, take advantage of new opportunities, respond and understand changing (science and policy) contexts, and include new members and skills: increases long term relevance
	Assessing efficiency (with what resources the goals have been met or not): helps to (re)direct resources
	Continuous evaluation of outputs and impacts against SPI objectives: needed for assessment of effectiveness in order to reformulate or continue with existing practices. Assessment of any unplanned/unintended functions the SPI is fulfilling.

Table 5: Attributes for SPI outputs.

Relevant outputs (timely in respect to policy needs, accessible, comprehensive; efficient dissemination…)	Strategic promotion: Launching outputs in relevant events (and right presenters for the audience) increases visibility
	Use of brief summaries: increases accessibility and expands audience
	Outputs tailored for target audiences and policy contexts: increasing accessibility of knowledge and relevance
	Communication of uncertainties, divergent views and knowledge gaps: increases credibility
	Patience: publishing premature results can decrease trust and lead to unnecessary conflict
	Clear communication and outreach strategy: helps to build effective media relations
	Outputs timely with respect to policy needs/cycle, mechanisms for rapid response if needed, and planning in advance for anticipated needs increases relevance.
Quality assessment (processes to ensure quality, comprehensive-ness, transparency, robustness, and management of uncertainty…)	System for continuous or periodic quality review of research and knowledge used in the SPI: increases reliability, credibility and quality of produced outputs
	Formal procedures for peer review: increase credibility
	Variety of existing and reliable data sources: widens knowledge base and ensures quality of knowledge
	Extended/stakeholder review: increases legitimacy and relevance
	Attention to uncertainty: adequate attention to accounting for and communicating uncertainty increases credibility
	Checking completeness of knowledge coverage: helps to identify knowledge gaps and further needs
	Transparency and traceability about the origins of each piece of knowledge: increases credibility
Translation (efforts to convey messages across different domains and individuals, and making the message relevant for various audiences…)	Adapting used language to the competencies of SPI members and to the audiences (jargon avoided, concepts explained, background assumptions defined…): helps to build common understanding
	Skilled "translators": can help to convey messages between scientists and policy makers
	Simplified communication tools (e.g. figures, maps, pictures..): can successfully translate scientific messages for policy makers
	Matching science and policy context (e.g. matching scientific findings to policy relevant scale): important for making message useful and relevant

Table 6: Attributes for SPI outcomes

Type of outcome	Potential assessment features
Social learning	Information from the SPI leads to learning: • Members of SPI learn and change their practices (leading to better capacities for further SPI work, and to changes in policy makers' behaviours to create or adopt new policy instruments) • Target audiences learn and change their practices of their organizations, • Wider public learns and change their individual behaviours;
Behavioural impact	Impact of the SPI on the behaviour of their target audiences. Information/learning leads to behaviour changes, that can have direct biodiversity implications, or they can result in further policy and consequent behavioural changes having direct impacts on biodiversity.
Policy impact	The policy changes resulting (in part) from SPI information, learning, and associated changes in policy-maker behaviour.,
Biodiversity impact	SPIs can be assessed regarding their contribution to the impact on the 1) state of biodiversity, 2) drivers and pressures threatening biodiversity and ecosystem services, and 3) societal responses directed at halting biodiversity loss and deterioration of ecosystem services and resulting well-being. These impacts form the overall result of learning, behaviour and policy changes associated with the SPI.

Table 7: Trade-offs among CRELE and the SPI attributes

Trade-off	Explanation
Quality assessment increases credibility, but may reduce possibilities for relevant and appropriate outputs	Checks, audits, review processes all take time and effort. So do trust and consensus building, and wide stakeholder involvement. Systems to allow fast reaction can be used, but could threaten credibility and legitimacy if errors are made or if some SPI participants do not agree with the products.
Increasing relevance through stronger links to policy could decrease independence, legitimacy and credibility of the SPI	SPI participants or audiences may fear the SPI has been 'captured' by political interests. Greater transparency and consensus building may reduce such risks.
Improving legitimacy by including new members could decrease credibility if expertise is compromised.	Competencies and respected expertise of SPI members build credibility; including stakeholders with vested or uninformed interests could damage this. Solutions include separation of 'advisory' roles ('neutral' advice on evidence) from 'representative' roles (representing specific stakes or interests), strengthening quality control, and providing training.
Clear messages are relevant but may not always communicate uncertainties credibly	Exploring and communicating uncertainties and tipping points increases credibility but may reduce clarity of message and therefore usefulness for policy makers. But, there is also evidence that policy makers need to know about uncertainties. So the challenge is to communicate them in clear and useful formats, not to gloss over them.
Keeping up continuity may restrict adaptability and sensitivity to change	Focus on adaptability and acknowledging constantly changing policy needs and contexts increases relevance, but may require changing SPI membership and audiences. Continuity and stability of objectives, structures and processes is likely to increase credibility and visibility of SPIs in the long run. The challenge is to successfully balance between adaptability and continuity.
Strong leadership may increase credibility but lead to poor legitimacy	Strong leaders can push issues forward, and hence increase the relevance of the SPI. Furthermore, leaders respected by their peers can increase the credibility of the interface. However, if an SPI becomes too closely identified by its leaders, opponents may claim that the SPI is not legitimate being dominated by only a few individuals.

Table 8: Attributes relevance and stage in the policy cycle

Policy cycle stage	**Role of SPI**	**Examples of attributes important at each state (but never *exclusively* at that stage)**
Issue identification	Gather evidence, Identify emerging issues, Raise awareness, Explain the issues	Horizon scanning; Vision; Adaptability; Translation
Issue framing	Provide data; Explore uncertainties; Develop indicators; Frame problem	Quality Assessment (evidence); Translation; Adaptability; Inclusivity.
Policy measure identification	Identification of choices	Balancing supply and demand; Translation; Relevant outputs
Policy measure development/adoption	Mobilization of actors; Development of instruments; Securing support	Trust building; Inclusivity; Conflict Management; Continuity
Implementation	Dissemination; Training; Operationalisation.	Capacity Building; Continuity.
Ex post assessment	Monitoring; Evaluation; New problem identification	Adaptability; Quality Assessment (results); Continuity.
Important at every stage		People; Resources; Relevant Outputs; Quality Assessment

Table 9: Importance of problem structure to SPI roles and attributes.

Problem structure	Features	Science role	Attributes
Well-structured	Consensus on knowledge need and values	Problem solving	Focus on fulfilling demand: quality control, clear communication.
Moderately structured	Consensus on values, uncertainty on how to achieve them	Resolve conflicts over science evidence	Transparency and independence; trust-building; conflict resolution.
Badly structured	Conflict about values, goals	Mediator in long term process of policy learning	Continuity, iteration, capacity building, inclusivity.
Unstructured	Off agenda	Identify and structure problem	Horizon scanning, inclusivity, multiple channels of communication.

4. Conclusions

SPIs influence biodiversity-related behaviour directly, and also indirectly via their impact on policy. These impacts can be enhanced by certain SPI features - not a single recipe for success, but rather a suite of features that need to be taken into account in a context-dependent way. We have developed attributes that can help to improve biodiversity SPIs, enhancing their impacts on policy, wider behaviour and ultimately on biodiversity itself.

SPIs influence biodiversity-related behaviour in two main ways:

- **Directly**, by 'social learning' through which SPI audiences learn and apply new knowledge to change their own behaviour.
- **Indirectly**, via their influence on the behaviour of policy makers, and decision-makers in organisations, who go on to implement new instruments to regulate or modify the behaviour of other actors.

In both cases behaviour is changed, and impacts on biodiversity change in consequence. These outcomes are generally very hard to assess, because they depend on complex chains of events in which the SPI plays only a limited role, and that often involve significant time lags.

Nevertheless, through analysis of existing SPIs, and expert experience with them, it is possible to identify key features of SPIs that are likely to be associated with stronger impacts on human behaviour and ultimately biodiversity.

There are many such features, and they are not universally applicable: there are trade-offs and inconsistencies among them, and the most appropriate and relevant features to prioritise vary according to a number of dimensions of the policy problem, governance context, and scientific evidence. The scale of the governance, the stage in the policy cycle, the level of clarity on the problem to be solved, agreement on objectives and possible policy mechanisms, the degree of certainty in the underlying science base… these and other factors will all combine in determining the most appropriate structures for SPI work. Similarly, the most appropriate policy instruments for changing behaviour to address a problem will vary according to a number of scientific, environmental, social, economic, political, and cultural factors.

So it is neither possible nor desirable to derive 'one size fits all' solutions to the problems of designing, evaluating and improving SPIs for influencing behaviour. Rather, we provide an overarching framework for assessment attributes for science-policy interfaces, based on different SPI dimensions (structures, objectives & functions, processes, outputs and outcomes). We highlight broad attributes, explain why these matter, and consider how their relative importance may vary according to contextual factors.

The attributes and related lessons learned can help those working with SPIs to find solutions for design problems. The attributes can be used to develop and modify SPIs in order to have stronger, more effective influence on the behaviour of policy makers and other stakeholders. The consideration of the relative importance of attributes in different contexts, including for different policy instruments, helps users of the attributes to determine what issues to stress and how to resolve trade-offs. The attributes aim ultimately to foster better connections between science and policy, as part of the adaptive governance process for biodiversity and ecosystem services, and could play a role in the further

development of evidence-based policies and associated policy instruments, and ultimately in changing human behaviour impacting on biodiversity.

Improved understanding on the linkages between SPIs and instruments stress also the importance of design of SPIs to support and use these instruments. As SPI design is linked to instruments and finally to biodiversity related behaviour, we think that the assessment attributes developed here can contribute to adaptive biodiversity governance processes by enhancing the connectivity between science and policy in the domain of biodiversity and ecosystem services.

Annex: Attributes Factsheets

Factsheet 1: Independence (Structure)

Category	Structure
Attribute	**Independence**
Components	Freedom from external control Neutral position Balanced membership
What to look for	Documentation and transparency of dependencies, funding links, power structures Stated neutral stance, not serving specific vested interests Balanced membership in terms of interests, perspectives, geographical representation
Rationale	Independence from external control and balanced memberships increase credibility Partisan policy agendas may decrease credibility
Improvements	Increase documentation and transparency Recruit members for under-represented interests and perspectives Peer review and quality control processes (see separate attributes)
Trade-offs	Including full range of interests and perspectives could decrease relevance if expertise is compromised or procedures become too slow Challenges related to democratization of science and inclusion of various other types of knowledge, without 'watering down' scientific evidence
Evidence	Some SPI organizations may not be invited to multi-stakeholder negotiations if they are seen as biased and not independent

Factsheet 2: People (Structure)

Category	Structure
Attribute	**People**
Components	All relevant expertise and interests Competent participants Open to new participants
What to look for	Wide coverage of expertise, including range of experts, coverage of different views/paradigms, mix of 'deep' expertise and broad / multi-disciplinary knowledge as required Competent participants with experience, peer-group respect, ability to represent interests and people they are supposed to Strong leadership driving dynamic SPI 'Champions' in strategic organisations and charismatic, well-respected 'ambassadors' Spread of expertise and 'translators' capable of communicating across disciplinary boundaries Clear understanding/reporting of what each participant's expertise and role are
Rationale	Ensure wide knowledge base for credibility Inclusive representation for legitimacy Facilitating multi-stakeholder dialogue, 'buy-in' and 'ownership' of SPIs' messages for policy makers and stakeholders
Improvements	Periodic review of competences and needs. Recruit to fill identified gaps Procedures for interested parties to participate/join Provide/explain incentives for participation Procedures to overcome language or cultural barriers to active participation
Trade-offs	Covering all paradigms may hinder consensus if fundamental disagreements: risks to timeliness and clarity
Evidence	Widely agreed in workshops and interviews that this is a key factor

Factsheet 3: Resources (Structure)

Category	Structure
Attribute	**Resources**
Components	Financial resources Human resources Networks and links to key organisations and funders.
What to look for	Participants are motivated: incentives, clear policy demand, or other mechanisms attract participation and action by relevant scientists, policy makers, and other stakeholders Adequate and sustained financing
Rationale	Adequate and sustained resources essential for SPI to achieve objectives. Enhances credibility and encourages virtuous circle of willingness to invest time/energy in SPI
Improvements	Seek long-term funding commitments/ relationships and diversity of sources Create/communicate incentives for participation. Ensure SPI addressing key policy needs and using best science resources. Support potential participants in communicating to their hierarchies why participation is beneficial Link science funding to commitment to disseminate (e.g. NERC's 'Pathways to Impact' requirement)
Trade-offs	
Evidence	Widely agreed in the workshops and interviews that science side has a problem regarding incentives to take part in SPIs "A good leader and a few good people" more important than lots of bodies and lots of cash

Factsheet 4: Vision (Objectives/functions)

Category	Objectives / functions
Attribute	**Vision**
Components	Clarity, scope and transparency of the vision and objectives of SPI
What to look for	Clear and transparent strategic vision Clear understanding of scales and topics of operation Ambitious goals
Rationale	Vision helps to develop agreement on target scales, sectors and actors Aiming to deal with large issues ensures relevance and can motivate participants
Improvements	Periodic review of goals in context of policy agendas Agree and publicise clear vision statement Capacity building to ensure key concepts and positions understood
Trade-offs	Choosing strategy between issue advocacy and honest broker: lobbying may be efficient in some instances, while honest brokerage probably increases credibility, but generally better to pick one and stick with it
Evidence	Workshop: importance of broad, motivating vision Example of slow progress due to imprecise objectives ("integrate biodiversity into activities" of a large organisation)

Factsheet 5: Balancing supply and demand (Objectives/functions)

Category	Objectives / functions
Attribute	**Balancing supply and demand**
Components	Striking balance between meeting policy needs and ability to communicate emerging science issues
What to look for	Clear policy mandate is ideal. Alternatively, mandate-seeking activity. In both cases, is there sufficient room left to take note of emerging issues? If science / supply driven, attention to creating policy demand by addressing societal problem, gaps in knowledge and policies, topical concepts and by related awareness raising
Rationale	Aiming for policy relevance and ultimately impact on behaviour, while at the same time enabling agility and long term policy relevance by responding to new science
Improvements	Enrol help of media in creating interest / policy demand Scan horizons, plan for flexibility and play a role in shaping new policy questions
Trade-offs	Too demand-led SPIs may end up producing knowledge only for immediate policy needs, missing emerging issues and losing credibility and relevance in the long run. Danger of 'lock-in' if SPIs become too strongly focused and grounded in a specific paradigm or policy Too supply-led SPIs may produce knowledge on interesting new issues without ever achieving policy relevance or demand
Evidence	Workshop stress that co-evolution and dialogue between demand and supply is important For large scale assessments, policy mandate is especially important Lack of demand identified as danger for IPBES – need for mandate-seeking Global Biodiversity Assessment: policy and stakeholder dialogue did not take place before dissemination: CBD states not involved in process, and so rejected it Millennium Ecosystem Assessment: science-led, lower buy-in / impact on policy side. TEEB: less science-focus, tight policy and funder involvement, higher policy impact (though some criticism that not innovative)

Factsheet 6: Horizon Scanning (Processes)

Category	Processes
Attribute	**Horizon scanning**
Components	Procedures to anticipate science and policy developments
What to look for	Planning for appropriate time perspectives Inclusive scoping processes: seeking out wide range of expertise Strategic scanning for potential collaborators (and opponents), opportunities, windows of opportunity, and threats Access to latest policy and research knowledge
Rationale	Horizon scanning enhances relevance, and gives time for knowledge gathering and drawing together expertise leading to credible and timely advice SPIs can be "gate keepers" making distinctions between crazy and useful new ideas in science and policy
Improvements	
Trade-offs	
Evidence	Examples of serendipity at critical moments, where the SPI was able to "break through" institutional constraints and achieve new objectives or success Agreement that research funding should not be exclusively policy-led: SPIs have role in horizon scanning and creating an evidence base for emerging issues

Factsheet 7: Continuity (Processes)

Category	Processes
Attribute	**Continuity**
Components	Continuity of SPI work with the same policy areas / issues Continuity of personnel Iterative processes and feedback / learning mechanisms
What to look for	Continuous and iterative policy support (e.g. periodic and regular policy advice) and evaluation/ feedback of results/ impacts Retention of key participants, network building and maintenance Recognise that SPI's continuity may be challenged by changing policy priorities and funding situations
Rationale	Continuity important for building trust, working relationships, smooth interaction between science and policy Build and maintain collaboration networks to enhance continuity and establish SPI as influential player Iterative SPI processes key to enhance commitment and increase learning
Improvements	Seek continuity of funding. Scan horizons. Build relationships across political divides. Introduce procedures for feedback and learning
Trade-offs	
Evidence	Lack of continuity of policy makers in a same position was seen as a challenge for building good relationships, and also frequently changing policy priorities were seen as a challenge for SPIs Assessment of Assessments: if policy makers knew from the beginning that it is an iterative process with continuing science-policy dialogue it could enhance sense of commitment and create buy-in in policy makers Examples of iterative learning: UN REDD in Nigeria, Finnish NBSAP development

Factsheet 8: Conflict Management (Processes)

Category	Processes
Attribute	**Conflict management**
Components	Appropriate strategies may include internal ombudsperson, allowing time for compromise, third party facilitation…
What to look for	Clearly stated and appropriate methods Staged process and internal ombudsman Recourse to external independent conciliation if internal methods fail Perhaps processes to postpone decisions on most contentious issues Open scientific debate with constructive 'conflict' can be seen as a healthy sign of open dialogue, provided mechanisms in place to deal with conflict and avoid lock-in
Rationale	Needed to prevent and manage conflict and power plays, to ensure fair hearing for all involved parties. In consensus based negotiations, may improve chances for reaching agreement
Improvements	
Trade-offs	Right to veto and consensus base can enhance legitimacy and buy-in but allow vested interests to hamper progress. Consensus is needed to produce strong mandate from governments, and if there is no consensus mandate suffers. On the other hand, non-consensus would allow explorations of more divergent viewpoints that could build legitimacy for the assessment
Evidence	Importance of conflict management strategies widely acknowledged: biodiversity and ecosystem services fields that often include contradictory interests and views Provocative suggestion that "IPBES needs to move away from consensus based negotiations, otherwise there will be nothing left in the produced documents." GBO3 conflict: academic scientists and NGO scientists, conflict regarding 2020 targets and conservation requirements for that. but seen as constructive, open debate, useful for CBD delegates to see divergent views

Factsheet 9: Trust Building (Processes)

Category	Processes
Attribute	**Trust building**
Components	Open participation in discussions Opportunities for informal discussions Clear procedures and transparency about processes and products
What to look for	Regular opportunities for (formal and informal) multi-stakeholder dialogue including local communities as appropriate Safe discussion arrangements (e.g. what is said in the meeting remains in the meeting) Procedures that allow for diverse cultural values of policy makers, scientists, member institutions and target audiences Defined contact points for participants to voice their concerns and agreed procedures for approving external statements Creating trust relationships for quick communications between scientists and policy makers (who can I call?) Open access to outputs and statements
Rationale	Trust leads to more effective communication which enhances relevance, as well as being essential to legitimacy
Improvements	Trust may take time to develop, but can more quickly be damaged "Early barrier breakdown meetings" at which the communities in new SPIs can meet to explore areas of contradiction and friction, and seek to find constructive paths Third-party "translator" with the role of facilitating interactions and building trust: needs understanding of the different "sides" (objectives, constraints, views) and ability to communicate in forms understandable by all
Trade-offs	Increasing trust in small high-level group may create more effective coordination but risks reducing trust for wider group (TEEB example)
Evidence	Acknowledged that an SPI can only function effectively if there is acceptance and trust among participants. Knowledge is not evenly distributed: policy makers have to trust science judgements at some point, while scientists need to trust the policy needs and questions

Factsheet 10: Quality assessment (Processes)

Category	Processes
Attribute	**Quality assessment**
Components	Processes to ensure quality, comprehensiveness, transparency, robustness, and explain uncertainty of the knowledge
What to look for	System for continuous and/or periodic quality review of research and knowledge used in the SPI Variety of existing and reliable data sources, checking for completeness, attention to uncertainty Formal procedures for peer review and extended stakeholder review Transparency and traceability about the origins of data/evidence
Rationale	Quality assessment increases reliability and also credibility of outputs. Widening the knowledge base and extended peer review also enhance legitimacy
Improvements	
Trade-offs	
Evidence	Example of International Council for the Exploration of the Seas (ICES) well defined quality assessment processes enhancing credibility IPCC / 'climate gate' – SPI attacked for lack of peer review: own-goal / opportunity for enemies. Robust knowledge tracking systems for showing where the arguments and data come from seen as essential Uncertainties need to be treated and discussed in outputs but also in the processes leading to those outputs

Factsheet 11: Translation (Processes)

Category	Processes
Attribute	**Translation**
Components	Efforts to convey messages across different domains and individuals, and making the message relevant for various audiences
What to look for	Adapting used language to the competencies of SPI members and to the audiences (jargon avoided, concepts explained, background assumptions defined…) Skilled "translators" to convey messages between scientists and policy makers Simplified communication tools (e.g. figures, maps, pictures...) to make translation easier Matching science and policy context (e.g. matching scientific findings to policy relevant scale One size does not fit all: the appropriate translation tools vary from case to case and depend on people involved. More 'art' than 'science'
Rationale	Translation is important for building broad understanding and making key messages useful and relevant
Improvements	
Trade-offs	Pictures, figures and maps seen as efficient translation tools. However, they compress and simplify message and often omit uncertainties
Evidence	Policy makers and scientists can have different education, experience, competences, language/jargon. GBO3 example: scientists struggled to communicate results to CBD delegates Getting the best out of the individuals involved in an SPI is heavily dependent on the characteristics and personalities of the participants, as well as on the institutional frameworks and constraints. Successful boundary work or translation cannot be fully planned, but must be designed to be adaptable to complex situations on a case-by-case basis Noted that relevant boundaries may exist not only between science and policy, but also between different individuals in both scientific and policy realms Translation may be also about matching scales between science and policy. Countryside Survey in UK: had to shift scientists from habitat focus to a 'broad habitat' focus, more useful for policy

Factsheet 12: Capacity building (Processes)

Category	Processes
Attribute	**Capacity building**
Components	Measures to help policy makers to understand science, and help scientists to understand policy needs Building capacities for further SPI work through training, websites, databases…
What to look for	Iterative and parallel processes of capacity building and SPI development Steps to enhance capacity for further work: for example by maintaining databases, training on data, availability and access Science training: training manuals and other tools used to build capacities for policy makers and stakeholders to understand science Policy training: scientists trained to understand policy processes
Rationale	Capacity building enhances understanding and communication, and in the long run builds a sense of continuity and commitment and increases SPI's opportunities to influence behaviour Sectoral integration by teaching and learning from other sectors can build capacities to mainstream biodiversity
Improvements	Help scientists find ways to share data and mid-term results without fear of their work being 'stolen' Joint working on outputs (handbooks, reports…) can help to build capacity and mutual understanding
Trade-offs	
Evidence	Need for capacity building in parallel to SPI development was widely acknowledged in the workshops and interviews. Wide interpretation: capacity building needed across the board, not just for developing world Noted that if scientists do not understand multiple influences within policy, then decisions that do not reflect science are assumed to be the result of ignorance or failure to take note of science. This can lead to disillusionment with SPI process

Factsheet 13: Adaptability (Processes)

Category	Processes
Attribute	**Adaptability**
Components	Responsiveness to changing contexts Flexibility to change
What to look for	Processes or ability to change previously agreed things or wordings, correct weaknesses, take advantage of new opportunities, respond and understand changing (science and policy) contexts, and include new members and skills Continuous evaluation of outputs and impacts against SPI objectives / goals, and assessing the efficiency of resource use to achieve goals
Rationale	Processes for review and adaptation help to assign resources effectively and increase long term relevance of SPI outputs
Improvements	Introduce continuous evaluations, horizon scanning. Prepare to respond to changing policy demand, and to take advantage from windows of opportunity
Trade-offs	Consensus building procedures may conflict with adaptability: example of UN conventions where the wording is gone through word by word, consensus becomes hard to revise later
Evidence	Noted that policy contexts and goals can change rapidly and thus adaptability and shock resistance are needed in SPIs

Factsheet 14: Appropriate outputs (Outputs)

Category	Outputs
Attribute	**Appropriate outputs**
Components	Timely in respect to policy needs Accessible, comprehensive, suitable for target audience(s). Efficient dissemination methods
What to look for	Outputs timely with respect to policy needs/cycle, mechanisms for rapid response if needed, and planning in advance for anticipated needs Outputs tailored for target audiences and policy contexts Clear communication strategy to build effective media relations Strategic promotion, launching outputs in relevant events, with right presenters, through varied channels, to maximise visibility Communication of uncertainties, divergent views and knowledge gaps
Rationale	Increasing accessibility of knowledge and its relevance to the policy process, while maintaining credibility through communication of uncertainties and quality control procedures prior to publication
Improvements	Build unofficial channels / networks to help policy makers access early or mid-term results on demand
Trade-offs	Patience can be needed: though timeliness is important, publishing premature results can decrease trust, lead to unnecessary conflict and damage credibility Communicating uncertainty important, but media and vested interests might not play along, instead focusing selectively on one view. SPI can lose control of the message Trade-off between strong, clear messages regarding tipping points etc., and more nuanced reporting of full range of uncertain outcomes – more credible, but may reduce impact and relevance
Evidence	Often, SPI faces multiple targets – academic, policy communities, landowners, industry, media.... can be desirable to recognise different needs and characteristics and tailor instruments and outputs. Noted that scientists are often doing good work but failing to present the results in understandable form for policy makers and stakeholders. Communication to policy makers needs to be short, snappy and issues presented in policy-relevant frames Global Biodiversity Assessment: problem of using a single, large document, rather than several shorter, more approachable documents tailored to specific policy audiences. TEEB, by contrast, produced different reports for different target audiences, such as scientists, business people, decision makers and civil society groups Argued that policy actors often comfortable with uncertainty as long as it did not put them to an uncomfortable situation compared to that what they had said before

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Endnotes

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[2] Vogel et al 2007; Pielke 2007; van den Hove 2007.

[3] These are very slightly modified from the original list in the SPIRAL Description of Work, in particular to reflect that the focus of the work is on instruments generally, not especially targets and indicators, and the our results apply to general types of SPI, not just to the specific instances used in the case studies.

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[36] UNEP/CBD/COP/9/INF/18, 2008; see also GBO 3 2010

[37] UNEP/CBD/WG-RI/2/INF/2, 2007; CBD/NBSAP/WS. 2008

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[49] http://sedac.ciesin.columbia.edu/ddc/ar5_scenario_process/index.html for the most recent scenario assessments.

[50] See for example Issue 30 (March 2012) of DG Environment's "Science for Environment Policy" newsletter, http://ec.europa.eu/environment/integration/research/newsalert/pdf/30si.pdf

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[69] see French & Geldermann 2005.

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