MARISCO: adaptive MAnagement of vulnerability and RISk at COnservation sites

A guidebook for risk-robust, adaptive and ecosystem-based conservation of biodiversity

Edited by
Pierre L. Ibisch and Peter Hobson
Centre for Econics and Ecosystem Management

MARISCO
METHOD

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Centre for Econics and Ecosystem Management
at Eberswalde University for Sustainable Development
Alfred-Moeller-Str. 1
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Acknowledgements

The MARISCO method is the result of several years of collaborative work involving many individuals as well as a number of institutions. The product of our efforts is based on existing models and tool-kits already used in conservation planning, including Conservation Action Planning, and the Open Standards for the Practice of Conservation with its software MiradiTM. We wish to thank all the inspiring people who introduced adaptive management to conservation, and therefore, built the fundaments of our work. Special thanks go to Nick Salafsky (Foundations of Success), Jora Young and Dan Salzer (The Nature Conservancy); and in particular, Ilke Tilders (Foundations of Success).

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Pierre Ibisch & Peter Hobson

[29] Since 2008, the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) has been financing climate and biodiversity projects in developing and newly industrialising countries, as well as in countries in transition. Based on a decision taken by the German parliament (Bundestag), a sum of 120 million euros is available for use by the initiative annually.

A.
Introduction & general guide[1]

The many problems linked to a fast changing climate have also awakened the science world to whole new understandings of complex systems dynamics.

1. Why this guide?

Global biodiversity conservation has evolved radically since the Rio Summit in 1992, indicating more fundamental shifts in the human relationship with the environment and the rest of biodiversity. The problems raised at the summit relating to the unrelenting exploitation of natural resources have forced society not only to take stock of the goods and services provided by ecosystems and biodiversity, but also to examine more closely human ethical values of nature. In 2005, the *Millennium Ecosystem Assessment* marked a watershed in new strategies and approaches to dealing with the environment, or more correctly, in the way human activities are to be managed. One of the clear signals to emerge from the assessment – and also from many other ongoing scientific programmes – pointed to the deeply complex and unpredictable problems occurring in the natural world as a direct result of human disturbance.

The most talked-about human-induced problem is climate change, not because its effects are acute and apparent at local scales, but because of the large-scale and long-term impacts it is likely to have on present and future generations. The many problems linked to a fast changing climate have also awakened the science world to whole new understandings of complex systems dynamics, with some of the most challenging issues being uncertainty, indeterministic tendencies, emergent properties, and non-linear relationships and feedback processes. Previously, many scientists and practitioners described the world using principles and concepts based on predictable and deterministic beliefs, conceiving of the planet as a steady-state system where balance represents stability. Conservation science and practice also found itself caught up in this ‘equilibrium paradigm’. It too planned and developed strategies around steady-state principles on the naïve understanding that balance would resume once all the elements in the system had been corrected through manipulation or restoration.

[1] The authors of this section are Pierre L. Ibisch and Peter Hobson.

In the years since the Rio Summit, new strategies have surfaced that focus more on interdisciplinary and transdisciplinary approaches, as well as on trans-systems management. The emphasis has been to work with real expectations of uncertainty and unknowns, which has prompted the application of adaptive measures. Adaptive management is not a new term or concept to society as adaptive thinking and practice has been an inherent part of human survival and existence throughout history. Adaptive management attempts to provide a contemporary and standardised framework for practicing conservation that can be applied across the different socio-ecological systems.

Conservation has begun the process of rolling out a new strategy. Already there are plenty of examples where conservation is being integrated into larger planning and management systems, such as forestry, agriculture and urban design. At the same time, conservation is experimenting with the sustainable management of its protected areas – its biosphere reserves, national parks and other designated areas – to determine how these sites can provide services and goods for local communities. Many of these initiatives have been put into effect in a rather ad hoc way and without the support and guidance of a systematic process.

The Nature Conservancy (TNC) introduced *Conservation Action Planning* (CAP)[I] as a set of standards and a framework for systematically planning for adaptive nature conservation. CAP is TNC's predecessor of the *Open Standards for the Practice of Conservation*, developed by the *Conservation Measures Partnership* (CMP).[II]

The main characteristics of both schemes include:

- widening the participation and representation of stakeholders;
- a multi-disciplinary approach to situation analysis and strategic planning;
- a community-based, open and transparent process;
- a process that is unconstrained by any lack of scientific, evidence-based knowledge (use of non-knowledge).

Where we come from and the kinds of experience that inform the creation of this manual.

Over the last 15 years, the authors of this manual have practiced both CAP and CMP's Open Standards but have also adapted the process for delivery in professional workshops on protected areas and larger landscapes. Through years of practice, evaluation and adaptation, the team has developed a modified version of the Open Standards that places greater emphasis on system dynamics and change, with a particular focus on the effects and problems relating to climate change. Until recently, this evolution of a 'daughter' model to Open Standards had remained nameless.

A variety of additional skills and activities are now included in the method, including spatial analysis, ecosystem diagnostics analysis and a more comprehensive assessment of stresses. Also included are scenario planning and the concept of vulnerability in adaptive conservation management. Much of this

The method was developed with a number of institutions and colleagues from conservation sites in China, Costa Rica, Guatemala, Peru, Ukraine and the United Kingdom, among others.

development took place as a result of in-house workshops and student theses, and as part of the process of experiential learning and improvement during the delivery of professional workshops with sector organisations (e. g., together with the Carpathian Biosphere Reserve in Ukraine[III]). On the back of this work, the concept of risk management was conceived and subsequently integrated into adaptive management.[IV] Further developments included work on the index-based assessment of the vulnerability of protected areas (to climate or global change).[V] The experience of working in Bolivia on conservation planning was particularly important for developing skills and also functional and more dynamic approaches to conservation planning that additionally factored in climate change.[VI] As the impacts and risks related to climate change become ever more apparent[VII] our understanding is that adaptive management is a necessary requirement for effective conservation management.[VIII] Following collaborative discussions with a TNC working group on climate change adaptation and Conservation Action Planning,[IX] a draft methodology ('PRO-CAP') was developed to make CAP more anticipative and proactive, introducing guidance on how to incorporate climate change into the various planning steps.[2]

2 Something comparable was introduced in the Open Standards for the Practice of Conservation (Version 3.0) manual in 2013.

Finally, a revised method was tested and further developed at a number of conservation sites in China, Costa Rica, Ecuador and Peru in collaboration with GIZ,[X] and also in Guatemala with OroVerde.[XI] This practical and semi-quantitative process was accompanied by the GIZ programme for the implementation of the Convention on Biological Diversity,[XII] which then led to the concrete proposal of the **MARISCO** methodology (from the Spanish: ***M**anejo **A**daptativo de Vulnerabilidad y **R**iesgo en **S**itios de **Co**nservación*, which translates as 'adaptive management of vulnerability and risk at conservation sites').[XIII] The latest version of adaptive conservation management has been tested in a number of workshops with diverse target groups, including: MSc students of Eberswalde University for Sustainable Development[XIV] and Writtle College;[XV] students from Albania, Kosovo and Montenegro;[XVI] and, to a lesser extent, with conservation managers from Germany,[XVII] Kazakhstan and Russia.[XVIII] This guidebook offers the latest and tested version of MARISCO and aims to contribute to enhancing the management of conservation around the globe by combining the benefits of systematic stepwise adaptive conservation planning and risk management.

For practitioners and students who want to learn more about modern, effective conservation management in the context of global change, and who want to be able to demonstrate how to integrate the management of risk and vulnerability into the process.

2. Who is the target audience for this guidebook?

The content and format of this manual are aimed at practitioners, and especially planners, who have already gained a certain level of working knowledge in biodiversity conservation and who wish to apply MARISCO exercises to their own sites. The manual does not provide the full complement of skills required for delivering MARISCO planning exercises and workshops; for this, further experience and training are needed. However, it can be used as a teaching resource for training 'coaches' who would then go on to deliver MARISCO. The text is also designed to serve as a relevant teaching resource for higher education programmes in conservation, environmental vulnerability and risk management.

MARISCO is not just a planning process; it is equally about enacting principles of ecosystem-based adaptation to change in all aspects of conservation management.

Practitioners with previous experience in delivering the Open Standards will be able to quickly learn the additional elements involved in MARISCO and successfully run training sessions or workshops. As with the Open Standards, MARISCO subscribes to principles of biodiversity conservation and requires that facilitators have a sound understanding and knowledge of ecology. MARISCO exercises can be run at different levels of detail and scientific understanding. In most cases,

Figure 2. Good MARISCO exercises are inclusive, participatory and democratic and support the identification of teams and stakeholders for conservation sites.

Figure 1. MARISCO workshops provide excellent opportunities for the development of communication and leadership skills. Therefore, they are commonly used for applied conservation learning and for exchange between academia and practitioners. Here, a group of Albanian students presents the results of their vulnerability and strategy analysis of a lakescape to conservation managers.

the stakeholder group is recruited from a broad spectrum of actors. In keeping with the ethos of the Open Standards, the process should demonstrate transparency and broad participation. Inevitably, there will be marked differences among participants in terms of skills, experience and education, but, when pooled, the collective knowledge among experts and stakeholders should provide the necessary breadth and depth to address complex, multi-disciplinary problems. It is expected that part of the group will comprise experts representing various fields of science. It is important that this scientific cohort includes people with an ecological sciences background.

MARISCO planning exercises, especially those related to the first three phases of work (see below), also inculcate a basic knowledge and understanding of: ecosystem-based development and management; adaptation to change; and systematic, participatory and adaptive planning. MARISCO has proven to be useful for building the capacities of employed and prospective conservation practitioners, as it encourages the use and development of professional skills like teamwork, leadership, documentation and communication.

3. How is this guide structured and what does it contain?

It is important to set out MARISCO's philosophy and principles before going into any detail. Although it shares ideas and practices with the Open Standards for the Practice of Conservation, there are also a number of distinctive differences. One of MARISCO's defining features is the context in which a situation analysis is carried out. Principles of ecosystem-based adaptation to change are engrained in the fabric of the process, unlike the method employed in Open Standards. The approach taken is rooted firmly in ecology and ecosystem theory. This is also true of the original approach for adaptive management[XIX], but in MARISCO's case there are additional elements that guide both the situation analysis and strategy formulation. The following sections provide the necessary background understanding and are recommended reading before moving on to the technical guide.

The first, conceptual part of this manual (pages 2–43) briefly outlines the basic concepts of biodiversity and also goes a little beyond mainstream views of species and habitat-focused descriptions. The perspective taken on biodiversity leans much more heavily on concepts of ecosystem structure, dynamics and function in the belief that this is a more appropriate baseline for understanding and launching strategies for ecosystem management. A more holistic perspective of biodiversity encourages stakeholders to think of nature and the environment as a deeply complex entity. Complexity here is not a synonym for 'complicated'; rather, it stands for the highly networked and nested characteristics of genes, populations, species and ecosystems, and for biodiversity across all levels of its organisation. Inherent in this complexity are emergent properties and uncertainty. Conservation is expected to draw up strategies and deliver measurable outcomes in this environment of uncertainty and unknowns. Importantly, MARISCO affirms and demonstrates that this is possible and that uncertainty and risk are common factors for consideration when planning for adaptive management.

The second, technical part of the guidebook (pages 44–170) presents the actual **methodology** for developing a management plan that is adaptive and that takes account of risk and vulnerability. The whole exercise comprises four interrelated phases:

It is recommended that you read the these initial sections first, before starting the actual technical guide.

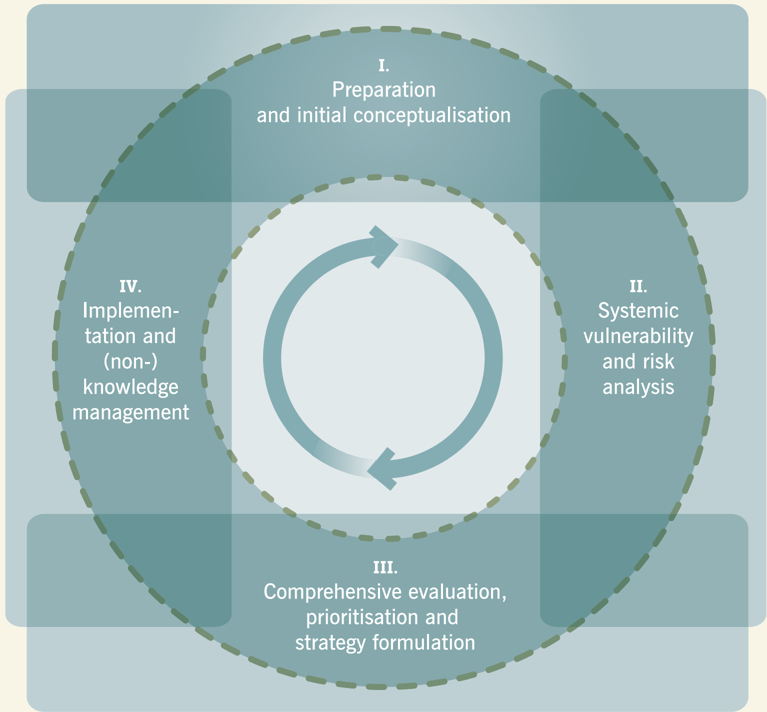

Figure 3. Overview of the four MARISCO phases: (I) Preparation and initial conceptualisation, (II) Systemic vulnerability and risk analysis, (III) Comprehensive evaluation, prioritisation and strategy formulation, and (IV) Implementation and (non-)knowledge management.



The second, technical part of the guidebook presents the actual methodology.

→ **Phase I** (page 52) starts the exercise with an Ecosystem Diagnostics Analysis (EDA). Other activities involve: compiling available information; defining the geographical scope for the project; and selecting the conservation objects, which should include both biodiversity objects and ecosystem-based human wellbeing objects.

→ **Phase II** (page 72) involves carrying out a complex situation analysis to establish a sound understanding of the status quo for the conservation objects, and to identify existing and potential stresses, threats and contributing factors. All these elements are assessed according to states of criticality, dynamics, and levels of knowledge and manageability, and are related to relevant stakeholders.

→ **Phase III** (page 126) comprises an analysis of existing strategies and the systematic development of new strategies that allow for the effective enhancement of the objects' functionality; the abatement of threats; and the avoidance or reduction of vulnerability and risk. It also includes a check for strategic consistency and complementarity, as well as for the elaboration of a monitoring plan.

→ **Phase IV** (page 170) covers the implementation of the strategic plan and includes strategic knowledge management and the evaluation of the implementation process.

The full sequence of steps is reflected in the following figure.

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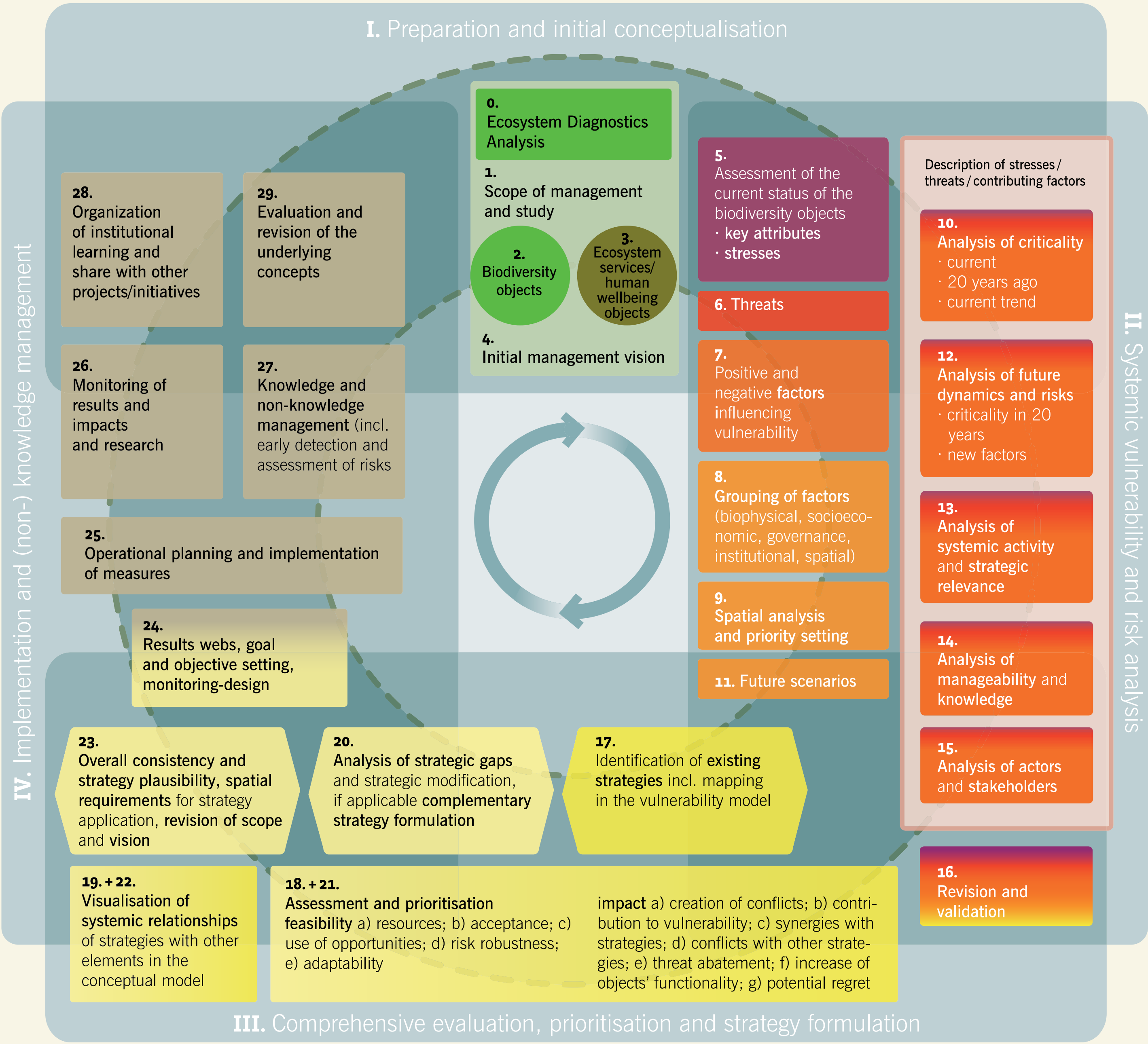


Figure 4. This MARISCO cycle diagram illustrates all the important methodological steps.

4. How challenges to biodiversity conservation are changing, and why we need new tools and approaches

Biodiversity: the quality and function of life-supporting systems

Changing perceptions of biodiversity

Human ethics and values are key drivers in conservation. Recent evidence of today's unfolding environmental crises has shifted the public's focus towards the value of ecosystem goods and services. This has not entirely replaced more abstract motives for conserving nature such as intrinsic or existence values, although this view is not generally shared by the public at large.

MARISCO is an **ecosystem-based approach to nature conservation and sustainable development**. Therefore, we need to understand what an ecosystem actually is[XX]. The popular understanding of 'ecosystems' is, for some people, an abstract concept referring to something that does not really exist in nature. For others, it depicts nature in the raw – systems of untamed wilderness that are increasingly scarce across the planet. These include iconic representations of frontier forests, rivers, wetlands, prairie, savannah, polar landscapes, and portfolios of charismatic species. As a matter of fact, the concept is scientific and refers to the 'household' of complex networks of organisms that live and evolve wherever certain minimum abiotic conditions exist.

> **MARISCO is an ecosystem-based approach to nature conservation; as such, we need to understand what an ecosystem actually is.**

Early biological research focused on individual species, animals, plants and other species but didn't analyse these organisms' relationships with, among other things, their environment. And it is still the case that the more profound technical descriptions and knowledge of networks, functions, structures and feedback loops remain the domain of a small handful of scientists. Today, we know that none of the elements of biodiversity on Earth can be understood in isolation. The politicising of biodiversity has gone some way towards readjusting popular perceptions of ecosystems and biodiversity by providing a better understanding of the interdependency of life on Earth, including humankind's relationship with biodiversity.

Ecological research and the rise of systems theory have significantly contributed to improving our understanding of ecosystems. Systems exist as nested structures – one or many systems operate inside larger systems, which, in turn, operate in larger systems and so on – and all of these interact within and across these scale breaks. Interacting systems can produce forces and emergent properties that do not equate to the sum of the parts of a system. In other words, it is not possible to accurately characterise a system by simply describing it in terms of its constituent parts. It is rather the interactions of these parts that make a system.

Ecosystems act as bioreactors that capture radiation energy from the sun and convert it into chemical energy in the form of more or less complex molecules and biomass.

Correspondingly, an ecosystem is much more than the sum of its species. The species in ecosystems are continuously interacting. These interactions are related to the exchange of energy, matter and information. At the most basic level, **energy is the driver for all of phenomena in nature**. In fact, ecosystems operate as 'bioreactors', capturing and using radiation energy from the sun and converting it into chemical energy or, rather, 'eco-energy'. The end result of this conversion process is the manufacture of elaborate and complex molecules with biomass and function. These also have the capacity to store remaining energy and even transfer it through and between systems. This captured eco-energy can be stored away in long-living organisms like trees or in organic compounds in the soils, or in fossil sediments. But it can also be used for maintaining food webs, including so-called producers, consumers and decomposers or *destruents*.

By using energy in coalescent structures, ecosystems promote self-ordering and become more complex and more functional. This process of ordering matter leads to a build-up of biological information, which is ultimately stored and processed as genetic information.

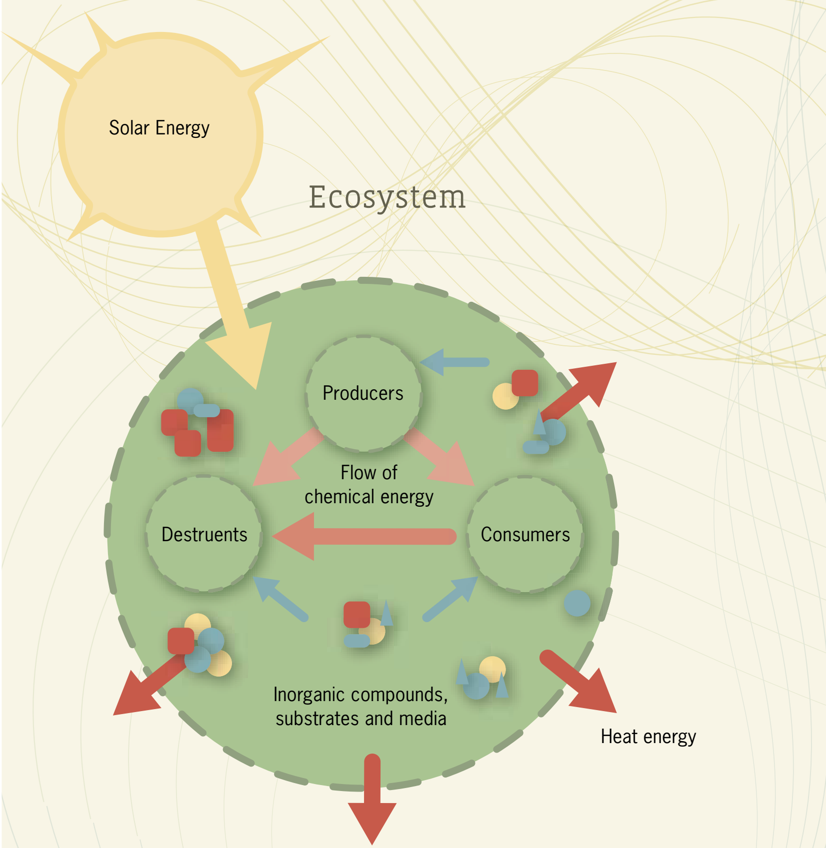


Figure 5. Ecosystems are bioreactors defined by the stocks and flows of energy and matter.

The presence of living systems dramatically alters the physical state of the Earth system. For instance, a build-up in structure and biomass changes the light absorption and reflective abilities of the Earth's surface, which, in turn, influences surface and ambient temperatures. The capacity for water retention and recycling above and below ground is also significantly enhanced by the presence of organisms. Again, this will influence local and regional climates, as well as determine the dynamics of natural and induced fires. Here we have examples of systemic processes that are caused by the interaction of system elements that can trigger new emergent properties and interactions, or have re-enforcing effects. These, in turn, can generate positive or negative feedback loops, as well as escalation effects or synergies.

Biodiversity is the variability of life, encompassing all its elements, patterns and processes. In the context explained above, it takes on a very functional role in the development of the planet.

The complex relationships that exist between all living forms and also between the living and non-living environment contribute to the regulation and support of dynamic processes.

Ecological evolution

Biological evolution is accompanied by ecological evolution, and both processes, of course, interact with one another.

Ecological evolution is the process of self-organisation in biological systems that are inherently designed to create higher levels of order and complexity and, in so doing, increase the capacity in systems to capture and store incoming energy, water and nutrients. This ensures resources are made available to the increasing number of life forms being integrated into the system, which ultimately results in changing the system's environment.

Ecosystems promote self-ordering and become more complex and more functional.

The efficiency of biodiversity in carrying out all functions relating to flows and stocks of energy, matter and water is governed by biological evolution. Over evolutionary time, species composition and function progress towards increasing complexity and this ultimately contributes to higher energy capture and storage efficiency in the ecosystem. The continuous supply of constant solar energy enabled early life forms to establish themselves and begin the process of growing their numbers. This early phase of genesis gave rise to the first effective energy capturing and storing structures, which allowed evolution to go to work in accelerating the generation of biological diversity. As biodiversity built more sophisticated forms and intricate connections across scales of time and space, so too grew nature's capacity to harness and store energy. Life on Earth was now demonstrating capabilities of self-organisation and self-referential properties. This 'downloading' of energy from the sun to the Earth's surface created ever more opportunities to support a greater abundance and diversity of life. The process of 'biological building' or self-ordering led to the evolution of increasingly sophisticated systems. These systems operated with greater efficiency and as semi-closed subsystems nested within the wider global ecosystem.

This rather simplistic explanation of ecosystems, biodiversity and ecological evolution outlines some fundamental principles that underpin ecosystem-based MARISCO.

Key points that structure the philosophy underpinning ecosystem-based MARISCO.

A summary of the key principles is given below.

- Biodiversity is the variability of living systems, encompassing both system components and their interactions.
- Ecosystem function and services are dependent on the entire ‘form and function’ of an intact biodiversity.
- Ecosystem function and biodiversity are interdependent in regulating ‘eco-energy’, water and material flows.
- Biodiversity function depends on biomass, information and network within a system.
- Sensitivity and vulnerability to change, together with resilience to disturbance and adaptive capacity (see below) are biodiversity properties that support the processes of self-ordering and evolution.

Principles and benefits of a systemic perspective on biodiversity for ecosystem-based conservation management

Why this crash course on ecology in the opening chapter of this manual? It is our belief that appropriate and effective action in conservation is best achieved once there is clear understanding and acceptance of the ecological principles and theories underpinning strategies and practice. MARISCO subscribes to the principle that biodiversity is not only measured in numbers of individuals and species but, rather, represents a key condition of biological function and a process that encourages evolution and competition in systems on Earth.

This functional description of biodiversity is used:

- to guide our understanding of ecosystems and the services they provide to humans;
- as the basis for our understanding of the vulnerability of biodiversity to disturbance and change; and,
- to orient priority setting when it comes to determining what our really important conservation objects are.

A systemic perspective of ecology and biodiversity recognises the planet as the ultimate ecosystem, constructed of a network of interrelated subsystems. The complex and nested nature of ecosystems often leads to widespread misunderstanding among managers and practitioners. Ecosystems exist as functional landscape units with no clear spatial definition. They represent compositional and conformational relationships within spatially defined patches in the landscape. Indeed, ecosystems are entities with permeable, overlapping and continuously changing boundaries. There are some ecosystems that appear to have more clearly defined boundaries, such as lakes and rivers, while others are less discernible, such as savannahs or wetlands. This promotes an understanding that spatially ordered natural systems can appear to be either relatively closed or open.

It is important not to fall into the trap of overly compartmentalising nature. As already discussed, interdependency and interactions are characteristics of nature that go beyond notions of independently operating components within a system. Take for example, wetlands. Many of the important wetlands across the world are a fusion of water bodies, swamps, grasslands and wet forests.

Boundaries are difficult to distinguish and any attempt to do so may devalue the biodiversity interest of the ecosystem in question. Adopting the larger-scale perspective – for instance, understanding 'wetlands' in its entirety (swamps, grasslands and forests) – would be an appropriate step for securing the collective ecological values of the ecosystem. This does not necessarily encumber the MARISCO process.

When analysing ecosystems in MARISCO, it is effective to analyse and present the nested situation of systems composed of subsystems comprising sub-subsystems, etc. This 'nestedness' is an important characteristic of biodiversity that is not always sufficiently described by

Natural systems are self-regulating entities made of smaller components and are, simultaneously, part of a bigger whole.

Applying the systems perspective to biodiversity provides people with a much more realistic perspective of the importance of nature

conventional definitions. Natural systems are self-regulating entities made up of smaller components. But, at the same time, they are part of a bigger whole. Describing an ecosystem as a Russian doll suggests that each enclosed doll functions independently and must therefore be a self-contained, self-regulating system. This idea could not be further from the truth, given that all the nested subsystems are deeply interconnected and the survival of the ultimate, macro-system is dependent on the interdependent dynamics and functions of the smaller subsystems within it.

A more holistic, systemic approach to ecosystems helps practitioners to understand the relationship between human wellbeing needs and the function and services provided by biodiversity. More conventional representations of biodiversity can result in 'blind spots' – for instance, an inability to make connections between the value of apex predators, the sustained regeneration of trees in landscapes, and the avoidance of soil erosion.

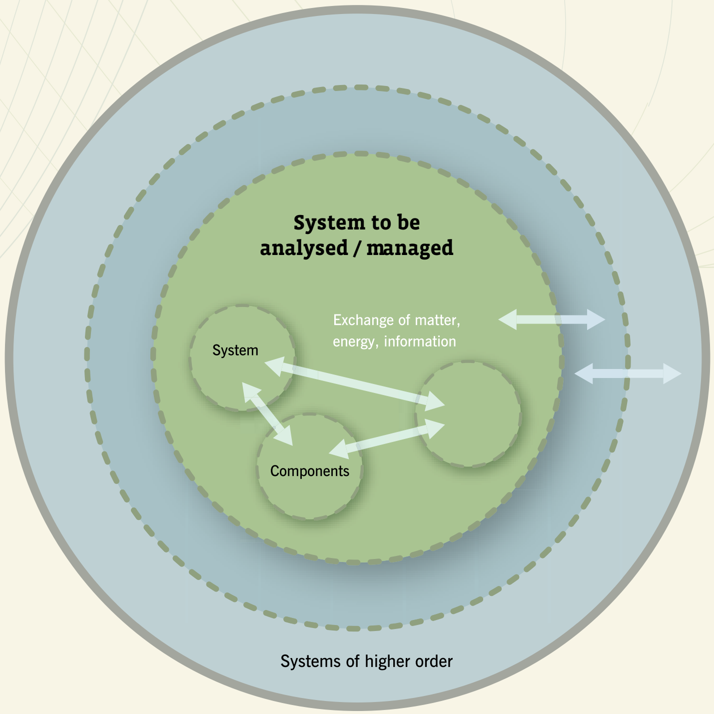


Figure 6. Although they may seem like Russian dolls, biological and ecological systems are made up of smaller interacting components and, at the same time, are part of bigger system.

Ecosystem functionality and vulnerability

A whole family of terms and concepts is available for describing the problems of biodiversity facing threats and vulnerability to change. The **functionality of an ecosystem** describes a certain state of ecosystems. It is characterised by inherent structures, ecological functions and dynamics that provide an ecosystem with the following conditions:

→ the necessary (energetic, material and hydric) efficiency; and,

→ the flexibility to demonstrate the development of resilience without abrupt changes in system properties and geographical distribution, and to respond flexibly to external change.[XXI]

During natural succession, ecosystems become more efficient, regulated and closed – and more resilient

Let us consider this by means of an example: in the beginning of a site's ecological evolution, bacteria on a rock surface cannot halt water run-off, part of the rock matter is washed away and the surface is left exposed to more or less dramatic temperature fluctuations between day and night. This is because energy is only stored in the rocks as heat and this gets radiated back into the environment at night. But the pioneering bacteria may prepare the ground for lichens and mosses, and these facilitate the colonisation of other plants, which leads to soil formation. Eventually, a forest may evolve containing a large amount of biomass and a thick humus layer that stores water even when there is no precipitation. The fairly dense vegetation covering the soil prevents rapid water run-off and thus mitigates soil erosion and the loss of nutrients. Incoming (solar) energy is not stored as heat in the rocks, but rather as chemical energy enclosed in the living systems, or as latent heat in the ecosystem water retained by organisms and their detritus. The process through which ecosystems become increasingly regulated, efficient and closed (in terms of maintaining energy, matter and water within the system boundaries) can be observed as natural succession after the disturbance of mature ecosystems (e. g. deforestation) or in primary new habitats, such as in sand dunes or volcanic rocks.

A more developed functionality of ecosystems also implies a greater capacity for self-regulation and self-ordering, which indicates that they can actively contribute to their own maintenance and are not passively dependent on their environment.

Figure 7. If the climatic conditions are relatively stable and allow long-term plant growth, the diversity of life forms will continue to increase. The manifold species in diverse ecosystems represent pathways of downloading, storing and degrading solar energy. The result of this activity is an increasing amount of biomass that is responsible for the ecosystem's functioning.

Figure 9. Hyper-efficient plant growth in productive forests can lead to natural degradation and small collapses. Trees with epiphytes or plant mats on rocks can become too heavy causing tree-fall or small landslides. This creates habitats for pioneer plants, which will re-start succession. The process is part of the natural dynamics and adaptive cycles in ecosystems that lead to a balance between efficiency and resilience.

Figure 8. In biodiverse tropical forest systems, efficiency in capturing energy is permanently maximised. Plant growth is three-dimensional and fractal. Epiphytes live on other plants and the leaves of epiphytes are, in turn, colonised by epiphytes of a second and third order (here epiphyllous bryophytes).

At its simplest, the functional and operational resilience of an ecosystem can be described using the principles of ecosystem theory.

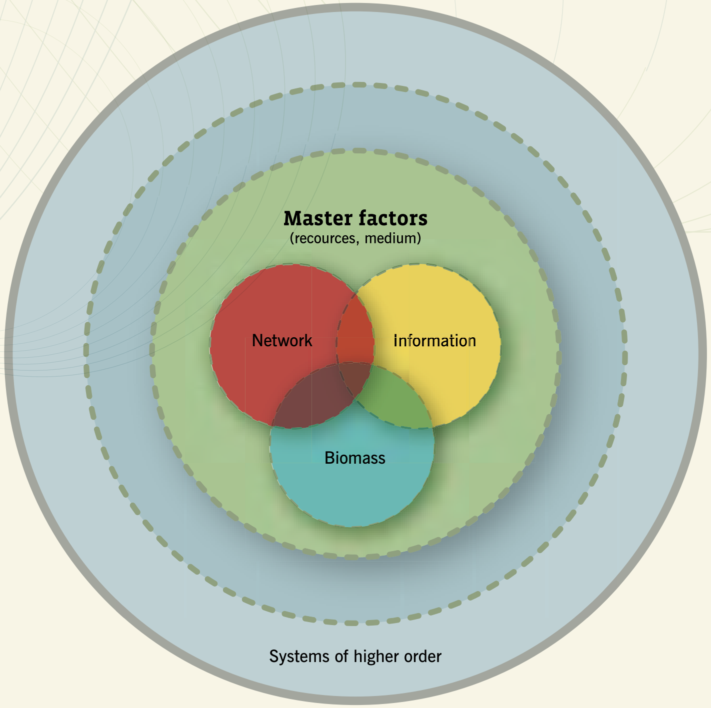
Ecosystems become more efficient and functional when they:

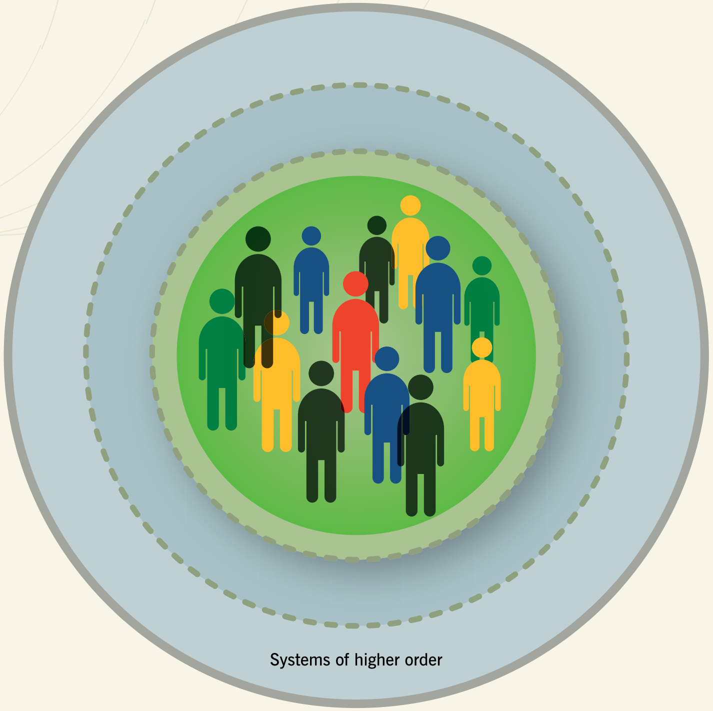
- harbour more biomass;
- contain more information; and,
- are organised more complexly, with a high degree of networking among the system's elements.

Ecosystem functionality depends on the availability of abiotic master factors, as well as on the included biomass, information, and degree of interaction and networking.

Figure 11. Ecosystem functionality depends on the availability of abiotic master factors (solar energy input, water, abiotic nutrients), as well as on the included biomass, information, and degree of interaction and networking.

Figure 10. A huge landslide caused by wood extraction and grazing. This kind of man-made degradation of ecosystems (the disturbance and elimination of biomass, information and networks) can result in the large-scale loss of regulating and stabilising functions.



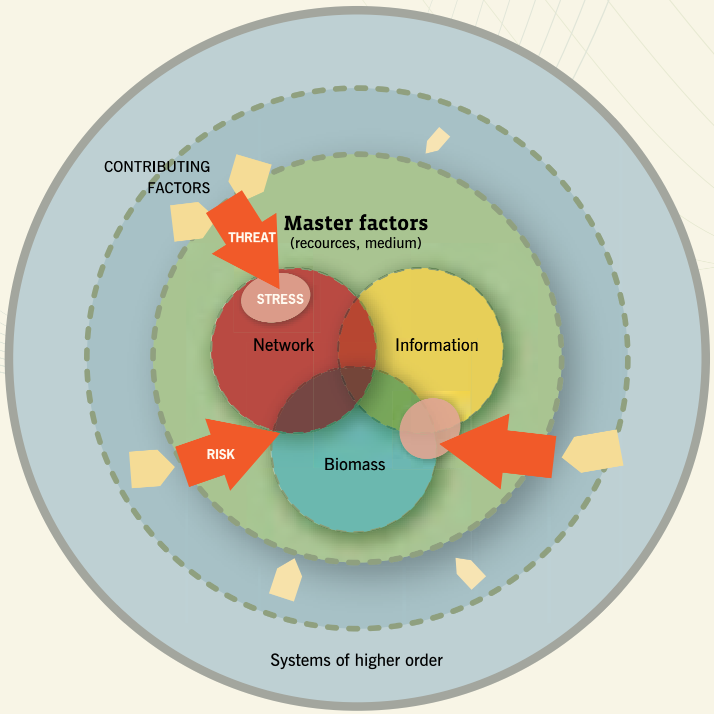


Threats degrade the key ecological attributes of ecosystems – biomass, information, network, and master factors – and cause stress in the system.

Figure 12. The functionality of social systems also patently depends on mass (the number of people), diversity (e. g., the different kinds of knowledge and professions, genetic diversity) and network (interaction, e. g. through exchange of information and matter, mutual support), as well as on the condition of the systems of higher order (other social systems like states; and ecosystems).

Sensitive ecosystems are prone to be impacted by external threats because they lack 'defence' mechanisms or a buffering capacity.

Figure 13. Stress in an ecosystem is caused by external threats, which lead to the reduction of the availability of master factors, biomass, information and/or network, and thus imply a loss of functionality.



Whenever an ecological system is subjected to **disturbance**, a certain amount of **degradation** of its basic key ecological attributes (biomass, information and/or connectedness) occurs. The extent of this loss influences the amount of functionality, which includes the remaining resilience in the system. This kind of negative change in state implies stress to the system. Too much degradation and subsequent stress and the system will change irrevocably or even expire. A disturbance that causes a negative change of key ecological attributes and stress in a biological or ecological system is called a **threat**.

Ecosystems that have suffered some level of degradation as the result of an impact can become vulnerable to further changes and this puts them under threat. The **sensitivity** and **change of exposure** in an ecosystem together constitute the **impact of a threat**. Some ecosystems are naturally less vulnerable to threats than others and have evolved the capacity to reduce sensitivity.

An example: a forest vulnerable to climate change

According to the principles outlined above, a forest ecosystem would demonstrate a greater sensitivity and vulnerability to climate-change-related threats when it is already stressed. There may be any number of factors contributing to its stressed condition, including the extraction of biomass (e. g., timber harvesting, firewood cutting), which would, in turn, reduce productivity. Harvesting would also open up the canopy and expose the soil to radiation and precipitation. This lead to the system losing water and nutrients through soil erosion, for example. The forest could also experience a loss of regulative capacity due to a reduction in the amount of water stored in the ecosystem. Water loss throughout the forest ecosystem can end up impairing microclimatic regulation.

Figure 14. Recycling of precipitation – the interaction of intact forest ecosystem with the climate system. The forest contributes to the local and regional regulation of a climate required for forest maintenance (Petén, Guatemala).

Other forms of stress could be caused by the loss of information as a consequence of the extinction of top-predators or the loss of plant species diversity due to pollution. Such changes can dramatically alter the regulatory function of a forest ecosystem, including nutrient cycling and population dynamics. The network function of a forest can be disrupted by the introduction of alien species that often results in the loss of native species. Displacement of native species causes a breakdown in the trophic structure, affecting not just primary production but also the wider food web. Once this happens, the supporting and regulating processes of forests diminish and the resilience of the ecosystem is impaired. Disturbance to a forest may take the form of physical disruptions and barriers such as dense networks of roads. Forests can become fragmented, leading to a loss of permeability for many species.

If climate change is then factored in, the loss of resilience caused by the other environmental stresses means the system is less able to cope with the unpredictable weather patterns (e.g., extreme temperature events, droughts or strong rainfall). There is scientific evidence to suggest that any substantial loss of or change to the forest's structural attributes or natural composition can reduce its capability to attenuate local temperatures. Such changes would expose sensitive species and processes to the negative impacts of extreme temperature fluctuations.

Within the wider landscape, if there has already been degradation or loss of habitats then any opportunities for the more mobile species to escape and seek out other forested landscapes are likely to be limited by the loss of connectivity and permeability.

Vulnerability has to be understood and analysed systemically as a phenomenon of complexly interacting processes. Stresses, threats and their contributing factors – whether climate-change-related or not – cannot be understood in isolation.

Vulnerability has to be understood and analysed systemically as a phenomenon of complexly interacting processes.

The unfolding biodiversity crisis and its consequences for effective conservation

More complex, more globalised and less predictable

The conditions in most ecosystems across the surface of the planet have altered to different degrees because of the impacts of a rapidly growing human population. Our scientific understanding of these changes has increased our understanding of humankind's dependency on biodiversity and of the vulnerability of human existence should the loss and degradation of global ecosystems go unchecked. This understanding exposes the complexity of both nature and our relationship with it. A more sophisticated perspective of ecosystems and the way we should manage humankind's dependency on them (without in any way diminishing or losing their function and services) has become the new directive for conservation. Earlier strategies in conservation that operated using simpler models of species and habitat protection no longer provide appropriate solutions for resolving the complex challenges facing the world.

It is important to think and act bigger, beyond the local scale.

In earlier times, conservation often meant the abatement of single threats that were generated locally, such as the overhunting of a game population, or the local pollution of a river. With human development – characterised by the growth of population, demands, development infrastructure and resource use – the trend goes from single local impacts on biodiversity to more complex threat situations with regional or even global processes becoming involved. For example, previously, it would have been relatively easy to prevent the local degradation of biodiversity at remote conservation sites; however, nowadays, the driving factors of globalisation, such as the global demand for agricultural commodities or global climate change, cannot be ignored in even these remote sites.

A world-view perspective of human dependency on global ecosystems is forcing change in the way we manage systems and human activities. It is prompting moves away from traditional solutions towards cause-effect problems and the development of strategies that attempt to address the complex issues of non-linear relationships and feedback loops associated with human disturbance.

Uncertainty features prominently in complex systems and this always presents managers with goal- and target-setting problems when formulating strategic plans. The solution to such uncertainty is not to attempt to eliminate it, as this would deny its importance in the dynamics of systems. Instead, the better approach is to embrace it as part of the system. When working with unknowns, scale and perspective constitute an important part of understanding indeterminacy. Often, what appears hidden and uncertain at one scale of resolution becomes apparent at another. When working at the site- and landscape-scale, it is often the case that, by taking a wider perspective of a situation (in other words, by putting it into a bigger context), some of the contributing factors to site-specific uncertainty may be revealed.

The performance of *complexly* stressed *complex* systems cannot be predicted. This means that, in management, indeterminacy and uncertainty must be reflected in conceptualisation and planning. Metasystemic management approaches identify and work with the interrelated factors that drive threats to biodiversity. They do not espouse the management of single ecosystem components at a local scale without seeing the bigger picture. This may suggest that it is important to think and act bigger, beyond the local scale – even if this is not facilitated by current legislation and management regimes.

Ever faster …

The rapid development of technology has engendered an exponential growth in the human exploitation of natural resources. Very little of the original global ecosystem remains unexploited or utilised. Accelerated socio-economic growth contributes greatly to uncertainty as the planet's systems respond to this trend in increasingly unpredictable and erratic ways. These rapid changes in conditions require management in all fields, and in conservation in particular, to repeatedly modify and adapt to new circumstances as they arise. This represents a very different approach to earlier strategies involving building desired conditions and resistance. As such, 'conservative' conservation that strives for the maintenance of a status quo becomes more difficult, if not impossible.

'Conservative' conservation that strives for the maintenance of a status quo becomes more difficult, if not impossible.

The adaptive management of threats and risks in natural and social systems

Conventional conservation practices operate under principles of reactive (crisis) management, sometimes referred to as 'countermovement'. Routinely, the strategy is to repair any damage to ecosystems or habitats caused by degradation or manipulation – an approach that somewhat typifies most forms of human management. To a certain extent, this kind of reactive management is also adaptive in the sense that it builds upon former experience.

Complex living systems are characterised by an inherent capacity to adapt to disturbance and change and, in so doing, strive towards an optimum state of resource exploitation. To reach a state of high resilience and maximum functional capability, a system must invest in growing three fundamental key ecological attributes: biomass, information and network. During a *growth phase*, an increase in any of these three growth forms is achieved when environmental conditions – the master factors including water availability, nutrients and temperature – are optimum. A typical growing ecosystem is a young forest that stores increasing amounts of biomass in trees and soils, becomes more species-rich and complex, and has increasing regulative capacity.

As resources become scarce and conditions deteriorate, the system graduates to a *conservation mode*, which identifies a period in its cycle of higher energy, material and hydric efficiency. By this stage the system should have built up enough resilience to be able to withstand certain levels of impact and disturbance. No system will remain immune from disturbance and change once it has reached a certain threshold that represents resource constraints and diminished opportunities. A collapse or release phase is inevitable, after which point a system may reorder itself or shift to a new regime.

Adaptive cycles: all complex living systems are characterised by an inherent capacity to deal with disturbance and change.

A collapse in a system does not always result in the loss of valuable information that has built up over time. For example, catastrophic fires in forests can destroy much of the above-ground vegetation and bring about the local extinction of numerous animal species. However, remarkably, such forests appear to stage a rapid recovery, which points to residual information and biological material being stored in the system – seed banks, unburnt logs and other forms of genetic refugia.

In natural systems, biological selection optimises towards better adaptive capacity.

After the disturbance event, the system demonstrates the ability to recover. This period in the cycle of a system is referred to as the *restoration phase*. Legacies in the system build new structures and connections to restore the bigger system and regain functionality. More than likely, the 'restored' system will be different from its original parent in terms of its information and network structures. Furthermore, it might be better prepared for the kinds of disturbances that caused the initial release phase.

To some extent, human social systems mimic patterns observed in nature. Political organisations, countries and empires have gone through cycles of rapid growth fuelled by aggressive resource exploitation, followed by periods of relative socio-economic stability and, finally, by unrest, instability and collapse. In most cases, unforeseen forces have triggered the unexpected decline and demise of civilizations or state integrity. Recovery has not always happened, but when it does, the new socio-political order is invariably different from the original one. As in natural systems, growth and release cycles occur at all levels and scales of resolution. If the cycle can in some way be structured and moderated – strategically 'engineered' rather than left to its fate – then what we have is 'adaptive management'.

Adaptive management is best described as a process that allows micro-collapses within a system, whenever an external disturbance shows that the system needs reorganisation. Adaptive management is mistake-friendly because it encourages systematic learning from errors in order to build more efficient and resilient systems.

The belief is that, by adopting principles of adaptive management, the task of protecting biodiversity will be both more resilient and robust. In some cases, this process may require a complete restructuring of existing conservation strategies. Adaptive management is not only about effective learning from experience; it may also include unlearning in order to reorganise the knowledge required for effective management. Such dramatic measures imply that adaptive management is more than just a potential mode of conservation practice; rather, it is a new way of dealing with **knowledge management** and is a distinctive brand of philosophy that provides the basis for an alternative form of interpreting and doing things.

From data and information to knowledge and intelligence

As mentioned above, information is one of the fundamental key attributes of ecosystems. The development of information and knowledge is an inherent characteristic not only of human culture, but also of evolving ecosystems and biological evolution. The formation and growth of ecosystems represents a transitional process from chaotic beginnings towards increasing states of order. Even though the concept may seem strange, organisms and ecosystems permanently generate, store and apply information. Indeed, this is a vital trait that is required for maintaining functionality. Therefore, effective ecosystem-based management will take care of the information in the ecosystem and use it wisely.

The raw material of information is data. Data is a (symbolised) representation of conditions, ideas or objects that, in their corresponding receivers, can eventually be perceived and used as information. Data becomes information when a receiving system uses it and makes sense out of it. Information is a message that can effect a reaction in the receiver.

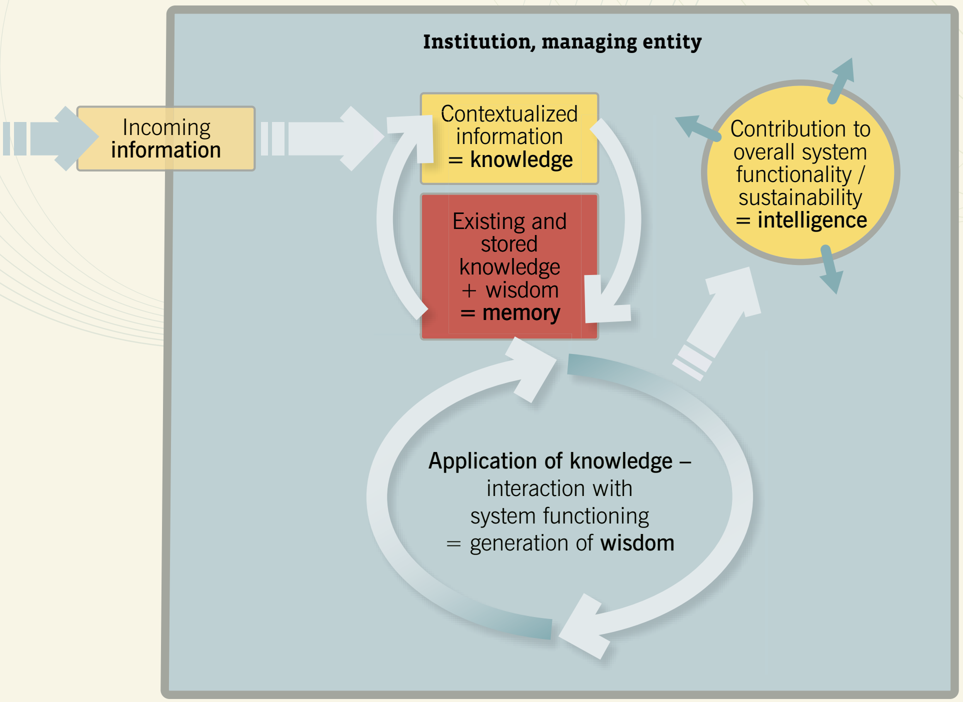
We can define knowledge as ‘information in context’, the ability to interpret incoming information against the background of previously processed and stored information and knowledge, i.e. memory. The ability of an organism to acquire and store knowledge and then, at a later stage, demonstrate appropriate behaviour to a situation is part of nature’s inherent intelligence. Intelligence in organisms is the result of the perpetual application of knowledge and information to solve evolutionary problems and thus maintain functionality and a sustainable existence.

During the ongoing functioning of a system, this stored knowledge is repeatedly applied and tested. Wisdom would be the knowledge that has been successfully tested and confirmed to be useful in the context of the system’s functioning. Intelligence would be the contribution of wisdom, knowledge and information to maintain a system’s functionality and sustainable existence. At multiple levels of organisation, nature acquires resilience and adaptive responses to disturbance and environmental changes.[XXII]

A successful institution or project will be fully aware of the relevance of generating not only information and knowledge, but also wisdom and intelligence. Knowledge can be theoretical and picked up

Figure 15. From information to intelligence: knowledge must be tested by applying it in practice to generate solutions and sustainability. A successful institution doesn't just manage information and knowledge, it also actively works to generate wisdom and intelligence[XXIII].

in books. Wisdom and, ultimately, intelligence are generated by the practical application of knowledge. If this message is adequately considered, the conclusion is that, in management, merely generating databases or increasing amounts of knowledge will not be enough. It can also be concluded that knowledge management cannot be outsourced and delegated to third parties like researchers or staff handling information technology. Knowledge and intelligence management must be an integral part of any managing action.



... humans are characterised by their ability to reflect on future situations and by their ability to act before a crisis in order to prevent it.

When comparing natural and cultural systems, it is also important to stress the contrasts that exist between them. Non-human systems in nature respond to disasters and less destructive perturbations by building resilience through processes of evolution and adaptation. Both strategies are driven by reactions or responses of genes to forcing factors, and these disturbance events are either intermittent and catastrophic or, more commonly, constant and intermediate. The instinctive nature of this cause-effect relationship sharply contrasts with the more deterministic tendencies that characterise cultural systems. The human ability to plan, to analyse existing conditions and compare them to past ones or check them in the light of theoretical knowledge, and then to predict future outcomes allows them to shape their environment. Human behaviour and cultural landscapes are strongly influenced by proactive tendencies towards risk aversion.

Risk management evolved in domains where the avoidance of damage was considered to be very important, such as in disaster prevention, safety management or the insurance business. In general terms, a risk is nothing other than a future event that will occur with a certain probability and may cause a given impact in a system. It can have either a positive or negative effect. However, popular concepts of risk imply a certain level of threat.

Adaptive risk management[3]

Risk management comprises three main elements:

- risk search and perception;
- risk assessment;
- risk response.

Risk search and perception describes the first important stage in the process of identifying or anticipating as many potential risks as possible to the conservation targets. In too many cases in the conservation arena, risks have been realised after they have emerged as realised threats. There are even a number of examples of this happening at the global scale, such as the acidification of oceans due to excess atmospheric CO_2. Similarly, the dramatic loss of Arctic sea ice took most scientists by surprise because the magnitude currently observed had not been anticipated.

There are also examples at the species level of undetected risks that have quickly developed into problems. For instance, in north-eastern Germany the normally drought-resistant oak suffered an unexpected and large-scale dieback following a run of dry and warm summers. At the time, scientists were not anticipating the complex disease in oak, which is currently affecting these trees.

Another example of an unsuccessful risk perception in conservation is that of the European policy on 'climate protection'. The promotion of renewable energy sources, such as biofuels, during the last decade, led to massive, rapid and unforeseen changes in agriculture and the landscape. By the time conservation stepped in, the changes were already quite visible.

Many of the problems encountered today in conservation are unexpected and fast acting. The traditional approach of implementing business-style management plans that remain unchanged for five or ten years is no longer appropriate for dealing with prevailing uncertainty. Conservation action must learn to adopt a rapid-response and adaptive approach to problem solving, and has to be better prepared to deal with unexpected changes to the environment. To do this, it must put in place scenario-based, proactive and preventive measures for dealing with uncertainty and rapid change

Conservation action must learn to adopt a rapid-response and adaptive approach to problem solving. It needs to be better prepared to deal with unexpected changes to the environment.

Working towards the abatement of recognised and realised threats is not enough. It might be of greater strategic importance to be more risk-robust and prepared for surprises, and to anticipate worst-case scenarios. The climate change studies that started in earnest after the Rio Earth Summit brought to the attention of scientists the need to be more intuitive in their research about uncertainty. Scenario testing has since emerged as a credible strand of environmental science. Understandably, any attempt to formulate a hypothesis and design a follow-up experiment when

[3] Authors: Pierre L. Ibisch, Peter R. Hobson and Laura Geiger.

so much uncertainty exists is likely to involve a certain degree of speculation and subjectivity. After all, that is the nature of scenario testing. There is a tendency for scientists to opt for the more optimistic and least-worst-case scenario. This certainly happened in the early days of climate change impact research. The later emergence of evidence of climate change impacts made clear that this optimism was unfounded. The tendency towards optimism is a profoundly human trait that has contributed to the survival of our species and is more easily understood in the context of earlier, less complicated periods of civilisation. However, in today's world, most natural ecosystems are modified and are behaving in increasingly unpredictable ways. The baseline from which we operate must also change towards being one of increased wariness and caution.

The ability to perceive and realistically assess risks is important, but it often requires a change in (management) culture.

On the one hand, optimism nourishes motivation for action and progress; on the other hand, ignorance about risks may lead to ineffectiveness or even failure. The ability to perceive and realistically assess risks is important, but it often requires a change in (management) culture.

To change direction and move away from the school of science that has provided conservation with convenient, linear, cause-effect evidence is not an easy task. It complicates the picture by throwing up 'fuzzy', unassertive assumptions about the impacts or potential risks of given threats to biodiversity conservation. The unwillingness of scientific conservationists to speculate about future risks can be a major hurdle for delivering a sound risk assessment. One could debate the philosophy of science and what constitutes 'good' science but this would divert attention away from the concerns raised in this manual. For the moment, we will use the term 'post-normal science' to describe the philosophy underpinning the applied principles of adaptive management used in MARISCO.

Adaptive management practises principles of post-normal science in as much as it fully acknowledges the enormous uncertainty and indeterminacy inherent in complex systems. To practitioners, uncertainty translates as 'non-knowledge' and unpredictable conditions that often lead to unavoidable surprises and mistakes. In some cases, what is believed to be rigorous scientific evidence can turn out to be misleading. The answer is not to abandon existing scientific practice, as to do so would be short-sighted and foolhardy. Instead, a more pluralistic approach is required that harvests appropriate concepts and applied principles from science.

All of the points raised so far provide context for risk assessment and for the broader task of risk management. We are now a little clearer about the nature of uncertainty and the need to be more accepting of it, rather than averse to it. A non-knowledge-based risk-management approach would also be rooted in the precautionary principle that it is better to prepare for an unlikely risk that later turns out to be based on wrong assumptions, than to be negatively surprised by a risk that could not be modelled from existing evidence.

The task of identifying risks requires some logical thought and structure and, to achieve this, it is important to prioritise both actual and potential critical factors for action. Risk management is the basis for effective adaptive management in a rapidly changing world. The acknowledgement that uncertainty will result in mistakes being made in conservation encourages a culture of mistake-friendly adaptive management. It also prompts an iterative approach to management that uses a stepwise process comprising: action-monitoring-evaluation-learning-adaptation.

If managers fully acknowledged uncertainty and the inherent 'riskiness' of complex systems, they would not only carry out ongoing horizon-scanning and threat-risk scenario exercises, but would also be less confident about their own actions. A mistake-friendly adaptive management approach would be constantly

Risk management is about adopting a general attitude, rather than carrying out simple working procedures.

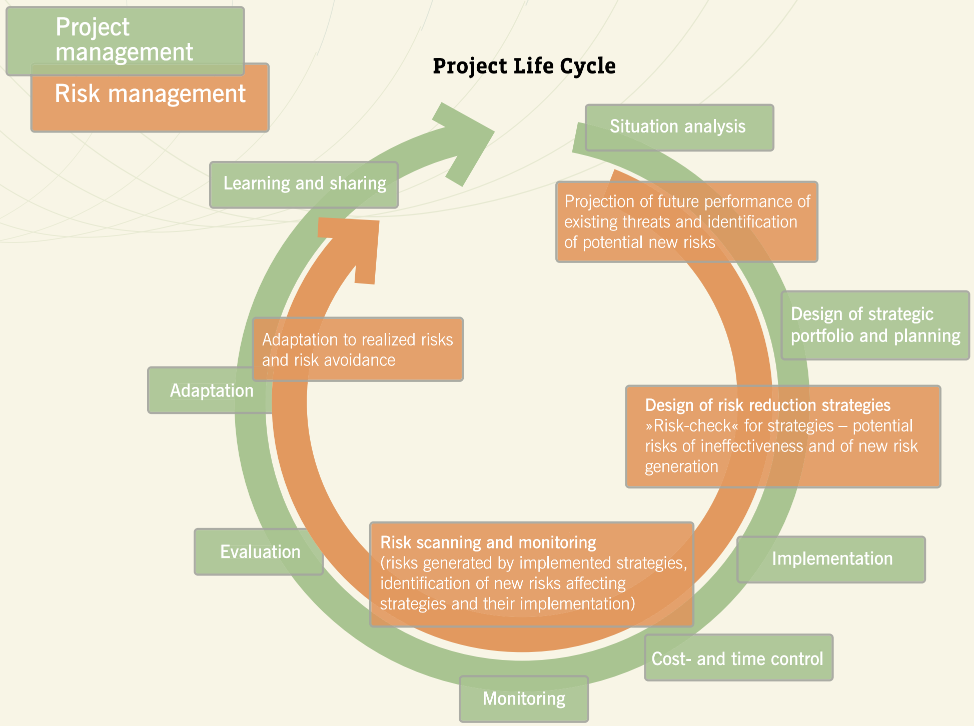


Figure 16. Adaptive management is cyclical and constantly revises its conceptual design and effectiveness. Adaptive risk management is a parallel and interlinked process that allows for checking in any phase of the project cycle where risks appear or where they may be generated by the implementation of strategies.

prepared to detect failures in the underpinning concepts, goals and activities of management that can lead to ineffectiveness or even harm – what one might call 'management-induced risks'. Thus, an effective, adaptive risk-management approach integrates mechanisms and steps for self-questioning and self-testing.

Apart from threats that cause stress by degrading master factors or key ecological attributes, it is relevant to recognise and manage risks that may potentially evolve into real threats.

From risk management to ecosystem-based adaptive vulnerability management in conservation

Vulnerability management in conservation is related to risk management, but it involves a more comprehensive, functional and dynamic process. It acknowledges:

- the relevance of dynamic and interacting risks;
- different entry points of strategies that tackle specific problems or enhance the viability of conservation objects by strengthening their resilience and adaptive capacity. It achieves this by focusing on the **fundamental key ecological attributes of ecosystems:** biomass, information and network.

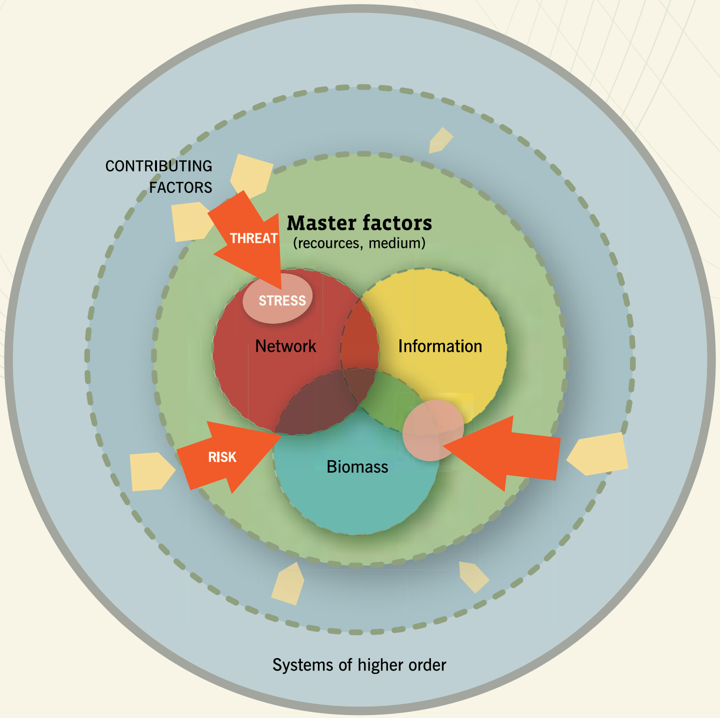


Figure 17. Conceptual model of the aspects and factors relevant for adaptive and proactive vulnerability management. Apart from threats that cause stress by degrading master factors or key ecological attributes, it is relevant to recognise and manage risks (together with their root causes) that may potentially evolve into real threats.

To a practising conservation manager, what does 'ecosystem-based adaptation to change' actually mean? It is worthwhile referring to some of the principles of the **'(radical) ecosystem approach'**, which constitute simple non-prescriptive guidelines for open-ended adaptive action (heuristics) and which are also rooted in ecosystem theory and ecology.

A radical ecosystem approach[xxiv]

Ecosystems as complex, nested systems that change permanently and dynamically

→ **Principle 1:** The 'Earth super-ecosystem' is a complex higher-order system of nested and/or overlapping and interacting subsystems.

→ **Principle 2:** Human systems (the anthroposystem comprising both humankind's biological population and social systems) are an integral and dependent part of the global ecosystem, and all laws of nature that rule the functioning of this system should equally apply to the anthroposystem. Biodiversity in particular will benefit from improving the thermodynamic efficiency of the anthroposystem.

→ **Principle 3:** Naturally complex ecosystems shall be managed with due consideration to emergent properties, non-linearity or feedback loops, as well as to the main drivers of self-organisation and evolution. The laws of thermodynamics are of special importance for understanding the functioning and change of systems.

→ **Principle 4:** The ecosystem approach shall be undertaken at the appropriate spatial and temporal scales. In a socio-economically and politically globalising world that is facing imminent threats related to global environmental change, ecosystem management must be implemented at the local, national and global scale.

Naturally complex ecosystems shall be managed with due consideration to emergent properties, non-linearity or feedback loops, as well as to the main drivers of self-organisation and evolution.

→ **Principle 5:** Recognising the varying temporal scales and lag affects that characterise ecosystem processes, objectives for ecosystem management should be set for the long term.

→ **Principle 6:** Management must recognise that change is inevitable.

Maintaining the sustainable function of the global ecosystem as a key priority

→ **Principle 7:** Conservation of ecosystem structure and function, as a prerequisite to maintaining ecosystem services, should be a priority target of the ecosystem approach. Maintaining the function of the global ecosystem and avoiding significant state shifts of the Earth system (that comprises all other ecosystems and species, as well as all social systems) must be the overarching goal of human development and biodiversity conservation.

- **Principle 8:** Ecosystems must be managed within the limits of their functional capacity, and ecosystem managers or users should consider the effects (actual or potential) of their activities on adjacent and other ecosystems. Ecological deficits created by the human use of ecosystem services shall not be compensated by the externalisation of environmental costs to other systems, but shall be reduced by seeking self-sufficiency (comprising strategies of sustainable degrowth in line with the carrying capacity of the ecosystems that are supporting a given social system).

- **Principle 9:** Due consideration must be given to the interlinkages between ecosystems, particularly in the context of global environmental change and human globalisation. No ecosystem should be treated in isolation; adaptive strategies for global change must be an integral part of ecosystem management, as well as a means to mitigate the effects of global change.

No ecosystem should be treated in isolation; adaptive strategies for global change must be an integral part of ecosystem management, as well as a means to mitigate the effects of global change.

- **Principle 10:** The ecosystem approach should strike an appropriate balance between the conservation and exploitation of biological diversity. Ecosystem use and its consequences must not compromise the functionality of the global ecosystem.

Responsible social participation, economic interests and future generations

- **Principle 11:** Management objectives for land, water and living resources are a matter of societal choices. Participatory decision-making shall take into account the interests of future generations, irrespective of the constraints to development opportunities for current generations and stakeholders.

- **Principle 12:** Holistic management principles that recognise the virtue and gains of the economic evaluation of ecosystems should be practised. Equally, ethical and practical limits to the economic valuation of biodiversity shall also be respected.

- **Principle 13:** Management should be decentralised to the lowest appropriate level, keeping vertical coherence between higher intervention levels and horizontal coherence between development sectors and scientific disciplines. Ideally, the structure, behaviour and institutional arrangements of management systems should reflect the nested, complex systems of nature.

- **Principle 14:** The use of local, regional and global ecosystem services shall follow the principle of equitable benefit sharing. All aspects of human development should be regulated and measured using appropriate indicators of ecological sustainability and equitable benefit sharing. These indicators of sustainability should reflect ecosystem function, efficiency and resilience (principles and measures of thermodynamic efficiency apply here), as well as social justice among present and future generations.

Participatory decision-making shall take into account the interests of future generations.

Use of information, proactive adaptive management and post-normal science

→ **Principle 15:** The ecosystem approach shall consider all forms of relevant information, including scientific, indigenous and traditional local knowledge, innovations and practices. In addition, all relevant sectors of society and scientific disciplines should be included in the process. Limits to knowledge, knowledge gaps, uncertainty and blind spots must be factored into all aspects of practice and management. While evidence-based management demonstrates good practice, a competent and conscious dealing with non-knowledge is a fundamental part of complex ecosystem management. Adaptive management should be as proactive as possible, anticipating potential impacts of future changes. A post-normal science perspective recognises the cognitive limitations of humans and provides important insights for complex systems management.

Limits to knowledge, knowledge gaps, uncertainty and blind spots must be factored into all aspects of practice and management.

The set of principles and conditions outlined above have been explored as a way of bridging the theory/practice gap. The following guidelines and conditions are contextualised for the delivery of MARISCO, focusing more on the adaptation of ecosystems and dependent systems to change. We do not see an end-point to the evolving understanding and practice of ecosystem-based adaptation. New experiences and continuing exposure to novel problems force us, as applied scientists, to rethink our concepts and models and to adjust practices accordingly. As happens in the natural world, these social constructs change and adapt to new circumstances; knowledge emerges, evolves and, in some cases, dies.

→ Ecosystems that have not been irreversibly altered are able to self-order if the stresses are significantly reduced.

→ It is important to recognise and accept that the re-ordering and natural adaptation of ecosystems to change or forcing factors will not follow predictable or desired pathways.

→ All ecosystems at whatever scale are dependent on the condition of surrounding ecosystems and also on the condition of ecosystems at higher or lower orders of scale.
→ Ecosystem resilience and adaptation are dependent on a full complement of the three 'growth forms' of biodiversity – biomass, information and networks.
→ The full complexity of nature cannot be described or understood. There will always be many unknowns and unknowables.

MARISCO can facilitate adaptation to climate change, but only if it is integrated into a broader concept of ecosystem-based climate management and ecosystem-based sustainable development.

→ It is probable and plausible that the prioritisation and conservation of more viable and functional systems will promote greater effectiveness in a system's ability to adapt and survive rapid and unpredictable environmental change. Planning must take into account the whole ecosystem and its context (surrounding environment).
→ Planning should factor in complexity and not assume that a few isolated strategies can produce easy solutions.
→ Understanding the processes and structures of ecological evolution is fundamental to all management practices concerned with natural resources; particularly, in the current context of climate change. Ecosystem-based adaptation or mitigation cannot be practised in isolation. Instead, strategies must adopt ecosystem-based climate management.
→ Practice cannot assume that action is dependent on the existence of full evidence, information or knowledge as this is unrealistic.
→ Practice should not assume that it can improve on or substitute natural self-ordering processes with prescribed management.
→ Practice should not assume that it can restore or create a desired 'original state' of the ecosystem, as this defies the fundamental principles of ecology – change, adaptation and evolution.
→ Practice must be prepared to demonstrate flexibility, willingness to adapt to changing circumstances and, above all, acceptance of uncertainty.
→ Practice must design a strong element of learning into management (based on observation, monitoring and evaluation).

Ecosystem-based sustainable development

If a more holistic, ecosystem-based biodiversity conservation and sustainable development concept is adopted, which includes ecosystem-based adaptation to environmental change, the artificial distinction between mitigation and adaptation becomes obsolete. MARISCO can facilitate adaptation to climate change, but only if it is integrated into a broader concept of **ecosystem-based climate management** and **ecosystem-based sustainable development**.

Aren't there already approaches and tools available that facilitate handling the complex and ongoing biodiversity crisis? What is MARISCO about, and what are the outcomes of MARISCO exercises?

Other approaches in conservation that offer versions of adaptive management do already exist. These include theoretical concepts and models, as well as practical methods and tools. Some recognisable practices include: working with conceptual models, stakeholder participation, permanent ongoing documentation, transparent decision-making processes, revision cycles, facilitating permanent learning and adaptation, and the standardisation of terms and methodological steps[4]. What was still needed was a more dynamic approach – something that did not stop short of current snapshot analysis and, instead, created more awareness about actual challenges to biodiversity conservation. We needed more future orientation, more proactivity, and more risk appetence (willingness to identify and address risks – both in situation analysis and also in strategy design).

MARISCO builds on the existing successes and strengths of CMP's *Open Standards for the Practice of Conservation*, but it is more than just another practical method for planning adaptive strategies for conservation. It is underpinned by a strong philosophy and theoretical platform that includes ecosystem and complex systems theories, as well as non-equilibrium thermodynamics. Rather than applying a 'cook book' principle to conservation, MARISCO demands justification and a rationale for each action taken. What is

[4] Mainly, CMP's Open Standards for the Practice of Conservation and TNC's earlier Conservation Action Planning

more, it offers a great capacity for flexibility and adaptive change.

Rather than applying a 'cook book' principle to conservation, MARISCO demands justification and a rationale for each action taken.

This guide invites practitioners to adopt a step-wise or staged approach to planning; there is no set requirement to apply all the stages in one exercise (see Part II).

MARISCO's outcomes are designed to be robust to change and risk at several scales, including local land use and climate change. The concrete outcomes of a full MARISCO exercise comprise the following:

→ A systemic and dynamic situation analysis of the conservation site and conservation objects, including biodiversity and ecosystem services. Any threats and risks that actually or potentially contribute to the stress and vulnerability of biodiversity objects are also mapped out.

→ A definition of the geographical scope of management, informed by all sources of information including the systemic situation analysis.

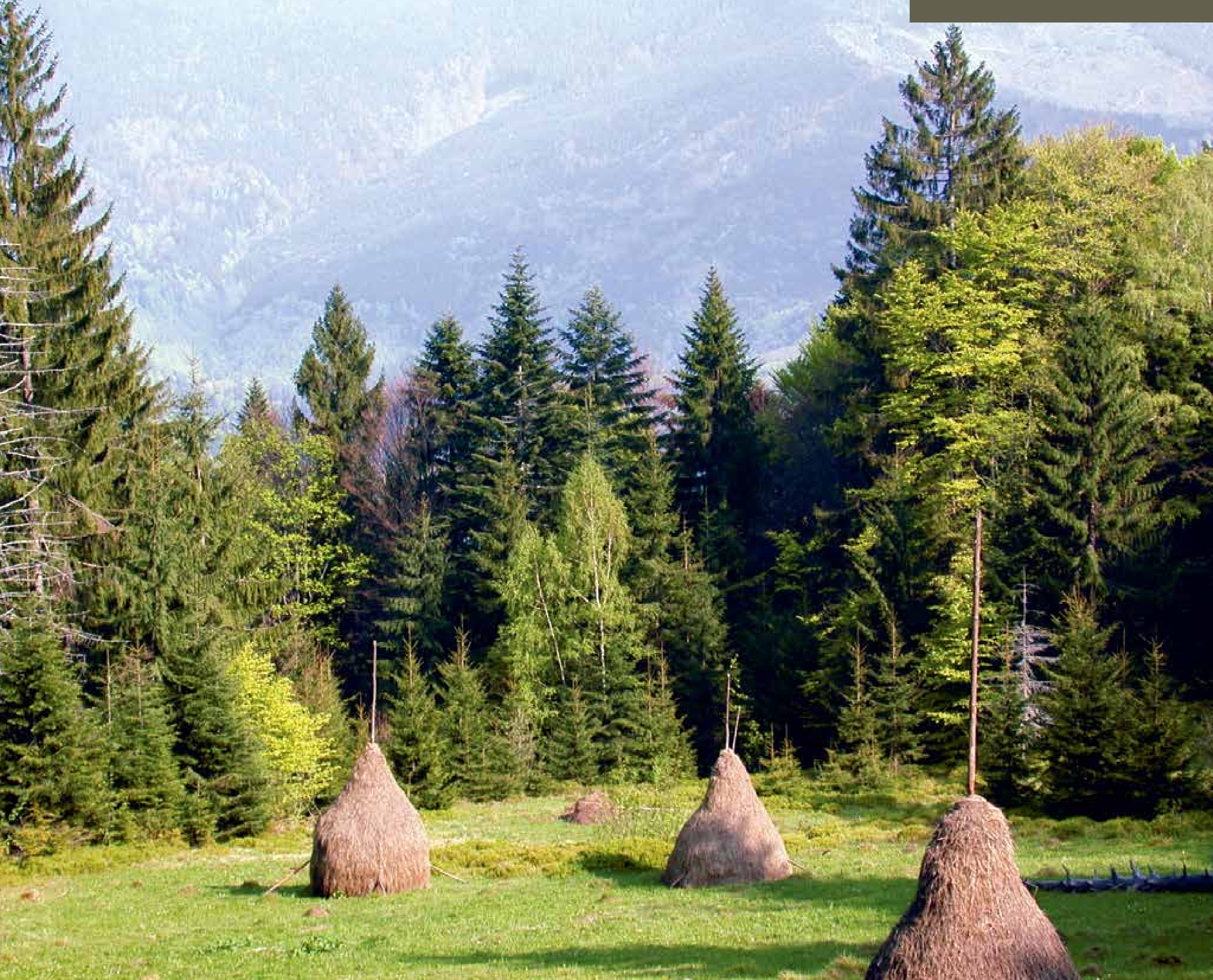
→ An overall strategy based on the principles of ecosystem-based conservation, which includes a vision, management objectives, specific strategies and activities, and a monitoring plan. Also part of this process is a critical evaluation of existing and new strategies to prevent or reduce the risk of failure and secondary, management-induced risks.

MARISCO also provides an opportunity to learn and share knowledge. It promotes general awareness and critical thinking about the risks and vulnerabilities of ecosystems and conservation objects to global change. Workshops act as training events for stakeholders and are designed to engender a collective interest and willingness to understand environmental problems, and to try and resolve them.

The results of MARISCO exercises are dependent on the collectiv e knowledge and resources of the participants and stakeholders involved in the planning exercise, and also on the willingness of the group to be creative and 'risk-appetent'.

MARISCO's outcomes are designed to be robust to change and risk at several scales, including local land use and climate change.

MARISCO workshops act as training events promoting general awareness and critical thinking about the risks and vulnerabilities of ecosystems and conservation objects to global change.



B.
Technical guide

1. How do you want to work with MARISCO? How do you want to use the manual?[5]

MARISCO's value and scope are described in the introduction; however, it is worth reiterating the range of possibilities for using the planning process. MARISCO is already used in the learning environment to deliver skills to higher education students in project planning and leadership. The specific context used is biodiversity conservation but this does not rule out its wider application in environmental and social studies. Within the conservation sector, MARISCO has shown it has considerable value in the review and amendment stages of existing management plans. It has provided ongoing management practices with an effective means of: informing the process, identifying existing knowledge gaps, highlighting potential risks and areas of uncertainty, and building both resilience and adaptability into future planning projects. The combination of knowledge-mapping and raising awareness of uncertainty, as well as identifying potential blind spots, is a hallmark of MARISCO.

[5] By Pierre L. Ibisch & Peter Hobson

What is a conservation site?

MARISCO means 'Adaptive MAnagement of Vulnerability and RISk at COnservation sites'. Does the title imply restricted use in protected-area management? The use of the term 'conservation site' in MARISCO has a wider meaning than just 'protected area', which is a legally defined conservation site belonging to one of the typical national or international categories, such as biosphere reserves or national parks. The term 'conservation site' can be applied to landscapes at any scale where there is societal concern for the status of its biodiversity. In this sense, a conservation site can be applied to an ecoregion, biocorridor, protected area, county or country. The approach uses a nested procedure, which it applies across scales to various sites that spatially include each other. There is no restriction in terms of size or scale. Inevitably, as the scale increases, the detail and depth of analysis will diminish.

MARISCO's broad appeal necessitates an open structure and approach to the method. This manual targets groups ranging from university teachers and students

in fields related to biodiversity conservation and planning, to conservation practitioners working on protected areas or for governmental conservation administrations and non-governmental organisations. The strong underpinning theory invites further research and development by academics, which, as the science basis develops, is likely to result in its gradual evolution. Equally, as the method is used more widely in increasingly varied situations, practitioners will wish to adapt the process to specific cases. In its current form, the manual is made for coaches and trainers who facilitate MARISCO exercises, rather than for workshop participants or project decision-makers.

2. What is a MARISCO exercise and what are its typical components?

MARISCO is a visualised systematic process designed for collecting, ordering and documenting both knowledge and non-knowledge related to biodiversity, threats and drivers of change, as well as the (previous) conservation management for a given site. It reflects the perceptions, assumptions and knowledge of people who participate in the exercise.

The method employs an ordered, stepwise approach to planning and, ideally, all stages of the process should be completed by conservation organisations that are working towards producing a risk-robust strategy for designated protected areas or landscapes. However, ideal conditions rarely arise and, if time and resources are constrained, MARISCO can be applied flexibly to the circumstances at the time. For example, if members of a project team wish to gain a better understanding of the situation of the management area (from another perspective), they can choose to carry out just the first two phases of the method. If the management objective is strategic planning, then the first three phases are recommended.

However, the identification of the scope, conservation objects and their stresses, direct threats and contributing factors – as well as the documentation of all this in a conceptual model that includes the various ratings – are integral parts of the analysis and should be carried out in any case. Some steps would be applied only if there are sufficient resources (of time, knowledge, money, etc.).

MARISCO involves an ongoing process of revising, informing and improving decisions about the management area, and it applies the principles and practices of adaptive management. Adaptive management is not a method; rather, it is a working culture and MARISCO is a means of delivering and promoting best practice in the sector. Short courses or workshops can therefore inject new ideas into the management process, and provide guidance for reflecting on and critically revising current practices. The method can be quite flexibly adapted to different conditions and needs. However, certain key steps must be carried out to fulfil the requirements of MARISCO. Anything less should not be called MARISCO. The well-tested mother approach, CMP's *Open Standards for the Practice of Conservation*, also deliver robust adaptive management solutions, but they are less complex and complete than MARISCO and are less grounded in 'ecosystem-based ideas'.

Table 1 below explains the various methodological steps covered in both Open Standards and MARISCO, and details which ones are considered to be indispensable key steps for the planning phases and corresponding (training) workshops (dark green):

Table 1. Overview of the methodological steps covered in the Open Standards and MARISCO.

MARISCO methodological elements and steps	Open Standards for the Practice of Conservation	MARISCO key step	Optional additional MARISCO step	Comment
0. Ecosystem diagnostics analysis		X	X	Not necessarily required if knowledge base about biodiversity objects is good; however, it is always useful to establish a common understanding of objects and problems and generate a common ecosystem-based view.
1. Scope of management and study	X	X		MARISCO especially encourages going beyond existing management boundaries and following an ecosystem approach.
2. Biodiversity objects	X	X		MARISCO focuses on ecosystem objects (ecosystem-based approach) and represents species as nested objects. In general, a nested (holarchical) structure of biodiversity should be considered.
3. Ecosystem services/ human wellbeing object	X	X		A key component for the depiction of ecosystem-based sustainable development. Carrying out an ecosystem services assessment is highly recommended. This is very useful for communicating with stakeholders and for the integration of biodiversity conservation and human development.
4. Initial management vision	X	X		
5. Assessment of the current status of the biodiversity objects: - key attributes - stresses	X	X	X	The analysis of conservation objects can be a very extensive and time-consuming process. The Open Standards offer a simpler working mode without viability analysis and without stresses. The stresses are considered to be very important in MARISCO and should not be skipped. The functionality (viability) analysis could be considered optional for ecologically well-informed teams. The reflection on key ecological attributes helps users to better understand the sensitivity and adaptive capacity of conservation objects.
6. Threats	X	X		
7. Positive and negative factors contributing to vulnerability	X	X		
8. Grouping of contributing factors (biophysical, socio-economic, governance, institutional, spatial)	X	X		Very useful for a more comprehensive and systematic analysis of contributing factors. Open Standards do not classify factors according to domains but do classify threats.
9. Spatial analysis and priority setting			X	Very useful for a more comprehensive and systematic analysis of contributing factors. Open Standards do not classify factors according to domains but do classify threats.

10. Analysis of criticality: - current - 20 years ago - current trend		X		Open Standards only include threat ratings (current relevance only).
11. Future scenarios		X		Highly recommended. Experience has shown that evaluating future criticality can be difficult without a prior step involving a more general reflection about the future. Additional methodologies, such as 'empathic perspective change', would only be applied in cases where plenty of time is available.
12. Analysis of future dynamics and risks: - criticality in 20 years - new factors		X		Users of Open Standards are encouraged to implicitly include future threats and contributing factors, which might appear within the next 10 years. However, they are not visualised or differently treated in the conceptual model.
13. Analysis of systemic activity and strategic relevance		X		
14. Analysis of manageability and knowledge		X		Very important as an input for strategy formulation and for relativising existing knowledge. This also means the overall quality of the analysis can be assessed and a more objective view of how sure the team is about its capacities can be developed.
15. Analysis of actors and stakeholders			X	Not necessarily required, but highly recommended. A very interesting extension is the 'empathic stakeholder perspective change'.
16. Revision and validation			X	A useful step that improves quality and also allows for the wider participation of further actors.
17. Identification of existing strategies, including mapping in the vulnerability model		X		
18. & 21. Assessment and prioritisation **Feasibility:** (a) resources, (b) acceptance, (c) use of opportunities, (d) risk robustness, (e) adaptability **Impact:** (a) creation of conflicts, (b) contribution to vulnerability, (c) synergies with strategies, (d) conflicts with other strategies, (e) threat abatement, (f) increase of objects' functionality, (g) potential regret				Very useful step that would, ideally, not be omitted. However, when time resources are scarce, the assessment can be simplified. NB: This step can also be used as a stand-alone exercise for the revision of existing strategic portfolios.

19. & 22. Visualisation of systemic relationships of strategies with other elements in the conceptual model		X		
20. Analysis of strategic gaps and strategic modification and, if applicable, complementary strategies formulation		X		Gap analysis is applied only if there are existing strategies.
23. Overall consistency and strategy plausibility, spatial requirements for strategy application, revision of scope and vision	X	X		
24. Results webs, goal and objective setting, monitoring design	X	X	X	The vulnerability analyses and the strategy formulation can be performed without this step, but it represents a further methodological element for quality control and provides important learning and insights about complexity and the risk of linear management thinking.

In the implementation phase, virtually all the suggested steps are highly important and build on each other, facilitating learning from success and failure and effecting adaptation to change.

25. Operational planning and implementation of measures	X	X		
26. Monitoring of results, impacts and research	X	X		
27. Knowledge and non-knowledge management (including early detection and management of risks, learning from failures)		X		
28. Organisation of institutional learning and sharing with other projects/initiatives	X	X		
29. Evaluation and revision of the underlying concept	X	X		

3. How to get started: the information and materials required

General requirements

At the outset, it is helpful to determine a common aim that defines what your planning team would like to get out of the process or achieve within the process. This aim should then be used as the basis for deciding on the exact procedure of the MARISCO exercise. All steps should be carefully selected so they meet the planning team's needs.

Required information

During the MARISCO exercise, different kinds of information are needed at different points to support the decision-making of the planning team.
For the first part of the exercise, it is useful to collect available/relevant information related to the biodiversity and geographical context of the management area. Where available, maps showing ecosystem types, species distribution, roads, settlements, etc. usually provide helpful input given they visualise different aspects of the area.
For the second part, it is useful to collect information about relevant socio-economic, political and biophysical processes related to the management area.
For the last part, an insight into the structure and functioning of the managing entity is important, as well as the collective knowledge of the entity gained in previous conservation measures and the entity's performance.

Planning team

The planning team consists of a specific core group of practitioners who are responsible for designing, implementing and monitoring a project. This group can include managers, stakeholders, researchers, operations staff and other key implementers.

A wide range of participants/team members ensures the coverage/consideration of the full range of perspectives and interests relating to the project area. It is recommended to include people in the team who have a good knowledge of the management area in order to meet the needs of the project data method. They should, in particular, be capable of making decisions and be available to participate regularly.

Those leading the project will be tasked with setting up the preliminary planning team and it is essential that group composition be discussed during the first project meetings. The MARISCO exercise can also be implemented iteratively with different groups complementing existing results or contributing some specific analyses to a more comprehensive model developed by the core group.

Workshops

Depending on the mission of the planning team, a workshop or series of workshops can have different durations and can be distributed over a time frame that suits the purpose of the exercise. All workshops, whatever the purpose of the mission, must be a minimum of two days long.

A four-days workshop provides enough time to work through the majority of the MARISCO cycle (parts I to III) and should deliver results that can feed into the management of the planning team. More days are, of course, preferred because, with more time, matters can be more intensively discussed. If MARISCO is used as a management approach, workshops can be distributed over a longer time frame. The time between the workshops can be used to refine and complete the results obtained from the group work.

The two most important ingredients for a good workshop are the calmness and continuity of the core team/participants; especially given the core planning team builds the basis of the process. Furthermore, experts can be drawn into the process at different stages to support the elaboration of outcomes. It might also be important to include in the process key figures, e.g. decision-makers or representatives.

Another important pillar of a workshop, and also of a longer planning process, is the MARISCO coach who guides the planning team through the process. MARISCO coaches have a critical understanding of MARISCO and the underlying concepts such as complex systems theory, risk management and ecosystems approaches. They are experienced in moderating and facilitating group processes and in applying MARISCO to real-life projects. In a MARISCO exercise, the coach supports the planning team by tailoring the process to their needs, explaining and facilitating individual steps, providing theoretical input where needed, and catalysing the process should the team get stuck in discussions or in the process more generally.

Regarding the workspace, choose a working area where you can concentrate and focus and can work without outside disturbances. In the group-work room, ensure there is enough wall space for pinning up the different parts of the conceptual model. The space should also provide enough room for working in smaller breakout groups, if required.

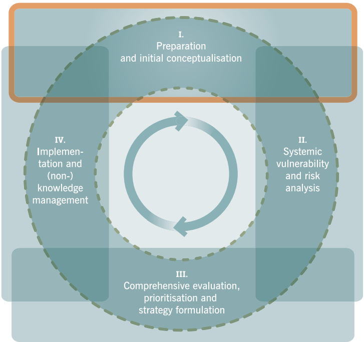
Workshop materials

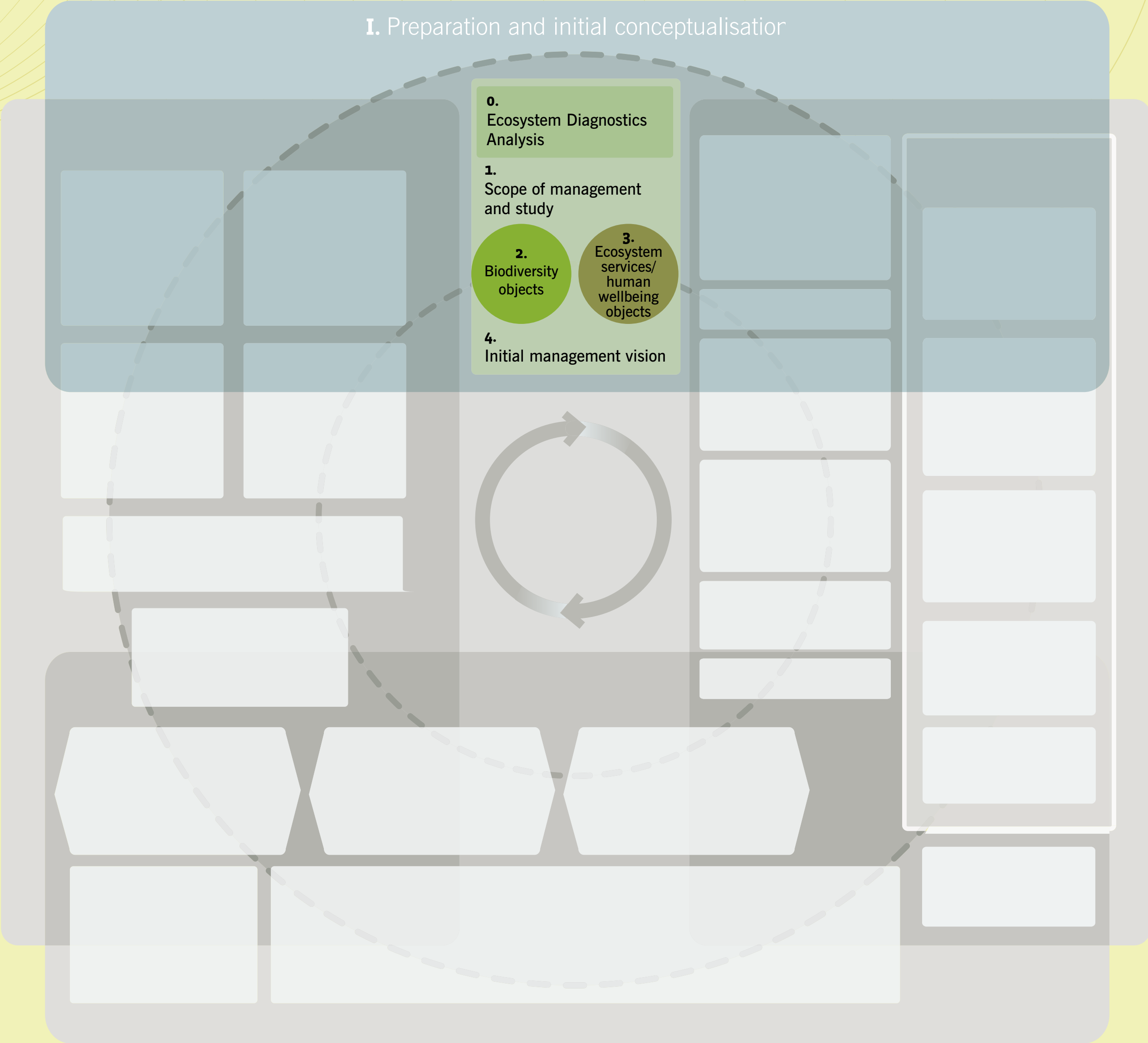
(see also workshop checklist – Annex II on page 180)

› Permanent markers
› Large paper sheets
› Cards in two shapes:
  * rectangular cards in green, turquoise, blue, purple, red, orange, white, light blue and pink (and also purple, red and orange cards with pre-printed rating forms – see the annex on page 178)
  * hexagonal cards in yellow
› Flipchart or similar-sized white paper
› Small, round stickers in red, yellow, and light and dark green
› Printed posters with the MARISCO cycle

4. Applying MARISCO[6]

I. Preparation and initial conceptualisation





[6] Authors: Pierre L. Ibisch, Daniela Aschenbrenner and Peter R. Hobson.

The rationale, objectives, input and output of this part of the exercise

An important part of running a successful MARISCO workshop is the initial planning stage where the basic information and materials are gathered together. Fundamental decisions have to be made about the setting, context and planning process and, naturally, the quality of these decisions depends on the experience of the project facilitators. This stage in the process remains flexible and can be revised whenever more information and knowledge is available. MARISCO is an ecosystem-based approach to conservation management and, to understand its application, it is essential that at least some of the experts involved have a sound knowledge of ecosystem ecology, as well as experience in identifying relevant ecosystem boundaries at the site you are working at. When describing the site, a key stage is to clearly establish the conservation objects. In all cases, conservation sites are designated because of the features noted – whether species, habitats or others. However, it is worthwhile asking the project team to re-examine the conservation objects in the context of both the concrete site and the wider landscape. This exercise should not be treated as trivial as it can result in changing the original list of conservation objects, as well as redefining the geographical scope.

The concrete objective of this phase is:

To identify the relevant geographical scope of analysis and management required to understand and manage a given set of conservation objects that comprise the local or regional biodiversity values and ecosystemic basis for human wellbeing, and which must be developed according to a consensual management vision.

MARISCO is an ecosystem-based approach to conservation management and, to understand its application, it is essential that at least some of the experts involved have a sound knowledge of ecosystem ecology.

INPUT

- Topographical, hydrological, ecological, socio-economic (e. g. urban centres, types of access, etc.), demographic maps.
- Biodiversity information (e. g., habitat types, species, distributional maps).
- Satellite imagery (as a minimum, Google Earth).
- Information about natural-resource and biodiversity use and ecosystem services (in terms of how they benefit local people, adjacent communities/settlements/cities; and also classification (e. g. according to the Millennium Ecosystem Assessment).

OUTPUT

- First map setting the boundaries of the geographical scope of analysis/conservation management and its relationship to the administrative boundaries of conservation site.
- A list of conservation objects:
  - Biodiversity objects logically listed according to landscape ecosystems (e. g., altitudinal belts, humidity gradients) and with included/nested objects.
  - Ecosystem services and human wellbeing objects and their relationship to biodiversity objects.

Explanation of key terms

Geographical scope

The boundaries of the geographical area to be analysed in order to better understand the existing conditions of the conservation objects and the future needs for more effective protection. The redefined boundaries do not necessarily conform to any political or administrative borders, even if this may result in extending management practice beyond the pre-defined limits.

Geographical scope: the boundaries of the geographical area to be analysed in order to better understand the existing conditions of the conservation objects and the future needs for more effective protection.

Conservation objects[7]

Those elements of nature that have recognisable functional importance in maintaining the integrity of an ecosystem and that also provide very real benefits in terms of goods and services for people. These features are singled out for conservation because it is considered that they are at risk or threatened by human activities. Action is needed to try and protect the features from possible degradation or, in cases where it is already happening, attempt to restore their functionality.

[7] According to the Open Standards for the Practice of Conservation, English speakers use the term 'targets' for what we call 'objects'. However, this frequently leads to confusion, as people tend to relate targets to objectives or goals, rather than to existing systems. In other languages, such as Spanish (objetos de conservación) or German (Schutzobjekte), the equivalent for 'objects' is always used, and so we have used this term herein.

Conservation

Conservation describes the process of securing or restoring the optimum conditions in an ecosystem that allows it to function unsupported to its full potential. It recognises the importance of maintaining all compositional and conformational attributes, including evolution, structures, patterns and dynamics that promote inherent resilience and adaptability – mostly to be achieved by reducing existing and imminent threats to the conservation objects, and decreasing their vulnerability against probable disturbances and changes. It does not intend to maintain the status quo for any preconceived historical or culturally desired state of a system.

Biodiversity objects

All elements of biodiversity falling within the geographical scope that merit conservation attention and strategically implemented action to: increase their functionality and viability, reduce existing and imminent threats, and reduce their vulnerability against probable disturbances and changes. Under an ecosystem-based approach the most important and principal objects are functional landscape ecosystems that embed nested objects, such as small-scale ecosystems or populations/species.

Biodiversity

Biodiversity is the variability of life, encompassing all its elements, patterns and processes. It is the full complement of form and function that makes up life on earth.

Functionality

Functionality describes the operational state of ecosystems. It is characterised by inherent structures, ecological processes and dynamics that provide ecosystems with both the necessary (energetic, material and hydric) efficiency and resilience to function effectively without (abrupt) alteration to system properties or geographical distribution during periods of external change. Ecosystems develop greater functional efficiency when they harbour more biomass, contain more information, and are organised more complexly with a high degree of connectedness among the system's elements.

Nested objects

Scale is one of the defining attributes of nature. Specifically, ecosystems are characterised by scale breaks that allow for the existence of ever smaller systems nested within each other. Therefore, any element of biodiversity can be a super-system for smaller enclosed subsystems and, at the same time, a component of a bigger whole. This is described as the 'holarchic' structure of interrelated parts, ranging from single cells up to the single global ecosystem. Much of the dynamics governing the state of nested systems are indirect feedback processes. Conservation in the past has tended to forget the importance of scale by focusing on easily observed and measurable objects (species and populations). More recently, scientists and practitioners have considered these same objects in a much wider context – the landscape.

Conservation objects: elements of nature that have recognisable functional importance in maintaining the integrity of an ecosystem and that also provide very real benefits in terms of goods and services for people.

(Biodiversity-based) Human wellbeing objects

Human wellbeing objects describe the recognisable human benefits derived from biodiversity through ecosystem services. Examples include food security, health, 'inspiredness', or sense of place.

Human wellbeing

Wellbeing arises from a combination of recognisable goods and services derived from biodiversity.

IT INCLUDES:

- what a person currently owns or exploits that is part of natural capital;
- what a person can do with what it has;
- and how it thinks about what it has and can do.

IT INVOLVES THE INTERPLAY BETWEEN:

- the resources that a person is able to command;
- what it is able to achieve with those resources, and what needs and goals it is able to meet;
- the meaning that it gives to the goals it achieves and the processes in which it engages[XXV].

On a notional continuum, wellbeing lies at the opposite end from poverty, which has been defined as a 'pronounced deprivation in wellbeing.' The constituents of wellbeing, as experienced and perceived by people, are situation-dependent, reflecting local geography, culture and ecological circumstances[XXVI].

Ecosystem services

Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as the regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits[XXVII]. Ecosystem services are based on emergent ecosystem properties, and a distinction is made between direct benefits provided by certain species – e. g., related to the production of plant or animal biomass – and indirect ones that exist because of the (inter)action of system components (e. g., pollination, climatic regulation).

Vision statement

A vision statement defines the existence value and importance of a conservation site and the intended or desired condition after conservation strategies have been implemented to secure its protection from current or potential degradation and loss. It predefines the ultimate management goal.

Working steps:

0. Ecosystem diagnostics analysis[8]

Modern day conservation is a sophisticated process that includes gathering information and conducting investigative science for use in the prioritisation, design and planning of protected areas or for the preservation of species and habitats. In cases where there is an availability of resources and expertise, scientists and managers will work together to develop a detailed portfolio of the biodiversity and conservation interests of a site or landscape. This often takes the form of a biological inventory and may even include detailed spatial data on species, vegetation and habitats. In exceptional cases, ecological studies of priority species and ecosystems lend extra weight to the process. The main objectives and methods of this process are often dictated by the specific conservation tasks for a designated site or region, although more common terms of reference that include population status, distribution, extent, diversity and threat are also used.

The approach described above is straightforward when applied to highly modified landscapes characterised by small islands of biodiversity and containing often impoverished communities of plant and animal species. It is also much easier if conducted by appropriately resourced and highly skilled scientists. Even under these circumstances, the margins of error and uncertainty inherent in scientific methods that are not designed for complex systems are high and can lead to problems of blind spots in conservation management. Take, for example, the mapping and recording of species. Species distribution maps rely on the efforts and accuracy of the surveyor.

[8] Authors: Pierre L. Ibisch & Peter Hobson

A process of characterising and evaluating land use change that has direct relevance to the conservation interests of the area.

In many cases, perceived gaps in distribution are a result of poor records or inaccessibility rather than for any natural reasons.

Ecosystems undergo dramatic shifts in heavily disturbed landscapes that result in significant changes to distribution patterns and behaviours of species, as well as to ecological structures and processes. The increase in the frequency and unpredictable outcomes of these changes are attributed to the emerging complexity that is manifest in human-modified systems. Attempts to conserve biodiversity in this landscape are made much more difficult as scientists wrestle with problems of interpreting natural patterns inherent in this complexity. To lend support to conservation under these conditions requires a more holistic investigation of the landscape, a large-scale perspective that enables the practitioner to view a project site in a wider context.

We refer to the suggested methodology as **'Ecosystem Diagnostics Analysis'** (EDA), which describes a process of characterising and evaluating land use change that has direct relevance to the conservation interests of the area. Working at a coarse grain resolution or landscape scale has the advantage of greatly increasing the extent of coverage, but at the expense of losing the ecological detail at the local scale. It is important to make clear the circumstances and rationale for adopting this approach before following it through. There are a number of principles and conditions that should be applied and these are summarised as follows:

- The use of ecosystem diagnostics analysis (EDA) requires either expertise or a good working knowledge in applied geography or landscape ecology.
- EDA is not a substitute for detailed environmental or ecological studies.
- EDA is based on observation and intuitive deduction, and does not attempt to provide testable evidence for cause-effect problems.
- EDA is designed as a rapid assessment technique that can be applied in an environment where there is limited knowledge and poor access to hi-tech facilities.
- EDA is only really appropriate for landscapes that include a range of land cover types, from natural to modified.
- Large-scale spatial data is required and this can be in the form of any one or combination of the following: satellite imagery, aerial photographs, detailed cartographic data.

→ The availability of published information in the form of scientific or technical reports, and/or historical accounts, notes, paintings and photographs are an important requirement for an effective analysis.

→ Any desktop study should be followed up by a 'ground-truthing' exercise.

There are three main objectives to ecosystem diagnostics analysis:

1. To provide a description of the character of the landscape in and around a (potential) management site.

2. To support the delimitation of boundaries adequate for further analysis and management.

3. To provide a provisional evaluation of the existing and potential risks and threats to the conservation interests of the project site.

The analysis combines elements of a l*andscape character assessment* with those of an *environment impact assessment*.

Method and stages in ecosystem diagnostics analysis (EDA)

The development of satellite imagery has revolutionised ecological and environmental studies. One of the system's key facilities is the ability to generate detailed, up-to-date and repeatedly refreshed photographic images of anywhere on the planet at multiple scales. In its simplest form, it is freely accessible to the public as Google Earth[9]. Much more sophisticated resources are available in a variety of other forms. In these more advanced programmes, spatial data is often chromatically filtered, grafted, blended, swiped and overlaid to provide complex representations of ecosystems and landscapes. However, for the purpose of MARISCO exercises – and in the absence of more sophisticated sources of spatial information – Google Earth is a very appropriate tool as it is easy to use and technical skills are not necessarily required to interpret the spatial imagery it provides.

The following structure provides the basic outline of an EDA:

1. Use of Google Earth images to scope the project site.

2. A desktop study based on existing reports, local scaled maps, photographic images, historical accounts/notes, specific socio-ecological or biological/environmental studies.

3. A field survey: targeted, in-the-field observation; a ground-truthing exercise.

4. Final analysis of the gathered evidence.

Using Google Earth

The project site should be analysed at several resolutions. The scale and extent of any investigation is largely dictated by the character of the landscape surrounding the project location. For instance, if the site rests within a heterogeneous landscape shaped by rivers, wetlands and hills or mountains, then representations of these forms should be included in the initial scoping exercise. This can often extend well beyond

[9] See: http://www.google.de/earth/index.html

the actual boundaries of the project site but, because of the nature of 'keystone ecosystems', they are likely to play an important part in regulating and driving the ecology of the target area. At this stage, the main typologies that make up the regional landscape can also be included in the analysis[10]. The focus should be on those natural/semi-natural ecosystems that provide important ecosystem services – forests, natural scrub, rivers, wetlands and lakes, and natural grassland. Human landforms are also to be included – both rural and urban domains.

The following guidelines for interpreting and using Google Earth are useful:

→ Record any recent obvious structural change to the landscape using the function 'historical imagery'.

→ Use the 'ruler' function to record the proximity of the project site to the main typological features, hills/mountains, rivers, lakes and wetlands, forests, farmland and urban/industrial infrastructure.

→ Use the 'time slider' function to better understand landform relief and the influence of topography on vegetation patterns (shading, exposition, and so on).

[10] These can be recorded using an existing landscape classification system such as that produced by UNEP-WCMC (1992). Equally appropriate is Leemans's life zones:
• Leemans, R., 1990, Global data sets collected and compiled by the Biosphere Project, Working Paper, IIASA-Laxenburg, Austria.
• Leemans, R., 1992, 'Global Holdridge Life Zone Classifications, Digital Raster Data on a 0.5-degree Cartesian Orthonormal Geodetic (lat/long) 360x720 grid', Global Ecosystems Database Version 2.0, NOAA National Geophysical Data Center, Boulder, USA. (Two independent single-attribute spatial layers. 537,430 bytes in 8 files.) First published in 1989.

Figure 18. Land use change visualised with historical satellite imagery provided by Google Earth. Here in Laguna El Repasto, Guayacán, within Guatemala's Sierra del Lacandón National Park, we can see how forests were fragmented and lost west of the lake over the years 1970, 2006 and 2010.

Figure 19. The morning and afternoon situation (4 January) in the Altai Mountains, Katunskyi Biosphere Reserve, Russia. The time slider can be used to better understand the topography.

Figure 20. The morning situation at Lake Shkoder – a Ramsar site in Albania. This panoramic landscape view shows the southern slopes abutting the Buna River.

- → Analyse the orientation and slope of the land in relation to the project site and the surrounding typologies.
- → Analyse patch size and configuration, land cover pattern, fragmentation and connectivity in the surrounding landscape.

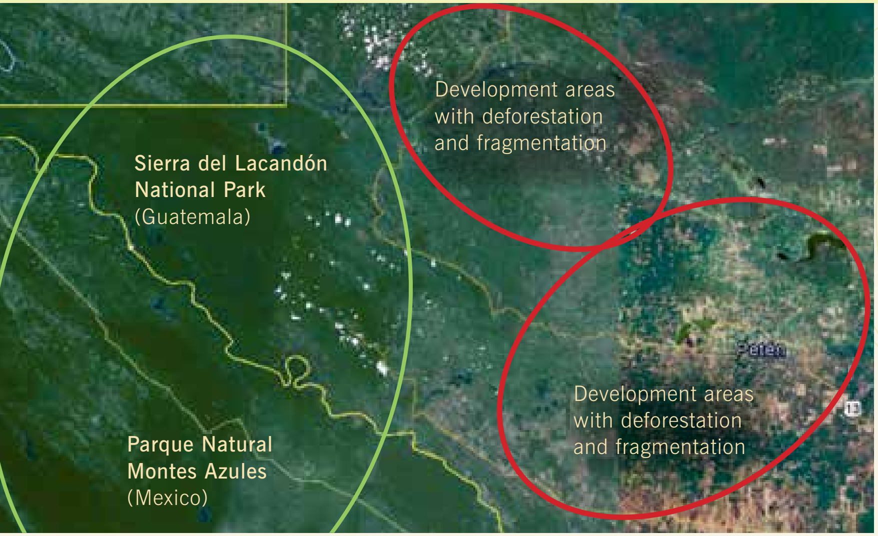


Figure 21. This Google Earth image clearly illustrates that the forests of Sierra del Lacandón National Park in Guatemala are increasingly isolated from better conserved forests in the north of Petén Department. It also reveals that the forests are part of a natural forest block in the Lacandon area stretching over to Mexico, where a homologue protected area would be the Montes Azules Natural Park. This analysis allows for greater fine-tuning of the geographical scope of analysis of Sierra del Lacandón National Park, and it demonstrates the importance of considering areas beyond the national border in order to understand the state of the forest ecosystem (in terms of the size of forest block, viability, habitat for large predators, etc.).

- → Record any evidence of ecosystem modification – river engineering, boundary alteration, mining, and others.
- → Establish the time of year the image was taken and then make brief notes on the colour, texture and reflective light of vegetation in each of the main typologies.
- → Repeat the same exercise for water bodies (you want to be able to detect signs of algal bloom, 'milky' colour or turbidity).

Figure 22. This Google Earth image shows how the sediment load of the Naranjillos River is impacting on water quality in the coastal area of Manuel Antonio National Park, Costa Rica. This therefore indicates that, to scope the planning area, it is important to trace the origin of the sediment loads in order to understand the cause of this disturbance. Ground-truthing can confirm to what extent the sedimentation is related to land use change/ agriculture or river manipulation

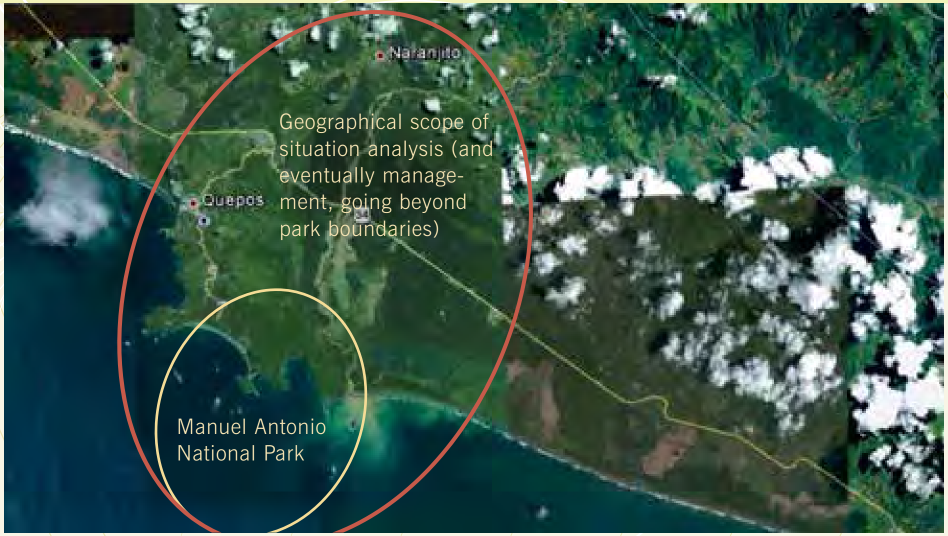


Figure 23. A rough identification of the geographical scope for analysis for Manuel Antonio National Park, Costa Rica, based on the water catchment area, land use, roads and settlements.

→ Where appropriate (and if not familiar with the site), view photographic images clipped to the Google image (enable Panoramio in Layers' menu[11]).

When conducting a spatial analysis from either satellite images or aerial photographs, any puzzling spatial anomalies should be noted down. These can then be revisited either at this stage of the analysis or later, during the field survey. In some cases, it is useful to cross-reference unexplained observations with earlier studies made in similar landscapes.

For instance, if a previous study was carried out in mixed farmed and natural landscape on limestone geology thrown up into relief in the western part of the Mediterranean, it is possible to use this experience to help interpret unexplained patterns observed in similar conditions but on the eastern side of the sea.

Desktop study based on existing reports, local scaled maps, photographic images, historical accounts/notes, specific socio-ecological or biological/environmental studies

In most cases, information exists in some form or other for a designated area or for a particular region of a country. It may be available in any one or combinations of the following: detailed scientific studies or reports carried out by universities or private consultancies, technical reports commissioned by government agencies, historical accounts, photographs, maps, paintings, or even registers and ledgers.

The depth and thoroughness required of a desktop study is case-specific and is determined by the level of information needed at the time. If it is believed that there is very little knowledge among stakeholders about a site or region, then a more in-depth study is required to provide a fuller context for MARISCO's conceptualisation process. Whether detailed or light touch, this stage of the EDA underpins the spatial

[11] Panoramio – Photos of the World: http://www.panoramio.com

analysis by providing an understanding of the shapes, structures, dynamics and patterns observed in satellite imagery.

The following list gives an indication of useful sources of information:

- → Technical reports, the so-called 'grey literature'. Often these can provide data and statistics for natural resource capital/stocks – forest cover, cropping land, water storage capacity, and others.
- → Historical photographs that are kept in government archives, universities, museums (particularly, wartime aerial reconnaissance photographs), and local history societies.
- → Biological records made by universities, environmental consultants, and national/local government agencies and conservation NGOs.
- → Archived illustrations, historical accounts/notes, ledgers, land registers and paintings (such as those held in museums and universities).
- → More rarely, archived recorded interviews with local residents and land owners (again, check in museums, universities and also in religious centres like monasteries, churches and mosques, which often have considerable library resources).

Field survey: targeted, in-the-field observation; ground-truthing exercise

To carry out an effective EDA, it is important to invest in this part of the analysis. Field surveys provide the necessary fine-grain information that would otherwise go undetected and unrecorded. Relying solely on spatial data and desktop information can quickly lead to false assumptions and blind spots. Ground-truthing is just that, a means of verifying what is observed remotely.

This stage of the EDA requires time and effort if it is to be effective. Rather than take a broad-sweep approach to ground-truthing, a more productive study can be performed by targeting specific areas identified in the first stage of the EDA – the spatial analysis. This is where an accurate identification of ecosystem typology is important as it provides a focal point for ground-truthing. Where rivers, streams and surface water are present, they should be targeted in a field survey as they are one of the driving forces of landscape patterns and change. In most cases, they also show evidence of any substantial human disturbance. Similarly, because of the services they provide, forests and wooded landscapes should be investigated. Often, the first stages of soil erosion occur in areas that have experienced significant removal of tree cover. The effects can also be far-reaching – in some cases, many kilometres from the point-source.

The following guidelines are useful in conducting a field survey.

- → Visit known sources of disturbance or environmental hazard – disused and working mines, factories, commercial plantations, fisheries, sewage plants, land drains and ditches, and settlements on riverfronts or estuaries.

Before a situation analysis is undertaken by stakeholders, a broad understanding of the project site is needed to ensure that all parties share a common knowledge of the landscape character and the potential risks and threats to the area.

- → Where there are rivers, track upstream to look for sources of effluent or mineral discharge, river barriers, abstraction points, incoming drains and ditches, engineering and 'pinching'. Examine river mouths for surplus sediment discharge, discolouration, flocculation and others signs.

- → Where there are lakes, reservoirs and large ponds or dams look for evidence of algal bloom, odour, abnormal drawdown and nitrophilous plants.

- → Examine the boundaries of key ecosystems (wetlands, rivers and forests) adjacent to urban and rural landforms.

- → Target unexplained anomalies noted during the first stage of the analysis (the spatial analysis).

Final analysis of the gathered evidence

The EDA has two main outcomes. The first is the provision of a baseline for the conceptualisation process in MARISCO. Before a situation analysis is undertaken by stakeholders, a broad understanding of the project site is needed to ensure that all members share a common knowledge of the landscape character and the potential risks and threats to the area. The second outcome is the provision of a process reference point based on the objective analysis of impartial scientists. The EDA's findings should be cross-referenced with the final outcomes of the situation analysis. In this instance, the EDA not only serves to validate the findings of the situation analysis but also reveals any gaps in the process that can then be revisited at a later stage.

1. Define the geographical scope of management

Rationale for this step

The scope defines the management area of a project or conservation site and includes all those features of biodiversity identified as in need of protection. In most cases, the management area already exists as a designated protected site or is soon to become one. However, decisions made to designate a site as protected are often based on socio-political factors or economic reasons and have very little to do with the ecological needs of biodiversity. Consequently, the areas are usually too small to ensure adequate conservation. There are other issues related to human impacts occurring in the wider landscape that may influence biodiversity on site but may remain undetected. Only a landscape

Figure 24. Ideally, the planning group will start a MARISCO exercise with a joint field trip to the area in question, where they can perform an ecosystem diagnostics analysis and talk to stakeholders and exchange views about field observations. Usually, field diagnostics are delegated to consultants and experts; however, the joint field trip is of the utmost value in that it creates opportunities for interaction between staff, scientists and stakeholders outside of lecture halls and planning rooms. This is true even if everyone feels sufficiently familiar with the area. In the above image, lecturers and students visit a conservation site and interview the construction team of a sewage plant at Lake Shkoder, Albania.

perspective that puts the site in a wider context is likely to capture these sorts of problems.

What you need

Most forms of maps can be used, as long as they provide suitable detail of the geomorphology and human infra-structure. Ideally, the maps should be in digital format and should include adequate information on habitat types, land use cover, administrative boundaries, as well as fine-grain details of topography and hydrology. In the absence of satellite images, aerial photographs or devices for their interpretation, Google Earth[12] images constitute a useful addition to cartographic records as they offer real-life images containing surface features that do not necessarily appear on maps. Furthermore, they allow the site to be scrutinised at different scales. Failing all this, where no such resources are available, crude hand-drawn maps can be sketched from memory, and these can then be converted to scaled maps at a later stage in the process.

The scope defines the management area of a project or a conservation site.

Application procedure

Using the map, demarcate the current limits of the management area and, within the team, evaluate the appropriateness of the existing area in the context of the biodiversity of the site.

The following questions offer some guidelines for this process:

→ Is the existing area coverage of the site large enough to allow for the effective functioning of the relevant ecosystems?

→ Does the projected scope take into account wider landscape features or ecosystems that may influence the biodiversity of the existing site?

[12] See: http://www.google.de/earth/index.html.

→ Does the area coverage of the current scope ensure/support the existence of a viable population of an important species?

→ Does the scope include relevant stakeholders and/or communities close to the conservation site?

Inevitably, some decisions must be taken on the ultimate limits of the scope as the forces of influence may come from far beyond the current boundaries of the site. Once the team has reached a satisfactory decision about the new boundaries of the project, a new map should then be generated either in GIS or another appropriate format. This map will later serve as a visualisation tool to mark up the outcomes from the following situation analysis. The dynamic situation analysis, which can also include several large-scale drivers of change and risk, often prompts teams to define a management scope area larger than the legally defined conservation site. This being the case, it is recommended to revisit the definition of the geographical scope at least once before starting on strategy formulation.

When using an ecosystem-based approach, it is important to identify, where possible, whole systems that represent not just the compositional elements of an ecosystem, but also the processes, structures and dynamics that govern them.

2. Determine conservation objects: biodiversity objects

Rationale for this step

The initial selection of conservation objects from among all the observed biodiversity on site defines the rest of the planning process. Ultimately, the outcome of the planning process is only as good as the initial prioritisation of conservation objects. Traditionally, the prioritisation of biodiversity attributes for conservation has been determined by specific measures such as species, habitats and populations. When using an ecosystem-based approach, it is important to identify, where possible, whole systems that represent not just these compositional elements of an ecosystem, but also the processes, structures and dynamics that govern them.

What you need

Naturally, a good knowledge of the area's biodiversity is helpful. That said, it can be counterproductive to go into detail too early without understanding the wider system. The use of ecosystem diagnostics analysis provides some measure and understanding of the appropriate level of detail required for this kind of work. For instance, it is important to understand which systems provide energy, material, and water input or retention, and also to be able to recognise the main types of vegetation, rivers and water bodies. If the conservation site has been created for the protection of selected species, it is essential to be able to understand the ecosystem(s) in which these species operate.

Application procedure

→ Identify a sufficiently large spatial unit that encompasses the most important ecological processes in the region. In most cases, this means ecosystems at the landscape scale, and can include smaller aquatic and terrestrial subsystems. A large spatial system may represent a certain type of landscape – e. g., forest landscape, lakescape (around a large lake and including surrounding mountains and [lower] catchment areas), seascape, coastscape, etc. This may well be the highest-order ecosystem object to conserve and it is likely to extend beyond the boundaries of the established protected area.

→ List the smaller ecosystems that are included and are assumed to contribute significantly to the larger system's functionality – e. g., rivers, water bodies, forests, mires.

→ Identify groups of species (guilds) or individual species that are of special importance for the functionality of the ecosystems. These can be: structural builders, such as dominant tree species; engineering species, such as beavers; or important keystone species, which are known to play a relatively large role in the system. Typical species to list might be apex predators.

→ All biodiversity objects are written on green cards.

→ Start to develop a conceptual model: assign the species or species groups to the ecosystems and provide a visual interpretation of how they are related to the ecosystems.

EXAMPLE CONCEPTUAL MODEL »MARISCONIA«

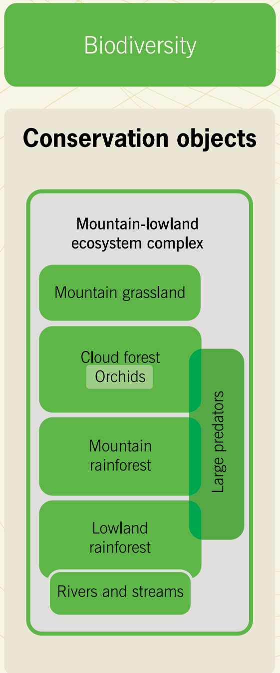


Figure 25. MARISCONIA: conservation objects
MARISCONIA is an imaginary conservation site where MARISCO is being applied. In this step, the initial analysis of conservation objects is visualised and the biodiversity objects are depicted. The nestedness of different objects is represented by the embedded boxes. The ultimate biodiversity object would be a bigger ecosystem complex stretching from the lowlands to the mountains and including the discrete ecosystem units identified, such as rivers or forests. Within the cloud forest object, a group of species – the orchids – is highlighted as a nested object of special importance. The large predators do not exclusively belong to the three ecosystem types along the altitudinal gradient and are therefore represented with a partially overlapping box.

3. Determine conservation objects: (biodiversity-dependent) human wellbeing objects

Rationale for this step

The identification of ecosystem services is essential for working with stakeholders, understanding their needs and perspectives, and also communicating the benefits of conservation to the public. The depiction of ecosystem services reflects the potential of a given site for ecosystem-based sustainable development. In fact, at certain sites like communal or indigenous reserves created for the protection of natural resources, this step may be performed prior to the identification of the biodiversity objects that provide the services. However it is done, when this step complete, the way people use or depend on the scope's biodiversity can be understood and visualised.

What you need

Cultural relationships to the site and the non-monetary value of biodiversity are important and, to understand this, it is important to identify local people's needs and their demands and activities in relation to local ecosystems. As such, an important part of the process involves appropriately documenting the demands made of the ecosystem by both local and outside stakeholders (e. g., climate-related services and global interest in significant forests; or stakeholders living downstream who are interested in upstream water regulation).

A management vision stimulates consensual strategic thinking and sets a baseline for goal formulation.

Application procedure

The preparation of an inventory of ecosystem services according to the categories laid down in the *Millennium Ecosystem Assessment* (supporting, provisioning, regulating and cultural services) is recommended. However, any other classification can also be used. The inventory can be started with a checklist of stakeholder groups and their corresponding needs. After recording the ecosystem services on the cards, the next stage is to determine how these influence human wellbeing. The categories for human wellbeing can also be lifted from the *Millennium Ecosystem Assessment*. Physical and psychological health may be defined as the ultimate state of human wellbeing. To promote the right conditions for good health, society would need to ensure adequate food security and access to clean drinking water, basic non-food materials for living well (e. g., for shelter), income, security, a reasonably good level of freedom of choice, and good social relations. In constructing the conceptual model, connecting arrows are drawn between the human wellbeing objects and the ecosystem services, and also the corresponding biodiversity objects.

There are several methods for ecosystem (service) assessments[13]. The following table summarises important guiding questions for the dialogue with stakeholders.

[13] E. g., CCI and BirdLife International (2011), Measuring and monitoring ecosystem services at the site scale, Cambridge Conservation Initiative and BirdLife International, Cambridge, UK. Kosmus, M., I. Renner, S. Ullrich (2012), Integrating ecosystem services into development planning. A stepwise approach for practitioners based on the TEEB approach, GIZ, Eschborn, Germany. UK NEA (UK National Ecosystem Assessment, 2011), The UK National Ecosystem Assessment Technical Report, UNEP-WCMC, Cambridge, UK.

EXAMPLE CONCEPTUAL MODEL »MARISCONIA«

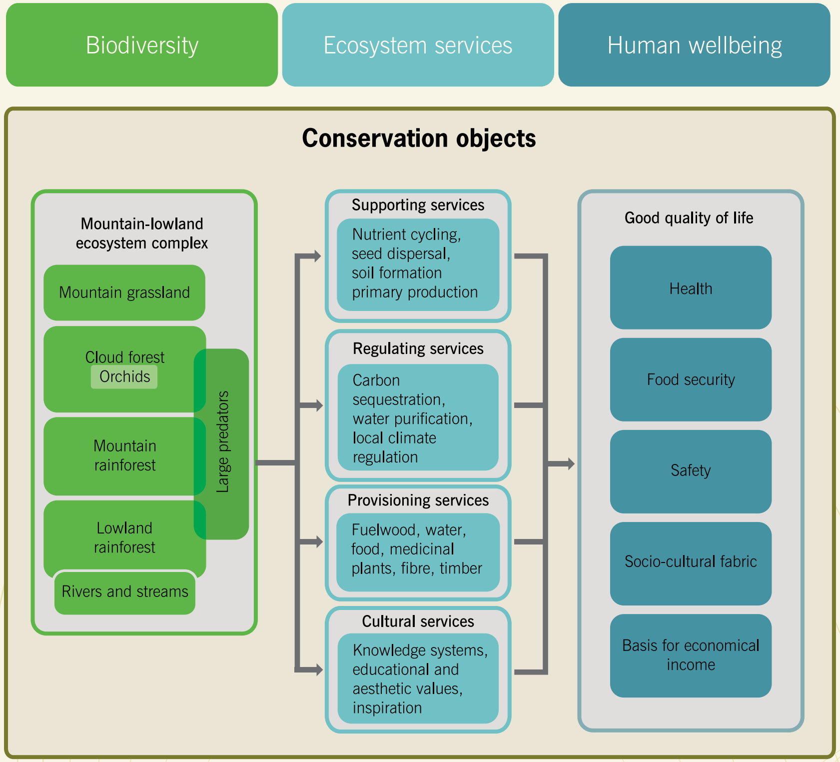


Figure 26. MARISCONIA: Ecosystem Services and Human wellbeing objects.
MARISCONIA is an imaginary conservation site where MARISCO is being applied. The definition of conservation objects is complete and the connections between them are now explicit: the human wellbeing objects depend on ecosystem services that are, in turn, derived from the biodiversity objects. These interrelations are, in this graph, rather simplified. In cases where more detail is required for the analysis or for stakeholder communi-cations, it is quite possible to develop a more complex network of connecting lines and arrows to describe relationships in more detail.

Table 2. Guiding questions for participatory ecosystem services (ES) assessment

Guiding questions for participatory ecosystem services assessment[14]

Question	Rationale	Qualifications/ratings
Which benefit?	Any such assessment is ES-specific. The initial decision is, therefore, which ES to consider.	(Identity of the ES under consideration)
The basic need?	A fundamental distinction is whether an ES is basic in character (i.e., for the survival of local people, such as basic foods) or, at the other extreme, is consumed just for pleasure or serves to generate income through export from the region (e. g. tobacco). Often, however, many luxury goods can also be viewed as relevant cultural ES (e. g. coffee).	1. luxury product/for export 2. mostly luxury/for export 3. mostly essential/locally consumed 4. essential/locally consumed
Main beneficiaries – who? Consider: producers, sellers, consumers	ES may benefit all of society (e. g. carbon storage for climate change mitigation) or, contrastingly, may benefit specific societal groups. In many ES, especially among the provisioning ES, it makes sense to assess who is involved in the supply chain. Another important aspect of an ES to take into account when developing a management strategy is the proportion of its beneficiaries compared to the entire (local) population. Basic needs (e. g. drinking water) will typically benefit most or all people (as consumers). In contrast, other ES may only benefit certain sections of the population because they are localised, expensive, etc.	(Description of the identity of the main beneficiaries)
Main beneficiaries – how many?		1. few 2. some 3. many 4. (almost) all
Quantity of demand – current trend?	The availability of an ES from an individual's perspective depends on the overall demand (i.e., level of competition for the ES) by society, as well as the volume of supply delivered by the ecosystem.	1. generally increasing 2. stable 3. in some places increasing, in others decreasing 4. generally decreasing
Quantity of supply – sufficient?		1. enough 2. just enough 3. not quite enough 4. not enough
Quantity of supply – current trend?		1. generally increasing 2. stable 3. varies between sites 4. generally decreasing
Seasonally variable? (within one year)	Ecosystems and the ES they deliver do not persist in a stable state. Apart from the directional changes addressed by the preceding questions, there are oscillations at various rhythms that can be nested within each other. The most important temporal variation is, of course, the annual change of seasons. However, ecosystems also fluctuate between years – for example, with dynamic climatic or biotic changes.	1. available the whole year 2. available most months 3. available some months 4. available for very few
Variable between years?		1. same every year in the last 10 years 2. most years out of the last 10 years 3. some years out of the last 10 years 4. few years out of the last 10 years

Quality of supply – good enough?	For a number of ES, alongside quantities, it is equally important to consider the quality in which the ES are delivered. Drinking water represents an obvious example. In some ES, however, it is difficult to differentiate between quantity and quality, e.g. in cultural services like the religious meaning of an ecosystem.	1. good enough 2. just good enough 3. not quite good enough 4. not at all good enough
Quality of supply – current trend?		1. generally increasing 2. stable 3. in some places increasing, in others decreasing 4. generally decreasing

[14] Prepared by Stefan Kreft.

4. Define the initial management vision

Rationale for this step

A management vision helps to orientate activities, and management goals and objectives. It is important to formulate this vision before moving on to the detailed situation and vulnerability analysis because the vision stimulates consensual strategic thinking and sets a baseline for goal formulation. Once this is done, the group can then address aspects of vulnerability, change and risk. First attempts at producing a vision statement can always be revised later on as the process unfolds.

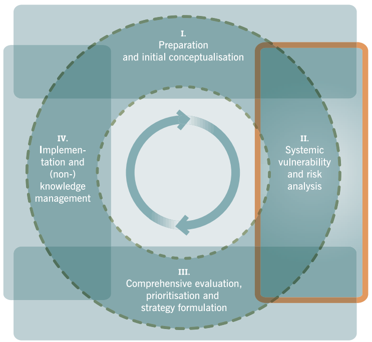
What you need

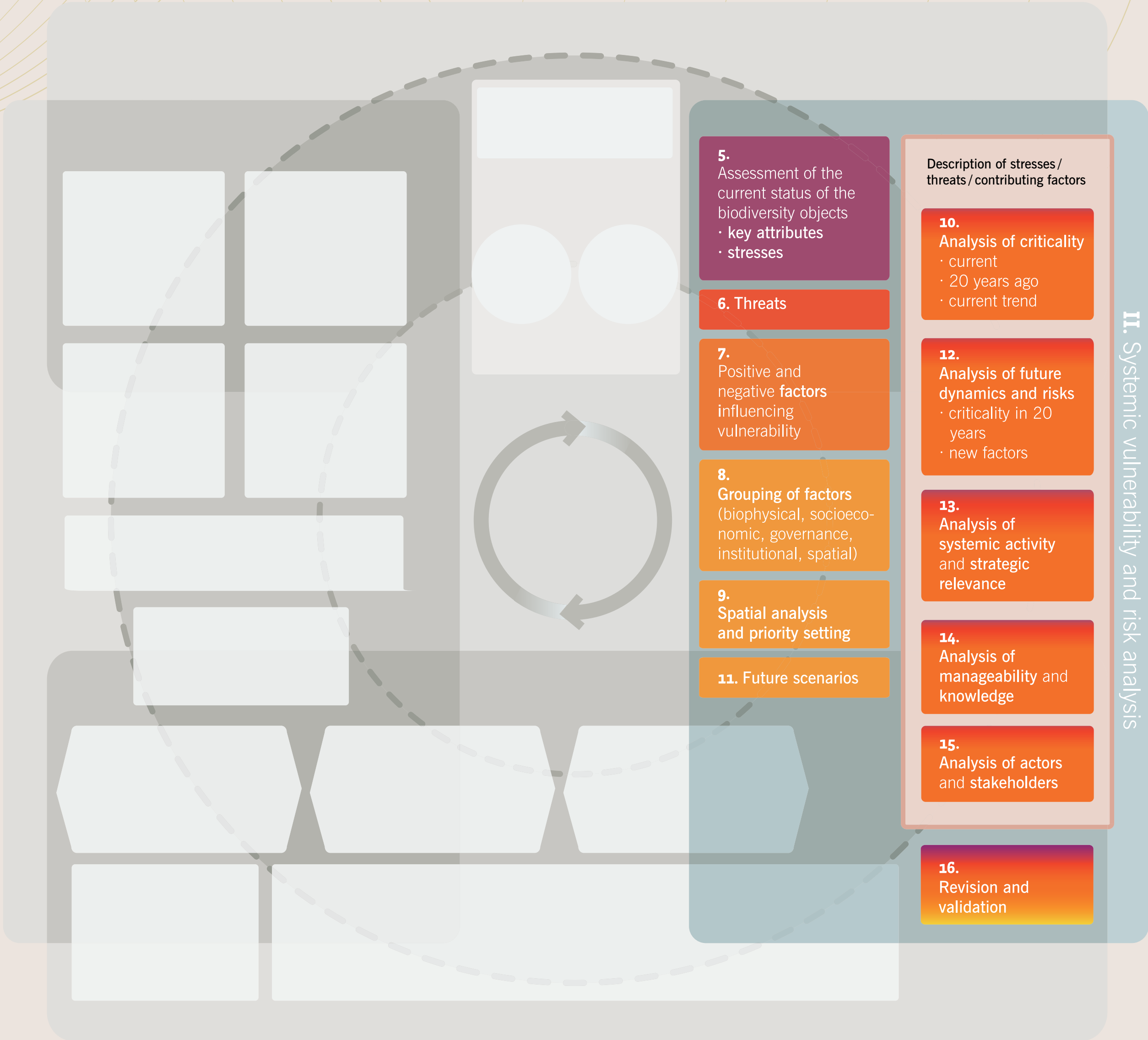
No special materials are required. Formulating a management vision represents a pragmatic and realistic approach to conservation planning but, at the same time, it sets sights on ideal-seeking outcomes.

Application procedure

Experience in running MARISCO workshops over the last few years has shown that it is useful to draw up single elements of a management vision without necessarily worrying too much about getting the language precise. At this juncture, it is worthwhile explaining the differences between a vision and management goals or objectives. A vision must not be too prescriptive in defining timelines and outcomes; rather, it should include a statement of intent for achieving ideal conditions for biodiversity and human wellbeing. It can also be based on a general concept of a 'wished-for' future state of biodiversity and human wellbeing. Vision statements should reflect a holistic approach to planning by incorporating institutional aspects (e.g. referring to the vision that an area becomes a model or experimental site on a national, regional or global scale; or resource availability), as well as spatial criteria (how big, how interrelated with other areas, etc.). In a workshop environment, the ideas or vision statement are best written up on a white poster that is then displayed on the wall of the workshop room until planning and/or vision-revisiting activities are complete.

II. Systemic vulnerability and risk analysis[15]





[15] Authors: Pierre L. Ibisch, Daniela Aschenbrenner and Peter R. Hobson

The rationale, objectives, input and output of this part of the exercise

Once the conservation objects for a conservation site are defined and before any further action towards strategy formulation is taken, it is important to establish, as best as possible, a detailed understanding of the set of circumstances and conditions that mark out the character of the site. The situation analysis should reflect as much of the complexity inherent in the ecosystem or landscape that is likely to be affected or to cause effects. The intimately related nature of objects in ecosystems poses problems for conservationists wishing to understand more about cause-effect dynamics, and even more so in cases where human intervention has profoundly changed natural patterns and structures. Nevertheless, it is important to capture in some way a rough representation of the situation. As a first step, this is performed through a consensual analysis, which is carried out by the planning team – ideally supported by different types of experts and knowledgeable persons. A so-called 'situation analysis' is also relevant for defining the management baseline and for documenting available knowledge as a starting point for change management.

The final output of the MARISCO situation analysis is a visual representation of a conceptual model comprising as many of the elements involved in the cause-effect dynamics of a modified landscape or ecosystem as possible. At another level, the model also attempts to capture what is known and understood about the system, as well as reveal the knowledge gaps and 'non-knowledge' inherent in the uncertainty of the complex system to be managed. The whole process of managing knowledge and working with uncertainty is a central tenet of adaptive management and, within this paradigm, evidence-based practice is but a part of the process. It is not the aim of the exercise to reflect only perfect knowledge. In the early stages of the exercise, the construction of understanding from collected and shared knowledge is likely to go through a process of revision as the model evolves and at each stage of review. The planning group will understand that the knowledge in the group is likely to be preliminary, laying the ground for further learning. **Any element that is integrated into the conceptual model represents a preliminary hypothesis to be validated, specified and improved or to be disproven and rejected in the course of the adaptive planning process.** Participants in a MARISCO exercise are encouraged to reflect on and reassess statements and decisions as part of the adaptive process of refining knowledge and understanding.

Figure 27. The process of constructing a conceptual model, working from the right-hand side, with the identified conservation objects being located towards the left-hand side. The analysis of the cause-effect relationships of different elements provides unique opportunities for sharing perspectives on biodiversity conservation and development challenges. The exchange among different stakeholders and conservation actors about the various elements of the model in itself represents a valuable outcome of MARISCO workshops.

THE CONCRETE OBJECTIVE OF THIS PHASE IS:

To adequately reflect on current knowledge about the complex systemic and dynamic cause-effect relationships between the various contributing factors and threats that influence the vulnerability of the conservation objects within the prescribed geographical scope of analysis, and to determine the criticality of the identified contributing factors, threats and stresses in order to facilitate strategy formulation and prioritisation.

Input	Output
• Information about environmental, socio-economic, legal, political, and institutional circumstances at the conservation site and vicinities. • Knowledge and ideas from any sources about objects, their situation and causal factors, and past and potential future changes.	• Systemic situation analysis in the form of a: → conceptual model that depicts the current management situation at the conservation site, including conservation objects and their stresses and threats, as well as contributing factors. These are then classified and rated according to their contribution to the overall vulnerability of the biodiversity objects and to their strategic relevance. → Realistic assessment of levels of knowledge and manageability.

Explanation of key terms

KEY ECOLOGICAL ATTRIBUTES

Key ecological attributes are best described as integral elements and properties of ecological systems that maintain function and provide the necessary adaptation and resilience to cope with perturbations. Underpinning the biological 'template' of ecosystems are the 'master factors', the physical skeleton primarily made up of energy input, moisture, temperature, and nutrients. The living systems themselves are best characterised in terms of biomass, networks and information, which represent fundamental key ecological attributes (see page 23 ff.). For example, in this context, the abundance and diversity of species matter, as does a certain level of connectedness, so that energy, matter and information can be exchanged between system components. In line with the concept of vulnerability, the key ecological attributes are very much related to the sensitivity of the biodiversity objects. Biodiversity objects with a lot of 'demanding' key ecological attributes would be more sensitive to changes in exposure to threats (e. g., narrow bands of preferred temperature, low variability of environmental conditions, the highly specialised dietary preferences of animals). The key ecological attributes might also be related to traits that are relevant in terms of the adaptive capacity of conservation objects. Whenever a conservation object requires a high degree of connectivity or a continuous range of occurrence, this may imply a lower adaptive capacity.

Stresses

Stresses describe the symptoms and manifestations of the degradation of key ecological attributes caused by the insufficient availability or quality of master factors, and manifesting as the loss of minimum levels of biomass, information and network. The implication of stresses is that, under certain conditions, the ecological attributes begin to degrade, which then impacts on the resilience and adaptive capacity of biodiversity elements, such as species or ecosystems. Over time, the systems will shift or even collapse.

Stresses describe a certain state, reaction or symptoms of a system or any of its components to anthropogenic 'forcing factors' – the so-called threats. If sustained, the impact will lead to shifts or changes in the system. Examples of stresses would include the loss of fertility in a species in response to temperature change; another example would be accelerated reproduction and growth of algae in a lake in response to raised nutrient levels from agricultural run-off. Further examples in ecosystems are poor species diversity, loss of keystone species, loss of connectivity between subsystems, and poor quality of resources and media (e. g. polluted water and soils).

The number and criticality of stresses gives further insights into the vulnerability of conservation objects. In terms of vulnerability, highly stressed biodiversity objects are, in general, expected to be more vulnerable.

Threats

It is important to set a clear context when applying definitions in an assessment or evaluation of ecosystems. MARISCO makes clear in its philosophy that all natural systems are subject to sudden indeterministic change that may result in regime shifts or even collapse – it embraces the law of evolution. In this context, nature is objective and 'free willed'. Therefore, threats are considered to be any human-induced forcing or pressing factor that is likely to directly or indirectly impact on the natural structure and dynamics of an ecosystem. They represent processes of change that negatively affect biodiversity objects by causing stress and increasing their vulnerability, ultimately inducing a state change connected with degradation (which means the loss of master factors, biomass, information or network).

There are both obvious and subtle examples of threats. Usually, the indirect or imperceptible effects are hardest to observe or identify, yet they may cause the greatest disruption in the ecosystem. We see evidence of this in the complex dynamics of human-induced climate change.

Some typical examples of threats would be extractive activities like logging or hunting, and also the consequences of altering the physical or chemical conditions of the environment like, for instance, increased water run-off, soil erosion and water pollution.

Contributing factors

A contributing factor is best described as a human action or activity that directly or indirectly results in the emergence of a threat, which then goes on to induce a stress or stresses in one or a number of components in an ecosystem. Often, contributing factors act synergistically but they may also produce antagonistic effects. Many of these factors represent risks because they can unforeseeably appear or change in the future and can contribute to impacts on biodiversity objects.

5. Assessment of the current status of the biodiversity objects

a) Determine the key ecological attributes and functionality of the target systems

Rationale for this step

The ultimate aim of conservation sites and projects is to improve or at least maintain the functionality of the area's biodiversity. Remember that we define **ecosystem functionality** in the introduction as **'a certain state of a system that is characterised by biological and ecological interactions of components that contribute to the system's efficiency and resilience'**. In this state of functionality, the system would not suffer were there to be any abrupt or significant changes in system properties, extent or geographical distribution. The absence of any stress and corresponding external stressors would represent the (ideal) state of functionality. This would also imply full access to required resources. In this (hypothetical) state, the system would only slowly evolve according to internal changes, and would simultaneously maintain and develop an inherent adaptive capacity required for coping with environmental change. In reality, a certain level of disturbance and corresponding stress is always driving the evolution and adaptation of biological and ecological systems (and is even needed so they can develop their adaptive capacity). Nevertheless, even if it were not wholly achievable, a system state where biodiversity objects have a high functionality would represent the ultimate conservation goal. In this context, several guiding principles must be taken into account.

The first principle is: 'unless it's broken, do not assume it needs fixing'. The premise adopted is one of 'nature knows best' when it comes to regulating and supporting nature's systems. We cannot assume that there are better and more efficient ways of driving function and dynamics in natural ecosystems – we meddle at our peril. Conservation only becomes relevant where human activity is seen to be negatively impacting on nature.

The second principle embraces environmental ethics. We have a duty of care to each other and to the wider biodiversity for both the present and the future. The imperative is to try to identify and correct the actions of people that cause unnatural changes and losses in nature. This principle is embedded in the first stage of the MARISCO cycle, where users map out as best as possible the situation for a project site in order to better understand the prevailing conditions that are affecting the function of its ecosystems.

The third MARISCO principle focuses on embedding strategies: once the condition of a system is identified and understood as best as possible, the next task is to build strategies into the management that aim to restore and maintain as much of the natural character of the original parent ecosystem as possible without losing sight of communities' needs and dependencies on biodiversity for their goods and services.
The process of 'mapping' the system and its attributes is described in the following section. This step can also inform management goal setting[16].

[16] In the methodology of the Open Standards for the Practice of Conservation, the corresponding analysis is called 'viability analysis'. According to the authors of this methodology, viability would indicate the intactness of a system and its ability to withstand external disturbances – thus being more or less synonymous with the concept of 'functionality' as applied herein. Metaphorically, viability also refers to the feasibility or probability (of success) within a certain environment (e. g., a viable idea or solution). Etymologically, the word is derived from 'life' (vita in Latin) and thus means something along the lines of 'capability of living'. Viability is a term and concept that is intensively applied in conservation genetics (viable populations). Functional is a more process-oriented word relating to connections and interactions within a system that lead to its functioning; even in mathematics, the word is used for describing the relationship of two variables (also compare the Merriam-Webster definitions: functional – 'used to contribute to the development or maintenance of a larger whole'; functionality – 'the quality or state of being functional' {http://www.merriam-webster.com/dictionary/, accessed on 30 March 2013}).

What you need

A foundational knowledge and understanding of the biodiversity objects, ideally informed by expert knowledge.

Application procedure

A stepwise approach to this stage of MARISCO begins with the identification of the key ecological attributes for all biodiversity objects. In order to measure the status of these key ecological attributes over time, indicators for every attribute should be defined.

In a next step, the natural range of variation for every indicator would be determined using a rating scale running from one to four. As a last step, the functionality assessment involves determining the current status and future desired status of the biodiversity objects.

→ Selection of key ecological attributes

Project participants begin the process of listing and recording the ecological attributes for each of the biodiversity objects on white cards. This exercise can be carried out object by object in individual working groups, although it is also possible to collect key ecological attributes in plenary. Often, the same key ecological attributes apply to various (nested) conservation objects. If working with a more scientifically informed group, it is suggested to group key ecological attributes according to the main categories: master factors, biomass, information, and network.

Guiding questions for the identification of key ecological attributes are:

- → Which key characteristics are required for the functionality of the biodiversity object?
- → Which key characteristics would lead to the loss or total degradation of a biodiversity object when altered or missing?
- → Which key characteristics are required to ensure the resilience of a biodiversity object and for it to have a certain adaptive and buffering capacity against disturbance and environmental change?

Key ecological attributes

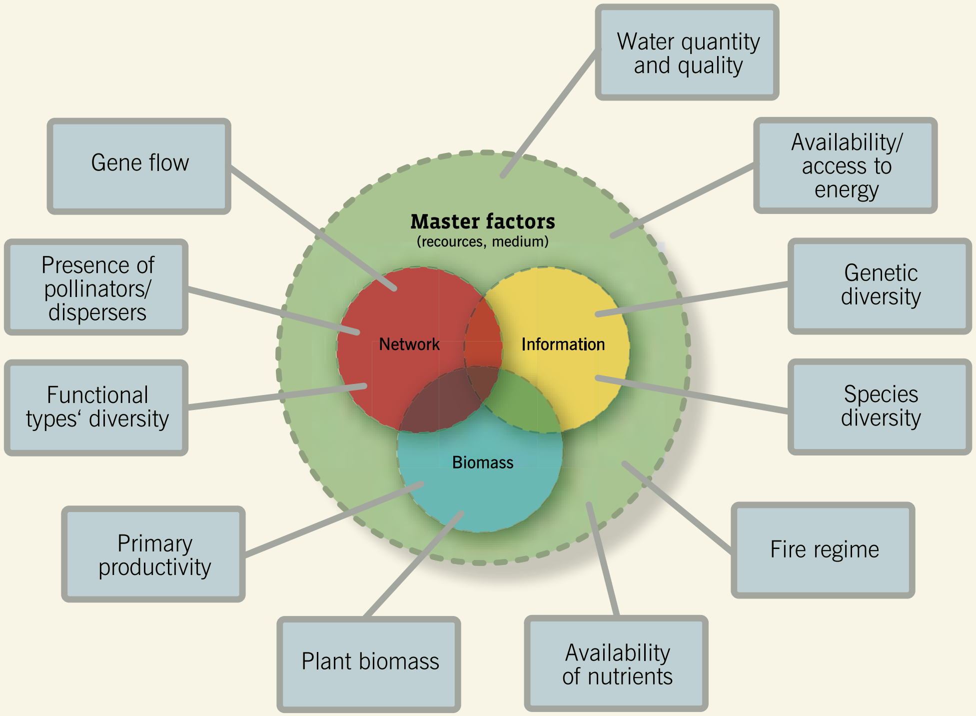


Figure 28. Examples of key ecological attributes related to master factors and the fundamental attributes of ecosystem growth and functionality.

EXAMPLE CONCEPTUAL MODEL »MARISCONIA«

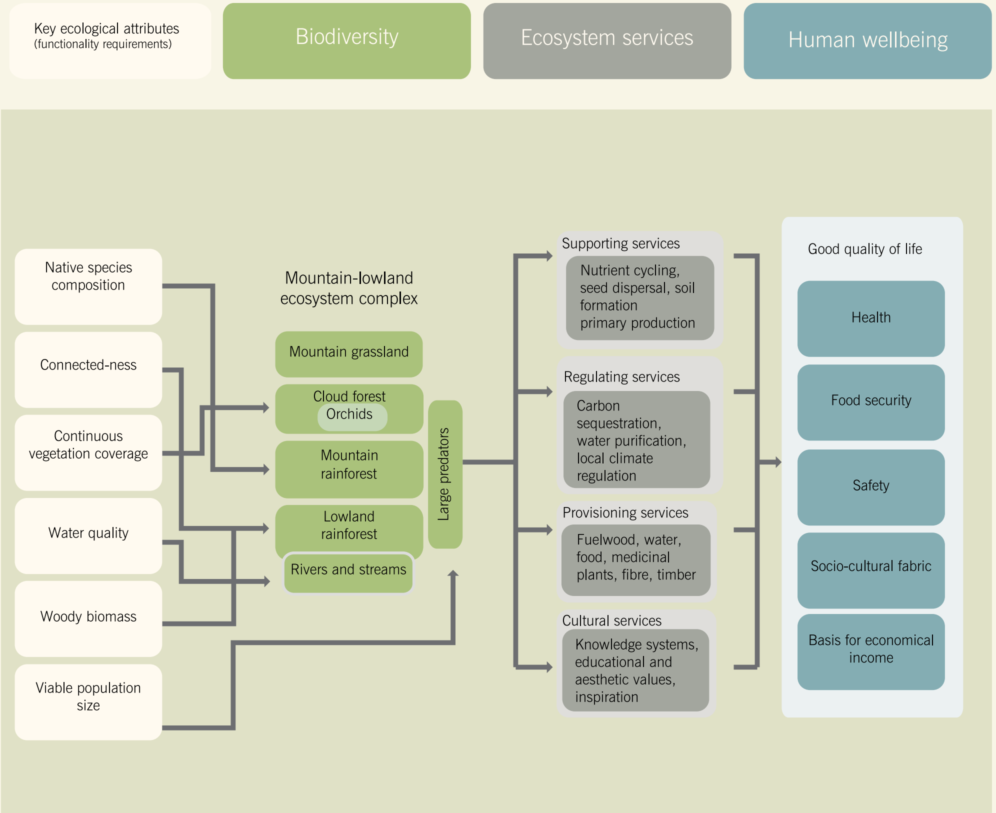


Figure 29. MARISCONIA's key ecological attributes. MARISCONIA is an imaginary conservation site where MARISCO is being applied. Here, the key ecological attributes of the biodiversity objects are included in the model. In a real MARISCO exercise, it is likely that more key attributes would be formulated for each conservation object in order to describe and assess their functionality.

→ Define indicators to measure the status of the key ecological attributes

Where possible, all available information relating to key attributes and indicators should be documented to help develop more quantitative goals.

Attempts should be made to identify at least one indicator for each attribute; although, in some cases, more than one would be needed to represent more complex attributes. In this context, it is relevant to factor in how intensive the management of the conservation site can be. When time and resource constraints are an issue, more attention should be given to representing the bigger systems within the project area. As always, the emphasis is on generating indicators that are measurable. **Enormous amounts of resources can be spent on monitoring the status of conservation objects – even though this does not necessarily translate into conservation action (effectiveness). So, at the outset, it is important to find good indicators that are significant, and also cost-effective.** In more fortunate circumstances, there may already exist substantial data from which the project team can draw down appropriate indicators. It is important for participants not to get lost in the detail of the process as this part of the exercise can always be revisited and upgraded.

THE S-U-M CRITERIA FOR GOOD INDICATORS

SENSITIVE: The change in indicator values must consistently correlate with changes in the condition to be managed, without showing any changes over time.

UNAMBIGUOUS: It is clear from the evidence and understanding that the indicator relates directly to the condition to be managed.

MEASURABLE: It must be possible to take reliable measurements with reasonably simple and costefficient equipment or methods.

→ Establishing what the acceptable range of variation is and a rating scale

According to the principles of non-equilibrium ecology, all attributes will vary in a naturally functioning ecosystem. Such natural variation is recognised as part of the oscillations and dynamics of an ecosystem and is considered to be within an 'acceptable range of variation' when its status is defined as very good or good. Scientists and managers are alerted to a potential threat when the status is not defined as falling in either of these two categories. Guiding questions for identifying the range of variation are:

- → How much alteration in an indicator is acceptable for a biodiversity object? How much alteration is too much?
- → How much restoration is enough?

To determine the rating and thus the status of an ecological attribute, an initial distinction can be made using best-fit data and information between very good/good vs. fair/poor. Once a broad distinction is established, it is then a little easier to further split the categories into the four levels: very good, good, fair, and poor. Although well-informed decision-making is important at this stage of the process, this should not preclude attempts at categorisation where there is very little information to go on. The emphasis in MARISCO is to always persist with adaptive-management planning and knowledge mapping even when the circumstances are far from perfect – in this case, where there are noticeable gaps in knowledge availability. Using this approach, the process can progress without stalling or getting lost in the aim of achieving a knowledge-perfect situation analysis.

→ Determining the current and desired future status

Once the rating status for each ecological attribute indicator is determined, the next step is to provide some indication of the current and projected future status for each of the attributes. The desired future status of the key ecological attribute is where you want it to be in the future – i.e., by the end of your planning horizon when you will have at least accomplished your management vision.

Table 3. Rating scale for indicators of key ecological attributes

Very good = 4	Good = 3	Fair= 2	Poor = 1
The indicator is in the desirable state. Only a minimum level of intervention – or even no intervention – is required to maintain the functionality of the biodiversity object.	The indicator is within an acceptable range of variation. Some intervention may be required to maintain the functionality of the biodiversity object.	The indicator is outside the acceptable range of variation. The functionality of the biodiversity object might be at risk if the situation is not changed. Interventions are required.	The indicator falls far short of the acceptable range of variation. The functionality of the biodiversity object is at serious risk. Restoration might be difficult.

			INDICATOR					
Biodiversity object	Key attribute	Indicator	Very good	Good	Fair	Poor	Current Rating	Desired Rating
Forest Ecosystem	Woody biomass	Standing and lying deadwood	Significant density of standing and lying big dead trunks all over the forest	Standing and lying dead trunks common in most parts of the forest	Only a few standing and lying dead trunks here and there; hardly any dead branches on the forest floor	Hardly any dead trunks or branches in the forest	Poor	Good
River Ecosystem	Water quality	pH	7.8–7.9	7.0–7.7	5.5-–6.9	‹ 5.5	Good	Very good

Table 4. Examples for key ecological attributes, indicators and indicator ratings

→ Repeat this procedure for the remaining biodiversity objects

Example

Note that, in the absence of sufficient resources for detailed research, indicators and indicator ratings can also be based on proxies and rough estimates (as in the forest deadwood example, Table 4).

KEY ECOLOGICAL ATTRIBUTES AND VULNERABILITY

Key ecological attributes are a measure of the function of a biodiversity object. In this context, function refers to the resilience of the biodiversity object to perturbation, and also to its inherent adaptive capacity for coping with (environmental) change. Both aspects describe the state of vulnerability of an object. Defined this way, attributes are important for understanding the adaptive capacity of an object. This will be useful when it comes to formulating ecosystem-based strategies for adaptation to global or environmental change.

b) Identify current stresses that reduce the viability and integrity of the biodiversity targets

Rationale for this step

A definition for stresses has already been given earlier in the text (page 75). For conservationists, a detailed analysis of stresses is important to understand how the target systems or biodiversity objects are affected by threats. It is the starting point for understanding the mechanisms of threat and risk generation, and for creating hypotheses about interrelated cause-effect chains. Generally speaking, stresses can be regarded as the manifestation of a biodiversity object's 'illness' or 'wounds' – the identifiable symptoms of bad health and vulnerability. The identification of stress is the first step in a thorough diagnosis of the biodiversity object's 'disorder', which will eventually be treated by the implementation of strategies.

What you need

For ease of reference, cards are used to create an interactive visual display board. To prevent any confusion once the concept model starts to develop and take shape, different coloured cards are used to represent each of the categories. In this step, use purple rectangular 'MARISCO stress cards' to represent stresses. Large rolls of single-sheet brown paper provide a useful support for a wall display on which cards can be posted.

Application procedure

By this stage in the exercise, the biodiversity objects may already be grouped under larger ecological proxies – for instance, species under habitats and habitats under ecosystems or even landscape types. It is hoped that this process of clustering objects simplifies the task. Each object is systematically considered in turn and assessed for stresses using the results obtained for the key ecological attributes. Start to collect the stresses of an initial biodiversity object. Those that are degraded or might become degraded within the time frame of your planning horizon can be classified as stresses. Whenever a complete functionality analysis has been carried out, it should be a little clearer from the status given to the attributes which of these are likely to translate into stresses. Once this exercise is completed, participants are encouraged to reflect on the health of the biodiversity objects; this can lead to the identification of further stresses, which might have been neglected when determining the key ecological attributes.

In general, guiding questions to help in the process of identifying stresses are:

- What kind of negative changes can be observed happening in the biodiversity object?
- What are the signs of 'disorder' and 'illness'?
- Are there any critical changes to the status of environmental master factors, such as climate[17], soils or water?
- Is there a loss of biomass, information or network within the system?
- Is there a loss of network/connectedness with other systems?

In some cases, a stress can cause or promote another stress. For instance, changes to the pH status of seawater in oceans alters the buffer capacity of water and its ability to regulate temperature fluctuations. Physical changes of this kind interfere with the ability of calcareous organisms to lay down an exoskeleton and, in the case of corals, to autotrophically feed (bleaching). Once these chains of events are identified, it becomes a little easier to construct cause-effect chains. In many cases, symptoms arise in organisms and systems as a result of the accumulative effects of several stresses, which may lead on to an escalation in the degradation of an ecosystem. The criticality of the individual stresses will be assessed in a later step.

The grouping of stresses is recommended in order to provide a clearer understanding of the situation and to help facilitate a further systematic situation analysis. Grouping can be done according to the relationship of stresses to:

- master factors,
- biomass,
- information, and
- network.

Repeat this step for all biodiversity objects. If necessary, you can also clarify interactions between the stresses of the different biodiversity objects.

[17] A recommended resource that details stresses related to global climate change is the Classification of Climate-Change-Induced Stresses on Biological Diversity by Geyer et al. (2011).

EXAMPLE CONCEPTUAL MODEL »MARISCONIA«

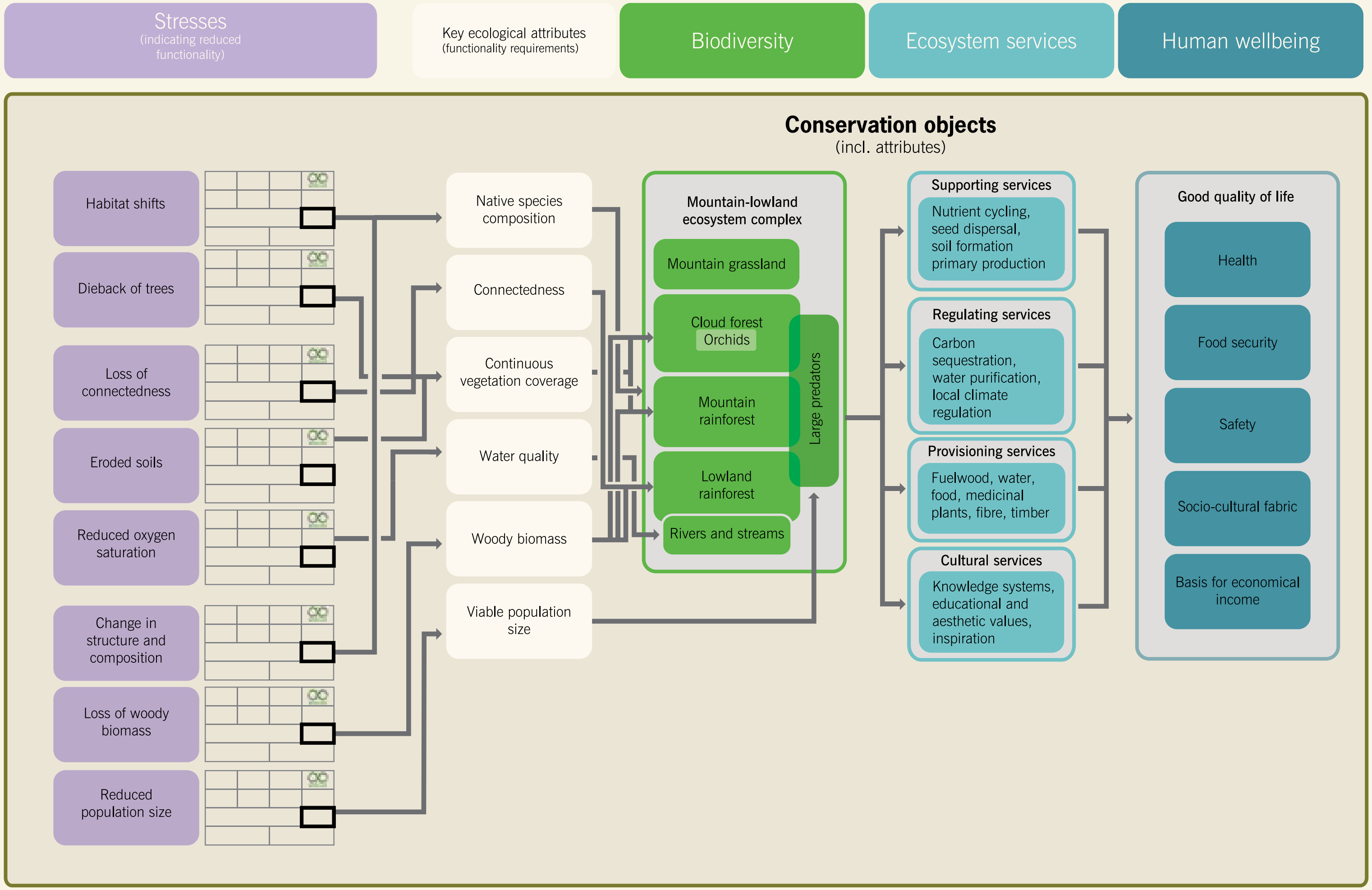


Figure 31. This situation illustrates a stressed forest ecosystem that is directly impacted by physical changes. The threat that causes these changes is road construction.

Figure 30. MARISCONIA: Stresses. MARISCONIA is an imaginary conservation site where MARISCO is being applied. Stresses have now been added to this illustration and have been connected to the key ecological attributes that they affect. In this way, we can see that the stresses relate to key ecological attributes that have been degraded. Again, in this example, the complexity of the possible connections is reduced and could be enhanced if necessary.

6. Threats: understanding the drivers of stress and the vulnerability they cause to biodiversity objects

Rationale for this step

In conservation, medical examples and analogies are often used, such as in this case where stresses have been described as the symptoms or illness caused by a threat factor. For their part, threats would best be described as the agents of disease.

Typical direct threats are human activities such as logging, hunting and fishing, road construction, or the discharge of pollutants. Also, local manifestations of global (or regional) climatic changes can be considered as threats, e. g. increasing droughts, heat waves, or severe rainfall events with increased run-off. Even though these drivers are not directly caused by humans, they undoubtedly cause stress for the biodiversity object.

STRESS OR THREAT?

Regularly, groups struggle with making a distinction between stresses and threats, especially in cases where the drivers of change are the result of indirect rather than direct human activities. To clarify: a threat is a human-induced forcing factor, a direct or indirect impact that will eventually induce a symptom or response (a stress) in a conservation object. There are no absolute distinctions between threats and stresses because of the ambiguities inherent in language and meaning, but this should not deter participants from exercising their understanding of the terms and applying them to the context of the project. Inevitably, differences in understanding will emerge that will reflect cultural perspectives. Nevertheless, it is always worthwhile reflecting on a medical analogy. A threat is an induced agent that elicits or, in time, will elicit a response or change in the status of a biodiversity object unless action is taken to reduce or eliminate the agent or its effects. A stress is the response or likely response observed (doctors prefer the term 'symptoms') in a biodiversity object that may be characterised by alterations to the object's physical, chemical or behavioural state.

Typically problematic examples are erosion and pollution, because of the ambiguity of the terms themselves. If erosion refers to processes affecting the soil involving run-off or wind, it would constitute a threat and would cause the stress of 'erodedness', which is related to the loss of humus, poor nutrient content in the soil, poor water retention capacity, etc. Pollution caused by the human activity of emitting pollutants into the environment constitutes a threat. 'Pollutedness', which manifests as high concentrations of contaminants causing physiological disorder, is the stress.

The evidence emerging from scientific studies of ecosystems is providing us with a better understanding of the complex dynamics driving natural systems, and this understanding tells us that indirect factors are influencing the greatest change in natural systems. The same principle can be applied to human-induced problems. However, this does not make the task any easier; on the contrary, often subtle changes in biodiversity objects are overlooked and are least known about. In most cases, participants focus on easily observable threats.

The identification of threats is a crucial step because they are the elements that ideally need to be managed and changed in order to reduce or eliminate the biodiversity objects' stresses. Threats may be unmanageable and impossible to eliminate, in which case, adaptation strategies might be required (note that manageability is assessed in a later step).

What you need

- → The initial part of conceptual model (biodiversity objects and stresses).
- → Red rectangular MARISCO threat cards.
- → Space on the wall.

Figure 32. Developing a wall-affixed conceptual model: identifying threats (red) that cause different kinds of stress (purple).

Figure 33. The preliminary identification of threats or other elements in the conceptual model can be carried out in breakout groups. It is always interesting to compare the diverse perceptions of threats put forward by participants with their diverse backgrounds and perspectives.

Application procedure

The previous exercise to identify stresses for the different biodiversity objects should give direction in drawing together a list of threats. Care must be taken not to confuse natural causes of stress with more ambiguous indirect human-induced factors – this is never easy because of the unknowns and uncertainties manifest in complex systems. Often, it helps to look for common threats that produce stress in several groups of species or whole ecosystems. A couple of examples would be agricultural nitrogen-based fertiliser and invasive species colonisation.

In general, guiding questions for the identification of direct threats are:

→ Which human activities are negatively affecting the viability of the different biodiversity objects?

→ Which other processes are degrading the functionality of the biodiversity objects by causing stresses?

Inevitably, in the course of the situation analysis, threats will be identified that do not have a corresponding stress. These common issues can be resolved by ‘filling in the blanks’ during work to progress the model.

Once the process has been completed for all the biodiversity objects, it is important to reach consensus among the project team about the links between threats and stresses before moving on to the next stage. As was suggested in the previous section, clustering or grouping threats according to common characteristics helps to provide some structure and order.

HOW SPECIFIC OR EXACT SHOULD STRESSES OR THREATS BE?

In general, there are no absolute rules determining how specific stresses or threats should be. The depth of analysis will always depend on the available knowledge and the resources spent on the situation analysis (time, number of participating experts). The recommendation is to formulate the threats as precisely and specifically as possible. A generic threat with the title of 'climate change' will be much less helpful in a situation analysis than the following more descriptive alternative: 'increased frequency of severe frosts in early springtime after warm winters'. It is important to specify the factor that causes stress. When threats are discussed, it might be concluded that the stresses actually need reformulation. Again, for the purpose of a meaningful analysis, it is important to be as specific and as clear as possible. For instance, using the above example, if during the analysis process the project team feel that 'increased frequency of severe frosts in early springtime after warm winters' is a really important threat they may choose to refine an earlier statement made about stresses from 'tree dieback' to 'spring frost damages in trees'.

IUCN-CMP's *Unified Classifications of Direct Threats*[18] provides a comprehensive list of direct threats with examples, and can be used to either systematically identify direct threats or to stimulate brainstorming. This classification is also used in the context of the global IUCN *Red List of Threatened Species*.[19] Some of the IUCN-CMP threats may be understood in terms of contributing factors that drive and influence threats (see the next step below), but the classification acts as a useful aide-memoire when constructing a threats analysis for the area of analysis. In the MARISCO process, it is important to maintain a steady flow rather than get snarled up in building long, drawn-out lists of threats. Keep lists simple and straightforward, and always ensure they tie in with the stresses. For example, the stress of 'isolated forest islands and fragments' can be caused by land use and urbanisation or by road development. In this case, it should be enough to state deforestation and road development as threats, and to spell out the contributing factors in the analysis (e. g., the development of housing, commercial and industrial areas, etc. – see below).

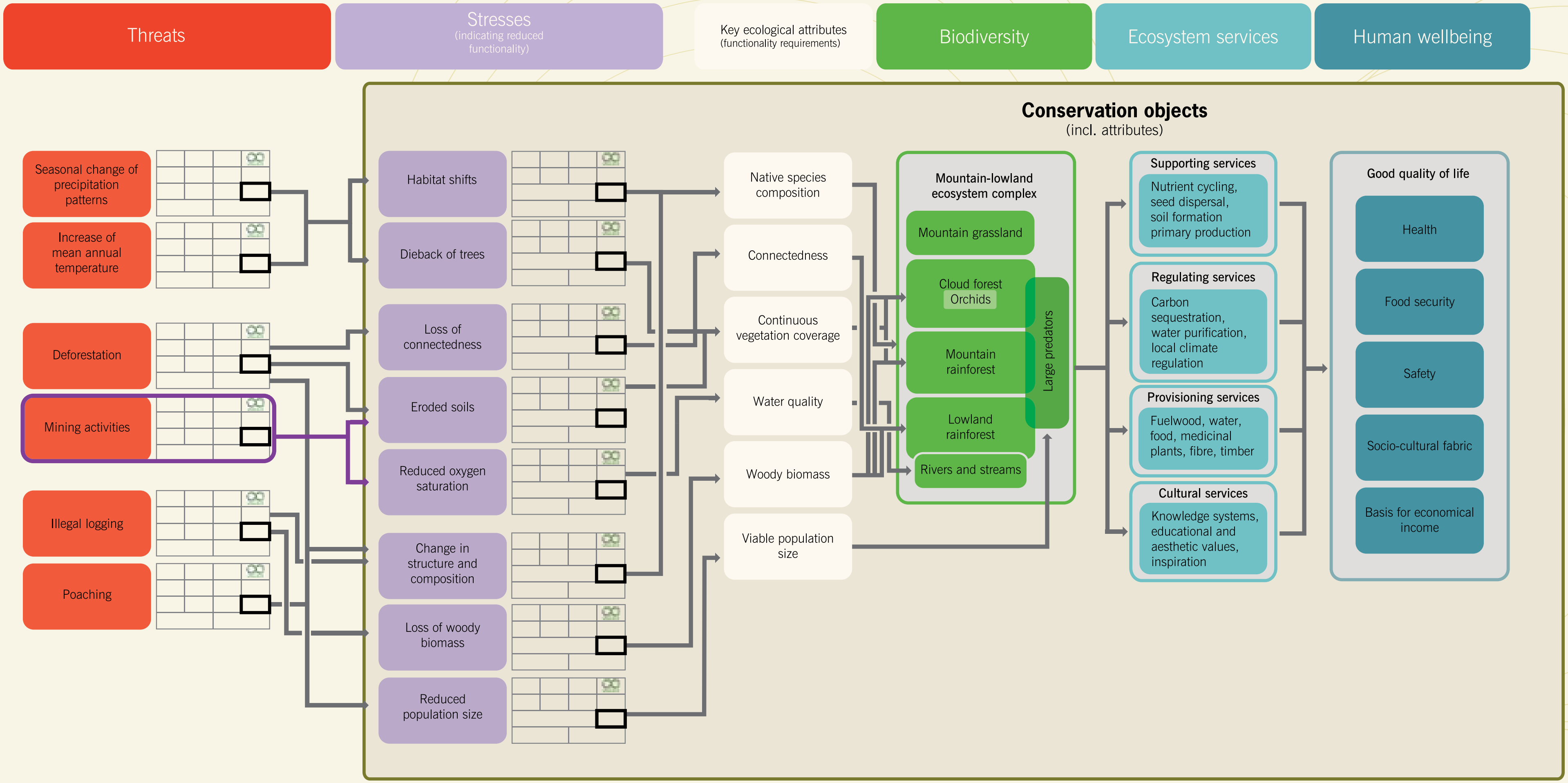
To reiterate: it is important to acknowledge very early in the analytic process that any factor written on a card and put into the conceptual model represents a preliminary hypothesis to be validated, specified and improved or, alternatively, to be disproven and rejected in the course of the adaptive planning process. It is beneficial to instil constant awareness about the preliminary nature and changeability of the exercise's results and to invite proposals for improvements at any point in the process.

[18] www.conservationgateway.org/ExternalLinks/Pages/iucn-cmp-unified-classifi.aspx; www.iucnredlist.org/documents/June_2012_Guidance_Threats_Classification_Scheme.pdf

[19] www.iucnredlist.org

EXAMPLE CONCEPTUAL MODEL »MARISCONIA«

Figure 34. MARISCONIA: Threats. s. MARISCONIA is an imaginary conservation site where MARISCO is being applied. Now, threats are added to the depiction of the situation analysis. These direct threats are connected to the stresses that they are inflicting on the respective biodiversity objects. The model also includes a future stress that is framed in pink.



CLASSIFICATION OF DIRECT THREATS (TAKEN FROM THE IUCN-CMP UNIFIED CLASSIFICATIONS OF DIRECT THREATS, SALAFSKY ET AL., 2008)

- **Residential and commercial development:** human settlements or other non-agricultural land uses with a substantial footprint.
- **Agriculture and aquaculture:** threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture.
- **Energy production and mining:** threats from the production of non-biological resources.
- **Transportation and service corridors:** threats from long, narrow transport corridors and the vehicles that use them, including associated wildlife mortality.
- **Biological resource use:** threats from the consumptive use of 'wild' biological resources, including deliberate and unintentional harvesting effects; also the persecution or control of specific species.
- **Human intrusion and disturbance:** threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources.
- **Natural system modifications:** threats from actions that convert or degrade habitat in order to 'manage' natural or semi-natural systems, often to improve human welfare.
- **Invasive and other problematic species and genes:** threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance.
- **Pollution:** threats from the introduction of exotic and/or excess materials or energy from point and non-point sources.
- **Geological events:** threats from geological events.
- **Climate change and severe weather:** long-term climatic changes that may be linked to global warming and other severe climatic or weather events outside the natural range of variation that could wipe out a vulnerable species or habitat.

7. Identify contributing factors to threats

Rationale for this step

To complete the situation analysis, a list of the contributing factors responsible for the threats is compiled. It is not unusual to discover that there may be several contributing factors to a threat, either acting independently or in synergy. Once the contributing factors are linked up to the threats, it becomes much more apparent how the stresses and vulnerability perceived in biodiversity relate to root causes manifest in human activities. The final analysis presents a structured and logical framework upon which to build strategies in the next stage of the exercise. For those managing ecosystems and landscapes, the identification of contributing factors is a crucial preparatory step towards the formulation of effective management strategies that take into account the root causes of problems. A good conceptual model facilitates understanding of how different stakeholders influence the threats to biodiversity objects and may even provide an analysis of their motivations. It also promotes a common understanding of a conservation situation among the various stakeholders tasked with visualising problems, needs, opportunities and conflicts. The ecosystems are the basis for sustainable development, including adaptation to environmental change; their functionality must be kept in frame when defining the goals and objectives of an overall conservation strategy. However, any specific strategies proposed for inducing change and transformation in the complex system of the conservation site must also adequately address people's needs and attitudes. Otherwise, it is very likely that they will be ineffective. This being the case, it is recommended to develop a very thorough and detailed analysis of the driving factors and root causes of the threats. It is particularly important to reflect social conflicts and (assumed) reasons for certain habits and actions. In this context, we must remember that people are part of the complex ecosystems that they live off and change. As a key element of these systems, the human subsystem deserves a careful analysis.

What you need

→ A conceptual model with biodiversity objects, stresses and direct threats.
→ Orange rectangular MARISCO factor cards.
→ Sufficient space on the wall.

Figure 35. Creating a pin-up conceptual model involves a participatory, dynamic and highly interactive process. In the case of larger groups, it might be better to work in breakout groups and specialise on given subtasks. Later on, breakout groups then present the results of their group work to the plenary group.

Application procedure

By this stage of the exercise, participants will have identified as many threats as they can and, where possible, will have grouped them. Each of the single or grouped threats can be treated in turn to ascertain, first, the direct contributing factors and, later, the more deeply rooted factors at the heart of the threats, thus completing the cause-effect 'net'. Typically, there will be several 'chains' of contributing factors, which may eventually build into a more complex net or web as the interrelationship between them becomes more apparent. The main focus of the exercise is to recognise the contributing factors that impact in a negative way on the biodiversity objects. However, the opportunity exists to identify those factors that can have a positive effect on either a threat or contributing factor.

GUIDING QUESTIONS FOR THIS PROCESS ARE:

- → What are the reasons for the appearance of a threat or a factor?
- → Which relevant actors and stakeholders are involved in causing a threat? What are their reasons for doing so?
- → Are there any factors from those listed that have a positive influence on another contributing factor or threat?

In large and rather heterogenous groups of workshop participants it has been effective to build small focus groups that concentrate on the causal analysis of selected threats or sectors (e. g., hunting, deforestation, problems related to social conflicts).

To complete as much of this stage of the model as possible, it is important to review all the links made so far between contributing factors and threats. At its most advanced, a conceptual model should include interlinkages between the various cause-effect chains without getting too lost in the detail of the less important factors.

FEEDBACK LOOPS AND SYSTEMIC INTERRELATIONS BETWEEN STRESSES, THREATS AND CONTRIBUTING FACTORS

In reality, in complex, natural and socio-economic systems, there are no linear cause-effect chains. The unpredictability and non-linear change in complex systems is caused by, among others, synergistic effects, escalation, or positive and negative feedback loops. There might even be stresses on conservation objects generated by anthropogenic threats that influence contributing factors in the system and therefore create a feedback loop. An example would be an increased inflammability of dry vegetation that can contribute to the risk or threat of forest fires. Reduced ecosystem functionality and loss of ecosystem services can also affect contributing factors and threats. People who are unable to satisfy their basic needs might be forced to exploit natural resources increasingly unsustainably – for example, a decrease in grassland productivity might drive nomadic herders to move beyond traditional grazing grounds or to return more frequently to the same lands, which can then, in turn, end up being overgrazed.

Local manifestations of global climate change often increase the complexity of threat generation. Droughts, heat waves and other weather extremes can directly impact on biodiversity objects, such as forests or water ec osystems. That said, they might also contribute to the ongoing adaptation activities of land users, which then creates new and additional threats to biodiversity. Extreme events also affect agriculture or forestry and their production strategies (e. g., new crops/trees to be planted, irrigation, expansion of the agricultural frontier in order to compensate loss of productivity). Climate change might allow for new, previously absent options of land use. There are examples where it is supposed that altitudinal shifts in ranges of fodder plants could prompt land use in previously unusable ecosystem types. Climate change has also triggered mitigation initiatives, which more or less subtly and indirectly increase pressure on biodiversity. For instance, policy instruments for 'climate protection' favouring renewable energies have been shown to drive land use intensification and the degradation of ecosystems (e. g., by increasing pesticide-intensive monocultures for the production of biofuels, or by promoting deforestation for the installation of solar panel parks).

Figure 36. Palm oil plant in Costa Rica.
International demand for palm oil production is a contributing factor that triggers deforestation for the purpose of establishing oil palm plantations. The pollutants emitted by a palm oil plant can also constitute a threat to a local ecosystem.

8. Organise, revise and complete the systemic conceptual model

Rationale for this step

As is often the case with working models that rely on input from several or many participants, the priority is to record all the information as it arises and worry later about the structure and order. As suggested in the previous two sections, a certain amount of structuring is advised and, indeed, is necessary if the model is to 'communicate' back to the contributors and also serve as an effective visualisation of 'knowledge in the making'. The completion of the contributing factors serves as a useful point to pause and review, and provides some time to create some order in the model.

Drawing on the principles of complex systems theory, MARISCO recognises hierarchical order in most ecosystems, which legitimises a certain degree of structuring during the process of building a conceptual model. Participants are encouraged to group threats and contributing factors into appropriate domains. A typical example would be grouping all the threats that pertain to agricultural land use and, in another example, grouping threats that relate to traffic disturbance and infrastructure. Applying a certain degree of reductionism to the model does not necessarily diminish in any way the complexity of the system. No information is lost; rather, it improves the agility of the reader who has to make sense of it all.

Application procedure

Look for contributing factors that can be grouped together according to the thematic domains: biophysical factors, socio-economic factors, political factors and institutional factors (see also the figure and box below). It is helpful to find titles for these groups (e. g., traffic infrastructure, criminality and corruption, governance, demography). If possible, you can also group the direct threats according to the IUCN-CMP categories for direct threats (see page 90).

In order to group the factor chains, including the direct threats, the chains can be moved if necessary. The connection to the biodiversity objects and cause-effect chains should not be lost. In the process of grouping, you may want to remove double factors or include missing factors in order to complete the logic of the factor chain.

Any institutional domain is likely to need careful attention because many of the factors affecting biodiversity are likely to relate back to the activities of the organisations employing the participants. Organisations tasked with a duty of care for biodiversity may also be innocent contributors to the vulnerability of the biodiversity objects. In this context, it is necessary to consider specific institutional weaknesses, such as: resources shortages; technical support/consulting shortages; deficits in terms of the availability of information; and conflicts with other actors. Also quite notorious are: the lack of knowledge management; the failure to consider cognitive risks; and weaknesses in decision-making in a self-referential and self-analysing system.

All this will, most likely, lead to additional factors in the factors chain for the institutional domain. Existing tools like SWOT analyses can be used in preparing inventories of institutional weaknesses that are then converted into contributing factors to threats and the vulnerability of biodiversity.

The groups of factors suggested below can support the identification of factors. In the case that any group is not represented, a critical reflection may be required to ascertain if any corresponding factors have been overlooked.

It is important to analyse the current impacts of biophysical or natural factors on human activities, as well as the resulting indirect changes. E.g. climate change might lead to conservation-relevant adaptation or mitigation measures in other sectors. A good example is the production of biomass for energetic use that is driving intensification of land-use and loss of diverse production systems.

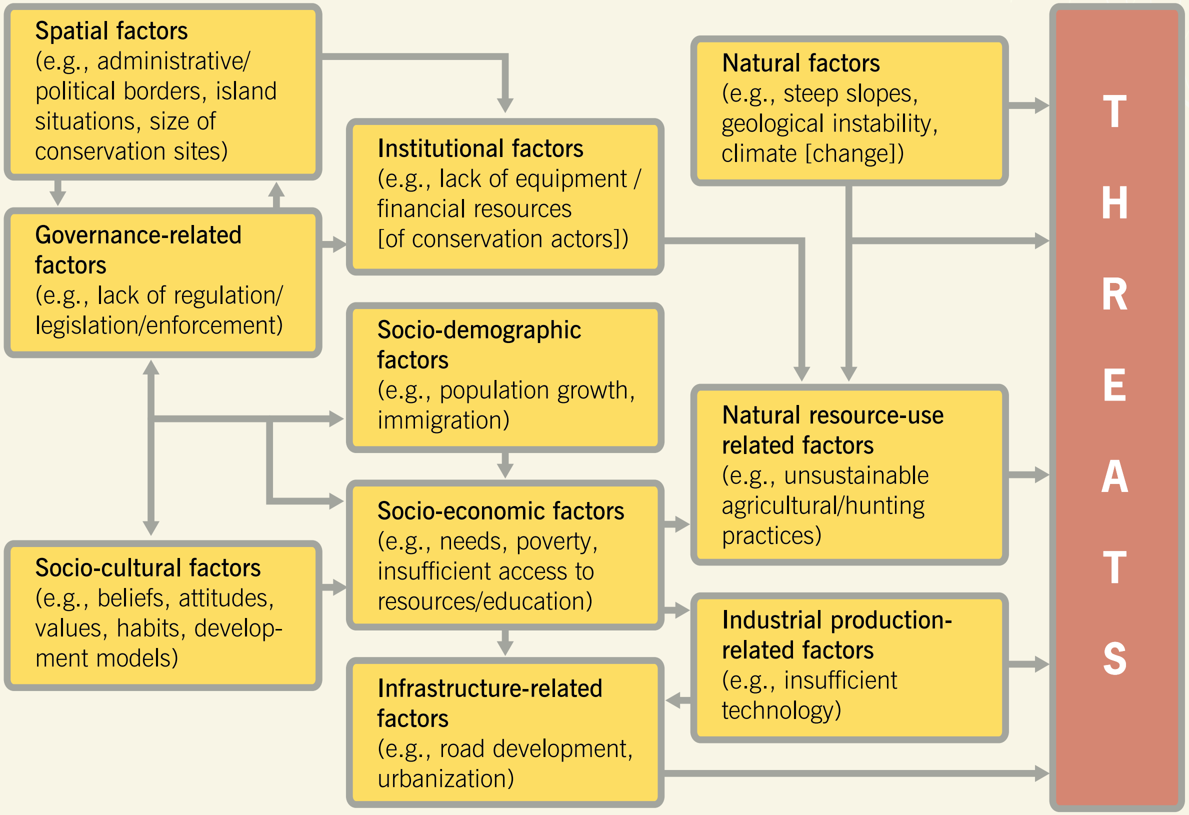


Figure 37. Generic conceptual model of interacting groups of contributing factors that are typically responsible for the generation of threats.

THEMATIC DOMAINS OF FACTOR CLASSIFICATION

- **Biophysical or natural factors** contribute to vulnerability through characteristics of biodiversity or through abiotic processes, which have an influence on biodiversity (e. g. climate, water balance, soils, steep slopes).
- **Socio-economic factors** are connected with/represent humankind's demand for natural resources. They can be divided into social factors (demography, organisation, etc.), cultural factors (perception, values, traditions, etc.), economic factors (needs, land use techniques, influence of the markets, etc.), and infrastructure.
- **Political or governance-related factors** concern processes related to governance, decision-makers, power, legislative bodies or instruments, administration, etc.
- **Institutional factors** are related to the acting and planning institutions themselves (e. g. the planning team, the protected area).
- **Spatial factors** are often man-made and related to institutional factors (e. g., administrative borders, inappropriate geometric shape of formally established protected areas); but also natural features can contribute to vulnerability (e. g., mountain ridges, rivers).

See Figure 37.

EXAMPLE CONCEPTUAL MODEL »MARISCONIA«

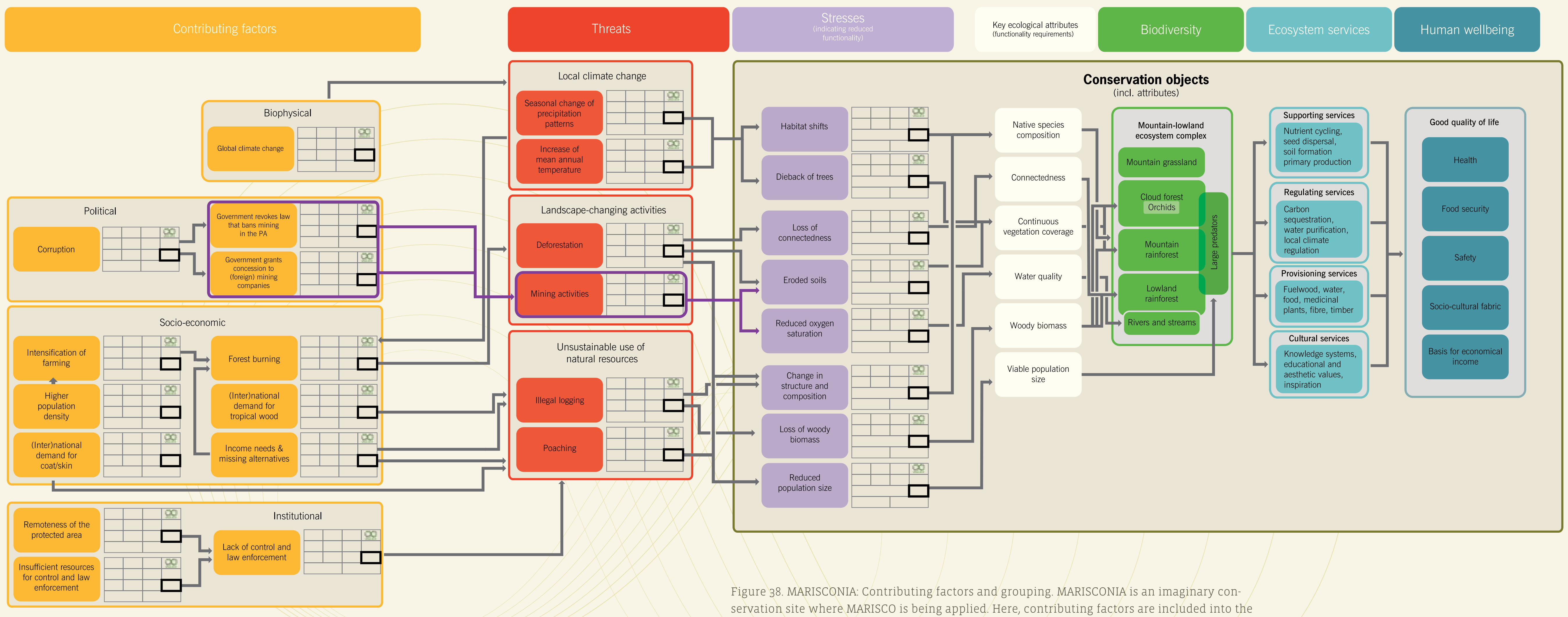


Figure 38. MARISCONIA: Contributing factors and grouping. MARISCONIA is an imaginary conservation site where MARISCO is being applied. Here, contributing factors are included into the situation analysis. They are connected to the direct threats and build cause-effect chains and webs. Future factors are framed in pink. Furthermore, the contributing factors and direct threats are grouped into thematic domains in order to simplify the complexity of the overall model.

9. Spatial analysis and priority setting

Rationale and description for this step

By this stage of the process, the project team will have two visual displays of their analysis: an initial geographical map (scope) of the project site, and a much larger interactive conceptual map that is still in progress. In some senses, the two remain somewhat detached. To try to better understand the geographical relationship between the biodiversity objects and the various threats with their contributing factors, it is worth spending some time mapping them out. By doing this, new relations can often be identified that were not obvious in the cause-effect analysis. Spatial factors – such as those related to the geographical distribution of objects, threats or (administrative) boundaries of conservation action – can also drive vulnerability (e. g., linear-shaped protected areas with significant edge effects). The mapping of key factors and threats can provide valuable insights into spatially related issues, which will need to be addressed at the next stage of strategy formulation. Overlaying the geographical ranges of biodiversity objects together with socio-economic factors like land use, property and use rights, or threats can be very helpful. The mapping of selected indicators can be used for spatial priority-setting. With the appropriate resources and sufficient time, a good deal of information can be generated in the form of detailed GIS maps. However, in many instances, this is simply not possible, in which case it is recommended that the planning team organise a moderated discussion around a single map, documenting the necessary details and views for the entire time frame. If new threats or contributing factors are identified in the course of the spatial analyses, they should be inserted into the conceptual model.

If appropriate and feasible it is recommended to film contributions and testimonies provided by knowledgable resource persons who comment on the spatial distribution of threats. Usually, the corresponding information is very rich and can be used for mapping at a later time.

Figure 39. The discussion about the spatial distribution of threats can be facilitated by simple maps of the area and coloured stickers that represent the presence or severity of threats in certain areas.

Description, qualification and consensual evaluation of the various elements of the conceptual model

The following steps lead to a description, qualification and consensual evaluation of the various elements of the conceptual model that contribute to the vulnerability of the conservation objects. As is to be expected, the importance to conservation management of various threats and their contributing factors is likely to differ according to the prevailing knowledge and understanding among participants. For instance, it is not uncommon for managers or other stakeholders to often hold entrenched prejudiced or traditional opinions about the severity of particular factors that may not necessarily be the root cause of bigger problems. To try to inject some balance into the process of analysis and strategy formulation, a rating system is applied to both threats and contributing factors.

The intended outcome is for a more considered and rational prioritisation of system elements for structuring an effective conservation strategy.
Finally, there are three principal criteria against which the stresses, threats and their contributing factors are assessed. These are: strategic relevance, manageability, and knowledge. Strategic relevance is further divided into various (sub)descriptors including: criticality (scope, severity, irreversibility, past criticality, current criticality, trend of change of current criticality, and future criticality); and systemic activity (level of activity, number of elements that are influenced).

The MARISCO cards are designed for recording a set of criteria with corresponding rating values. In this case, four levels of rating are recorded using different coloured stickers.

Figure 40 (left). Throughout the entire exercise, it is important to make available geographical maps of the area in question for reference purposes, as well as regional maps so participants can look beyond the borders of the conventional management area and understand any interrelationships with other conservation sites.

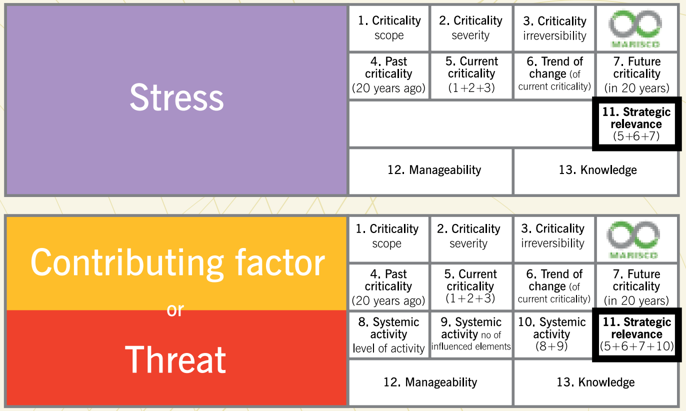


Figure 41. The MARISCO cards facilitate the rating of stresses, threats or contributing factors and contribute to the visualisation of the working results (templates for printing are provided in the annex on pp. 178–179).

10. Assess criticality of stresses, threats and contributing factors

Rationale for this step

The criticality of a stress, threat or contributing factor refers to the perceived importance of those elements for the state of vulnerability of a biodiversity object. As is to be expected, any system component with a high rating for criticality is likely to be targeted in the final prioritisation process.

What you need

- The conceptual model developed so far, including the MARISCO cards.
- A diverse group of participants, ideally representing different sectors and fields of expertise.

Application procedure

Taking each stress, threat and contributing factor in turn, record the perceived criticality of these elements in relation to the biodiversity objects by estimating the spatial scope, severity and degree of irreversibility or permanence. There is no objective or absolute measure of criticality, not even with the highest levels of scientific support. The exercise is much more about capturing opinions to provide a best-fit judgement on the status of a biodiversity object. This stage of the analysis can be carried out by a core planning team, with the results being validated later by other experts. The assessment can be performed in a single workshop or in a series of workshops.

Assessing stresses, threats and contributing factors against the criteria

a) Current criticality

In order to determine the current criticality every factor/threat/stress will be evaluated according to the following descriptors:

- scope,
- severity, and
- irreversibility/permanence.

Using the four colour-coded rating levels, the participants mark up each of the stress, threat and contributing cards in turn with the perceived rating for each of the abovementioned descriptors. Ideally, the legend for the rating scheme for criticality and all the other criteria should be printed up as a poster, which can then be pinned up next to the conceptual model.

Local occurrence = 1	Medium area = 2	Large part of the area = 3	(Almost) omnipresent = 4
Stress/threat: The stress/threat is likely to be very limited in its spatial distribution, affecting the biodiversity object across a small proportion of its occurrence in the area of analysis (1–10 %). **Contributing factor:** The factor is likely to be very limited in its spatial distribution, affecting other elements across a small proportion of the area of analysis (1–10 %).	**Stress/threat:** The stress/threat is likely to be fairly restricted in its spatial distribution, affecting the biodiversity object across a certain part of its occurrence in the area of analysis (11-30 %). **Contributing factor:** The factor is likely to be fairly restricted in its spatial distribution, affecting other elements across a certain part of its occurrence in the area of analysis (11–30 %).	**Stress/threat:** The stress/threat is likely to be well spread, affecting the biodiversity object across a significant part of its occurrence in the area of analysis (31–70 %). **Contributing factor:** The factor is likely to be well spread, affecting other elements across a significant part of the area of analysis (31–70 %).	**Stress/threat:** The stress/threat is likely to be pervasive in its spatial distribution, affecting the biodiversity object across all or most of its occurrence in the area of analysis (71–100 %). **Contributing factor:** The factor is likely to be pervasive in its spatial distribution, affecting other elements across all or most of the area of analysis (71–100 %).

Table 5. Rating categories for ‚Current criticality: scope'

Light = 1	Moderate = 2	Severe = 3	Extreme = 4
Stress: Within the scope, the stress does not imply a reduction of the overall functionality of the biodiversity object. **Threat**: Within the scope, the threat is not likely to degrade or harm the biodiversity object. **Contributing factor:** The factor is not likely to generate a significant impact in the influenced elements.	**Stress**: Within the scope, the stress eventually may imply a certain reduction of the overall functionality of the biodiversity object within the next 10 years. **Threat:** Within the scope, the threat eventually may imply a certain degradation and harm to the biodiversity object within the next 10 years. **Contributing factor:** The factor may eventually generate a certain impact in the influenced elements	**Stress**: Within the scope, the stress is likely to create a reduction of the overall functionality of the biodiversity object within the next 10 years. **Threat:** Within the scope, the threat is likely to degrade and harm the biodiversity object within the next 10 years. **Contributing factor:** The factor is likely to generate a clear impact in the influenced elements.	**Stress**: Within the identified scope, the stress most likely means a serious reduction of the overall functionality of the biodiversity object or even its loss within the next 10 years. **Threat:** Within the identified scope, the threat is most likely to degrade and harm the biodiversity object and even cause its loss within the next 10 years. **Contributing factor:** The factor will most likely generate a significant impact in the influenced elements and become a driving force that ultimately harms one or various biodiversity objects (at least within the identified scope).

Table 6. Rating categories for ‚Current criticality: severity'

Probably disappearing in the short term = 1	Probably not disappearing in the midterm = 2	Probably staying in the long term and hard to reverse = 3	Probably rather permanent and irreversible = 4
It is likely that the stress/threat/factor will disappear spontaneously (without management) in the short term (1 to 5 years), possibly implying nothing more than easily reversible consequences for conservation objects.	It is likely that the stress/threat/factor will not disappear (without management) in the midterm (6 to 20 years), but this does not imply long-term and irreversible consequences for conservation objects.	It is likely that the stress/threat/factor will stay present (without management) in the long term (21 to 100 years), which also implies long-term consequences for conservation objects that are hard to reverse.	It is very likely that the stress/threat/factor will stay present in the long term (probably for more than even a century), which also implies long-term consequences for conservation objects that cannot be reversed in decades.

Table 7. Rating categories for ‚Current criticality: irreversibility'

The overall criticality is calculated as a combination of the three criteria. First the combination of scope and severity is calculated as **magnitude**.

MAGNITUDE scope → / ↓ severity	Local occurrence = 1	Medium area =2	Large part of the area = 3	(Almost) omnipresent = 4
Light = 1	1	2	2	3
Moderate = 2	2	2	3	3
Severe = 3	2	3	3	4
Extreme = 4	3	3	4	4

Table 8. Table to calculate the magnitude (combination of scope and severity)

Then the combination of magnitude and irreversibility/permanence is calculated. The result is the **overall criticality**:

Rating scheme for 'Overall criticality' (magnitude and irreversibility)

Magnitude → OVERALL CRITICALITY ↓ Irreversibility	Low = 1	Medium =2	High = 3	Very high = 4
Probably disappearing in the short term = 1	1	2	2	3
Probably not disappearing in the midterm = 2	2	2	3	3
Probably staying in the long term and hard to reverse = 3	2	3	3	4
Probably fairly permanent and irreversible = 4	3	3	4	4

Table 9. Table to calculate the overall criticality (combination of magnitude and irreversibility)

The final value of the current criticality is classified according to the categories as defined in Table 9.

As well as recording the results on to each of the cards, it is also recommended to record the figures in an Excel spreadsheet for further analysis.

In an ideal situation with ample time and resources, it is always best to carry out the full assessment of each descriptor (scope, severity and irreversibility/permanence). However, where this is not possible, an abridged or 'override' assessment can be carried out. Applying the following categories is recommended for this kind of assessment:

Slightly critical = 1	Moderately critical = 2	Critical = 3	Very critical = 4
The stress/threat/factor does not play a very important role in generating the overall vulnerability of the conservation objects in the area of analysis.	The stress/threat/factor plays a fairly important role in generating the overall vulnerability of the conservation objects in the area of analysis.	The stress/threat/factor plays an important role in generating the overall vulnerability of the conservation objects in the area of analysis. It is an important driver of negative change in the analysed system.	The stress/threat/factor plays an extremely important role in generating the overall vulnerability of the conservation objects in the area of analysis. It is a major and persistent driver of negative change in the analysed system.

Table 10. Rating categories for ‚Current criticality'

b) Past criticality

Rationale for this step

Some of the problems facing conservation relate to shallow 'here-and-now' perspectives that have little or no historical context. People easily get accustomed to changed situations, tend to forget earlier conditions, and underestimate the dynamics of change. Scientists have described this phenomenon as 'shifting baseline syndrome'. Often, it is the result of a disconnection between a rapidly progressive generation and its traditional 'parent' community. Any received wisdom about the state of nature and historical land use practices that may have kept parts of biodiversity in play are lost in the process of modernisation.

An important aspect of MARISCO is to attempt to capture the historical integrity and received wisdom that may still be present among the participants and, in so doing, provide an idea of the extent of change or shift in the ecosystem(s). Recording historical change will also provide some guidance on expected future changes. In most cases worked on, there have been enough individuals in the cohort who have witnessed events and changes over the last 20 years and are thus able to provide a good level of detailed collective understanding of what has passed. This time frame provides a suitable 'extent window' for making forecasts about further likely changes, but also for reflecting on so-called 'black-swan risks' (i.e., highly improbable but wielding a very high impact).

Application

In order to determine past criticality, compare the current situation of every stress/threat/factor to the (assumed) situation prevailing 20 years ago.

Guiding questions for the determination of past criticality are:

→ Did the element actually exist 20 years ago?
→ If so, how has the criticality changed since then (especially in terms of scope and severity)?

By reviewing and assessing the past critical state of a biodiversity object, it is possible to bypass the descriptors (scope, severity and irreversibility/permanence). With this approach, the evaluation is based instead on the groups' or your own observation, experiences and knowledge of the conservation site and its surroundings.

In working with past and current indicators of criticality, it is important to avoid misconceptions that could easily translate into ill-informed strategies. An example would be the construction of settlements in the core zone of a protected area in a previous time followed by a period of inactivity that leads participants to believe that the problem is less severe today, despite the fact that the settlements are still in place and ecosystem conversion is still ongoing and accumulating. In this case, it simply means that any future expansion of construction is less critical but, in a current context, the settlements might be of a higher relevance than in the past (because there are more of them).

Lower than current = 1	Equal to current = 2	Higher than current = 3	Much higher than current = 4
The past criticality (20 years ago) of the stress/threat/factor is lower than the current one.	The past criticality (20 years ago) of the stress/threat/factor more or less equals the current one.	The past criticality (20 years ago) of the stress/threat/factor is higher than the current one.	The past criticality (20 years ago) of the stress/threat/factor is much higher than the current one.

Table 11. Rating categories of ‚Past criticality'

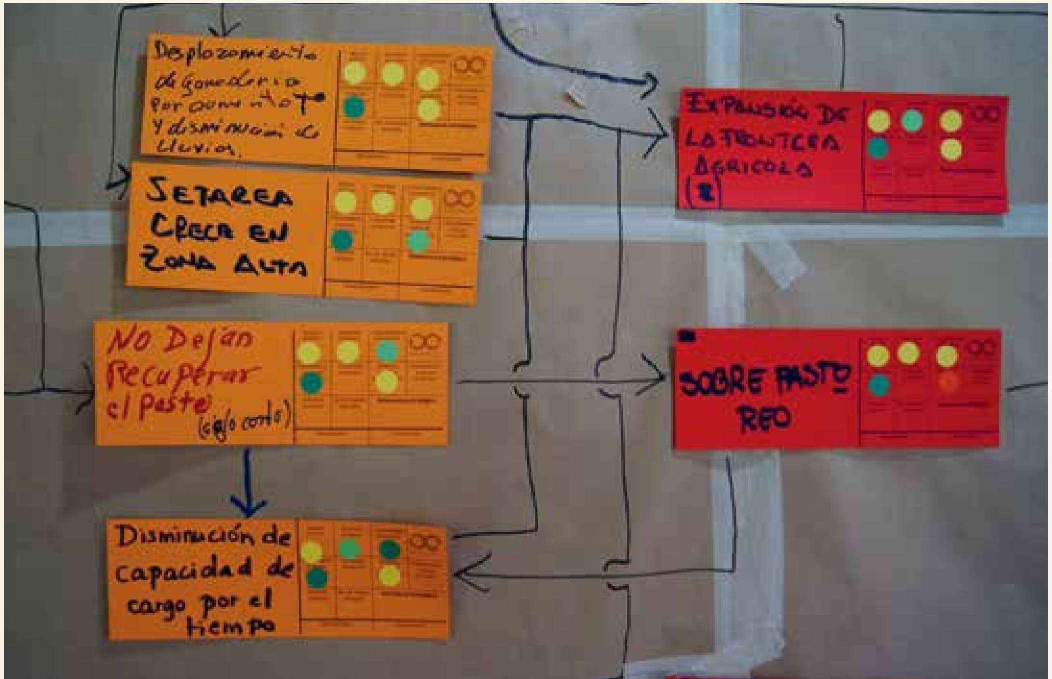


Figure 42. Part of a conceptual model with threats and contributing factors that have been preliminarily assessed with regard to their current and past criticality, as well as the current trend of change.

Decreasing = 1	Stable = 2	Gradually increasing = 3	Rapidly increasing = 4
Currently, the criticality of the stress/threat/factor is tendentially decreasing.	Currently, the criticality of the stress/threat/factor seems fairly stable. No change is recognisable.	Currently, the criticality of the stress/threat/factor is tendentially increasing, but it is doing so gradually and apparently quite predictably.	Currently, the criticality of the stress/threat/factor is tendentially increasing in a fast and accelerating way (exponentially).

Table 12. Rating categories for ‚Current trend of criticality change'

c) Current trend of change

An aspect of a biodiversity object that is worth recording is its dynamic behaviour or current trend of change.

Guiding questions for the determination of the current trend of change are:

- → How is the situation of the stress/threat/factor changing at this very moment? Is it receiving a lot of public attention? Why?
- → Is the stress/threat/factor currently increasing or decreasing? Slowly and gradually, or exponentially?

Document the results in the rating matrix next to the factor/direct threat/stress in the conceptual model. In addition, you can document the results in an Excel spreadsheet.

11. Develop future scenarios

Rationale for this step

The focus so far has been on recording the current and past criticality of stresses, threats and their contributing factors on biodiversity objects. Some mention has been made of the value of speculating about future changes, a point that needs further explanation. In the context of adaptive ecosystem-based management in a rapidly changing environment, MARISCO attempts to promote strategies that are proactive in nature and that seek to avoid purely reactive, 'quick-fix' solutions to symptoms that do not alleviate the real causes of conservation problems. It is important to identify the effects future risks may have on existing threats or how they may present new threats and stresses.

The accepted view among advocates of complex systems theory is that the passage of time increases the likelihood of environmental uncertainty and unexpected risks, and more so in ecosystems subjected to human-induced escalator effects. Increasing uncertainty can only mean any attempt to predict likely events and outcomes will be further removed from reality. If we look back through history, we can see that it was often difficult or actually impossible to foresee and predict some relevant mega-trends and single events that changed the course of development (see the evaluation of past criticality). In MARISCO, the purpose of future scenario analysis is to present 'what-if' forecasts that set the framework for proactive planning, rather than adopting a 'wait-and-see' approach for a possible future crash. When such unexpected events occur, the only cause for action is to mitigate symptoms after the event. The length of time frame that has proven to be practical is roughly that of a human generation, so around 20 years. The purpose of the exercise is most certainly not to predict the future in order to prepare prescriptive and deterministic 20-year plans. This would not be in line with the principles of adaptive management.

In various cultures, it is uncommon and fairly difficult to think into the future, and there might be a certain reluctance to do so. Also, trained scientists are frequently unhappy with future prediction exercises. The human tendency is, in general, to operate in the 'here-and-now' rather than project into future-based scenarios. A founding philosophical tenet of adaptive management is the engineering of a culture shift towards an ethic of 'here-now-and-in-the-future' in order to design less static strategies that embrace uncertainty and other forms of non-knowledge.

What you need

→ Moderation cards
→ Flipchart paper

Application procedure

First, the planning group or, in the case of larger cohorts, small breakout groups are invited to reflect on the future and identify relevant drivers of change and mega-trends. Past experience indicates the usefulness of distinguishing between local, national and regional scales.

Tools for scenario development

Sometimes, future scenarios are difficult to imagine. In order to trigger your imagination in this process, you can use different tools like perspective change or exaggeration to overcome routine thinking and its associated blind spots. These exercises may not only help in identifying future risks, but may also remove any blind spots relating to current elements.

Time machine

The group is asked to travel in time and first list events or trends that were relevant 20 years ago - differentiated according to local, regional/national and global levels (e.g., certain presidencies, important international meetings or treaties, populations numbers, existence of IT devices, internet etc.). The results are used for a reflection about the extent of changes that can happen in 20 years. Afterwards, they are requested to develop future scenarios for the time in 20 years (e.g., type of government, state of corruption, forest coverage, available technology).

Empathic perspective change

Empathic perspective change is a tool for changing your own perspective and, more importantly, for allowing you to consider the perspectives of other actors relevant to the management area and whose actions and plans can represent risks (or opportunities) for your conservation action. It is necessary to consider a wide range of perspectives, whether they have been agreed upon or not. Eventually the managing entity is confronted with the conflicting interests of other stakeholder groups. Practising taking these perspectives into consideration and sharpening the team's empathic skills can foster effective strategy development. By enhancing empathy through perspective change – by hypothesising about what others need; how they think, plan and act; and how they see conservation – some blind spots can be removed or avoided, or strategies can be sharpened to become more effective in how they facilitate understanding and communication with other stakeholders. It is also possible to consider diametrically opposing views – a 180° perspective change – where the actors analysed are hostile towards biodiversity conservation. From this perspective, it can be very insightful to imagine conservation activities as threats (e. g., to infrastructural development objects) and to envision what kinds of strategies opponents would devise and implement to overcome conservation. In general, a level of understanding about relevant stakeholders can be developed.

The team must identify relevant stakeholder groups in the project area and decide how they want to include them in the analysis. One option is to set up an extra planning team, which analyses the whole situation from their adopted perspective (e. g. that of indigenous people, industrial investors, agribusiness, road builders) and follows all the methodological steps for constructing the conceptual model and potentially even undertakes strategy formulation. The conservation objects would be the elements the corresponding stakeholders want to protect or develop (e. g., roads, mines, livelihoods, plantations). Stresses would equate to elements representing the reduced viability of these objects caused by threats and contributing factors.
This tool requires more time and staff resources than is normally available at conservation sites, but could be extremely informative for strategy building. So far, this particular tool has only been tested on student groups. It is highly recommended for teaching purposes and is especially effective when different student groups work on the same management area in parallel, but then take on different or opposing perspectives.

The 180° scenario tool

In the 180° scenario tool, elements of the current situation analysis are flipped and reimagined as the opposite situation. Negative contributing factors/threats/stresses are turned into positive aspects and vice versa.

A guiding question in this process can be for example:
› In what scenario can you imagine an opportunity turning into a negative contributing factor or vice versa?

The exaggeration tool

With the exaggeration tool, the (future) positive or negative impacts of contributing factors, direct threats or stresses are inflated.

A guiding question in this process could be, for example:

› What could be the worst/best development of a factor/threat/stress?

The completion of this part of the exercise may lead to the identification of new contributing factors, threats or stresses. They are clearly marked as future elements (by drawing a coloured frame around the MARISCO card) and are integrated into the conceptual model. The arrows that connect these future elements with others can also be drawn in another colour.

12. Analysis of the future criticality of stresses, threats and contributing factors

Rationale for this step

Having completed these future scenario exercises, participants are now in a position to move on to making judgements about the future criticality of stresses, threats and contributing factors (occurring over the next 20 years). Any factor that is not only crucial today, but is also expected to become even more important in the future, merits more attention than a factor with decreasing relevance.

What you need

→ The conceptual model, as developed so far.

Application procedure

Discuss and make consensual decisions about the future criticality of each factor, threat, and stress in the conceptual model.
As was the case for past criticality, participants 'fast-track' the respective judgement for future criticality (i.e., they do not individually assess the descriptor's scope, severity and irreversibility).
It is always worth keeping in mind that this whole exercise is based on a 'best-guess' approach and not on empirically derived outcomes. However, the evaluation will be based on the group's experiences and knowledge of the conservation site and its surroundings and will reflect the most plausible (current) scenarios.
Document the results in the rating matrix next to the factor/direct threat/stress in the conceptual model. In addition, document the results in an Excel spreadsheet.

Lower than current = 1	Equal to current = 2	Higher than current = 3	Much higher than current = 4
The future criticality (in 20 years) is expected to be lower than the current one.	The future criticality (in 20 years) is expected to be equal to the current one.	The future criticality (in 20 years) is expected to be higher than the current one.	The future criticality (in 20 years) is expected to be much higher than the current one.

Table 13. Rating categories for ‚Future criticality'

13. Analysis of systemic activity and the strategic relevance of stresses, threats and contributing factors

a) Systemic activity: level of activity

Rationale for this step

Very few, if any, threats or contributing factors act independently of each other, unless they are a 'novelty' phenomenon from outside the system. It has already been mentioned that some factors are more apparent than others by virtue of their force and impact. Similarly, some factors are equally visible because they produce clear synergistic or systemic effects. Factors or threats with high systemic activity will have a higher influence on the system. They are drivers of change and may play a key role in the cause-effect relations pictured in the conceptual model. An analysis of the level of systemic activity is important to improve the understanding of these cause-effect relations within the situation analysis. Furthermore, these drivers of change can be used as leverage points to change problematic cause-effect relations. Therefore, they should be given special attention when designing conservation strategies in order to generate changes at the level of root causes.

What you need

→ The conceptual model.

Application procedure

At this stage in the conceptual model's development, all the connecting arrows between the system elements should be in place and the next step of determining the systemic activity for every element in the conceptual model should have been carried out. The systemic activity is calculated in the first instance by counting the number of incoming and outgoing arrows for every factor and threat, and then classifying them according to the categories described below. Contributing factors placed in a group box are recorded as one factor – for instance, if an arrow from one contributing factor points to a group box with three contributing factors, it is treated as three individual arrows to each of the factors in the group box[20].

The systemic analysis does not include stresses as these are perceived as outcomes (symptoms) of the threats and their contributing factors.

Document your results in the rating matrix next to the contributing factors and threats in the conceptual model and in an Excel spreadsheet.

Passive = 1	Inert = 2	Active = 3	Very active = 4
The element within the conceptual model is influenced by more elements than it is influencing. (difference {influencing - influenced} = < 0).	The element within the conceptual model is influenced by as many elements as it is influencing. (difference {influencing - influenced} = 0).	The element within the conceptual model is influenced by less elements than it is influencing. (difference {influencing - influenced} = 1–3).	The element within the conceptual model is influencing other elements much more than it is influenced. (difference {influencing - influenced} = >3).

Table 14. Rating categories for ‚Systemic Activity: level of activity'

b) Systemic activity: number of elements that are influenced

Then document the activity according to the number of influenced elements:

Modestly influential = 1	Moderately influential = 2	Highly influential = 3	Extremely influential = 4
The element is influencing 1 element.	The element is influencing 2–3 elements.	The element is influencing 4–5 elements.	The element is influencing >5 elements.

Table 15. Rating categories for ‚Systemic activity: number of influenced elements'

[20] If, in some domains, the planning team tends to perform more grouping than in others, this may lead to a certain distortion of the values of systemic activity.

Level of activity → / Overall systemic activity / ↓ Number of influenced elements	Passive = 1	Inert = 2	Active = 3	Very active = 4
Modestly influential = 1	1	2	2	3
Moderately influential = 2	2	2	3	3
Highly influential = 3	2	3	3	4
Extremely influential = 4	3	3	4	4

Table 16. Matrix to calculate overall systemic activity

c) Strategic relevance

Rationale for this step

The strategic relevance sums up the outcomes of the different ratings undertaken in the previous steps and can be used to identify the most relevant elements in the conceptual model (stresses, threats and contributing factors). Therefore, it serves as an input for prioritising these elements, which is important when developing strategies.

However, it is important to keep in mind, that the strategic relevance is a derived value and should not be seen as a replacement for the individually derived outcomes for each factor.

Strategic relevance[21]

$R = C_C + C_T + C_F + S_A$

R = strategic relevance
C_C = current criticality
C_T = current trend of criticality
C_F = future criticality
S_A = systemic activity

What you need

- → Results for the rating of elements in the conceptual model.
- → The evaluation matrix for the conceptual model.

[21] Strategic relevance for stresses is calculated without ‚systemic activity'.

Application procedure

A table showing the strategic relevance of all the threats and their contributing factors is generated, if possible, as an Excel spreadsheet. The table can include information about the group of threats, contributing factors or stresses (if there are any). By applying a rank score to the rated threats and factors, an order of priority is produced. The values can be assigned to four classes of equal size (from *1 = low* to *4 = very high*). It is better to colour-code the final rank value for each threat and factor in the table (*4 = red, 3 = yellow, 2 = light green, 1 = dark green*). When complete, the table is then printed out as a poster in readiness for the next step, which is the formulation of strategies.

Table 17: Example table of a formatted threat-ranking list

	Scope	Severity	Irreversibility	Past Criticality	Current Criticality	Current trend of change	Future criticality	Systemic activity (level of activity)	Systemic activity (no of influenced elements)	Systemic activity	Strategic relevance (value)	Strategic relevance (final range)	Knowledge	Manageability
Seasonal change in precipitation patterns	4	3	4	1	4	3	4	3	2	3	14	4	3	4
Increase of mean annual temperature	4	3	4	1	4	3	4	3	2	3	14	4	3	4
Illegal logging	2	3	4	1	4	4	3	1	2	2	13	3	2	3
Deforestation	2	3	3	1	3	4	3	3	3	3	13	3	2	2
Mining activities	1	4	3	2	3	2	3	3	2	3	11	3	1	2
Poaching	4	4	4	2	4	2	2	1	1	1	9	2	2	2

14. Analysis of knowledge and manageability of stresses, threats and contributing factors

a) Analysis of knowledge

Rationale for this step

Unlike conventional 'Systematic Conservation Planning', adaptive management does not rely entirely on a qualified body of knowledge to structure its strategies. Instead, it recognises the incompleteness of information and knowledge at several levels within conservation management: at the level of the planning team, among stakeholders, and in the wider scientific community. It is important, then, to try and harvest as much knowledge as possible while at the same time embracing unknowns and non-knowledge.

Any decision made during any part of the MARISCO process is considered to be preliminary and open to alteration at a later date when more information surfaces. An important part of conceptualisation is the ongoing review process by all the participants, which encourages the team to challenge the information put forward and also to identify where there appears to be deficits. At the end of the day, the final strategies and conceptual model produced by a project team are only as good as the information they put into it, so the aim should always be to strive towards a better informed process. A more formal assessment of the conceptual model to test the validity of the embedded knowledge and also to expose knowledge gaps helps the project team with decisions about consulting experts.

At any moment, detailed scientific information or even evidence can be integrated into the MARISCO assessment. But, apart from anything else, a knowledge assessment of the situation makes clear the interdisciplinary (and transdisciplinary) nature of conservation planning and also reveals the extent to which scientific knowledge is limited to providing evidence in more linear formats. The findings of the assessment may convert into factors contributing to threats that require action (e. g. institutional weaknesses such as the lack of documentation, insufficient access to up-to-date information, the lack of time for reading and learning).

What you need

→ The conceptual model, as developed so far.

Application procedure

Using the categories given below, classify the level of knowledge that exists within the planning group about the contributing factors, threats and stresses. 'Knowledge' comprises all possible dimensions that can be known about an element, such as its relevance in the cause-effect network, its behaviour, its dynamics, etc. It does not include an assessment of knowledge from other institutions operating in the field and outside of the influence of the project team.

Document the results in the rating matrix on the MARISCO card. In addition, document the results in an Excel spreadsheet. In this worksheet, you can also include the sources of the existing knowledge as well as the location of these sources.

Well known = 1	Somewhat known = 2	Not known, but theoretically knowable = 3	Not knowable = 4
The level of knowledge about the factor/threat/stress is very high; the planning team has a precise idea of the element's characteristics, relevance and dynamics.	The level of knowledge about the factor/threat/stress is fair; the planning team has a fairly good idea of the element's characteristics, relevance and dynamics. Some knowledge gaps might have been identified.	The level of knowledge about the factor/threat/stress is poor; the planning team does not have a good idea of the element's characteristics, relevance and dynamics. Some better knowledge might be available, but this is not currently possessed by the team.	It is impossible to obtain a level of good knowledge about the factor/threat/stress; the planning team can only formulate assumptions about the element's characteristics, relevance and dynamics. Further research would not provide better knowledge. This non-knowability is related to the fact that the element is complexly influenced by other uncertain elements, or that it represents future risks.

Table 18. Rating categories for ‚Knowledge'

b) Analysis of manageability

Rationale for this step

All too often, conservation management neglects to assess the manageability of threats and change to biodiversity in protected areas or landscapes and, as a result, strategies can be misguided, unrealistic and ineffective. Equally, without a more informed assessment of the situation, the tendency is to avoid tackling problems that initially appear to be 'unmanageable'.

Often, the recognition of unchangeable challenges, which cannot be (directly) influenced by local action, gives rise to fatalism or displacement behaviour, which means that managers focus on easily manageable threats that do not constitute the real danger to the biodiversity objects. A systematic assessment of the manageability of threats and their contributing factors provides the basis for rationalising action, and it is important to acknowledge that unmanageable threats may also require strategies. For instance, with problems of 'high strategic relevance' – like those linked to climate change that are likely to score low in terms of manageability – the alternative way forward would be to seek adaptive strategies. In these cases, management can seek to reduce the vulnerability by either decreasing the sensitivity or increasing the adaptive capacity of the biodiversity objects. An example is the evidence for the increasing incidence of forest fires caused by prolonged droughts in certain regions of the world. Clearly, there is little that can be done to reduce drought in the short term, but more immediate and effective action can be taken to prevent or reduce considerably the occurrence of forest fires.

What you need

→ Conceptual model, as developed so far.

Very manageable = 1	Somewhat manageable = 2	Poorly manageable = 3	Not manageable = 4
The element can be easily and directly influenced by strategies and project activities; usually these refer to mainly local elements.	The element is likely to be directly influenced by strategies and project activities to a certain extent, especially if more resources are made available than at present.	The element is not very likely to be directly manageable. It can be influenced instead in a meta-systemic and indirect way.	The element is not manageable at all; it is extremely unlikely that local management would effect any change, either directly or indirectly.

Table 19. Rating categories for ‚Manageability'

Application procedure

Evaluate the manageability of each contributing factor, threat and stress using the categories set out below. It is important to keep the context of the conservation site in perspective and not to drift into discussions on manageability beyond the practical realms of the management team (in other words, avoid more general and wider issues relating to a global context).

Document the results in the rating matrix on the MARISCO cards. In addition, document the results in an Excel spreadsheet.

15. Understand the relevant actors and stakeholders

Rationale for this step

At some level, factors that contribute to threats to biodiversity have a point source that can be attributed to individuals or organisations (called 'actors' in the conceptual model). Part of the MARISCO exercise is to identify, where possible, these actors and to make their relationship to the listed contributing factors clear in the model.

What you need

→ Conceptual model, as developed so far.

Application procedure

Systematically map the actors and stakeholders that are related to every factor or direct threat in the conceptual model (or to group boxes).

Guiding questions for the identification process are:

→ Who is responsible for the occurrence of the factor/threat/stress?
→ Who has an interest in the existence/occurrence of the factor/threat/stress?
→ Who has an interest in the mitigation of the factor/threat/stress?

Document the results next to the factor/direct threat in the conceptual model (e. g. on a white moderation card or by drawing symbols into the conceptual model). In addition, document the results in an Excel spreadsheet.

The following table summarises all the criteria and categories applied to the element rating. For the workshops, it is recommended to print out this table in the form of individual hand-outs or wall posters.

	Low = 1	Somewhat known = 2	Not known, but theoretically knowable = 3	Not knowable = 4
Current criticality: scope	Local occurrence = 1 **Stress/threat:** The stress/threat is likely to have a very limited spatial distribution, affecting the biodiversity object across a small proportion of its occurrence in the area of analysis (1–10%). **Contributing factor:** The factor is likely to be very narrow in its spatial distribution, affecting other elements across a small proportion of the area of analysis (1–10%).	Medium area = 2 **Stress/threat:** The stress/threat is likely to be fairly restricted in its spatial distribution, affecting the biodiversity object across a certain part of its occurrence in the area of analysis (11–30%). **Contributing factor:** The factor is likely to be fairly restricted in its spatial distribution, affecting other elements across a certain part of its occurrence in the area of analysis (11–30%).	Large part of the area = 3 **Stress/threat:** The stress/threat is likely to be well spread, affecting the biodiversity object across a significant part of its occurrence in the area of analysis (31–70%). **Contributing factor:** The factor is likely to be well spread, affecting other elements across a significant part of the area of analysis (3–70%).	(Almost) omnipresent = 4 **Stress/threat:** The stress/threat is likely to be pervasive in its spatial distribution, affecting the biodiversity object across all or most of its occurrence in the area of analysis (71–100%). **Contributing factor:** The factor is likely to be pervasive in its spatial distribution, affecting other elements across all or most of the area of analysis (71–100%).
Current criticality: severity	Light = 1 **Stress:** Within the scope, the stress does not imply a reduction in the overall functionality of the biodiversity object. **Threat:** Within the scope, the threat is not likely to degrade or harm the biodiversity object. **Contributing factor:** The factor is not likely to generate a significant impact on the influenced elements.	Moderate = 2 **Stress**: Within the scope, the stress may eventually lead to a certain reduction in the overall functionality of the biodiversity object within the next 10 years. **Threat**: Within the scope, the threat may eventually lead to a certain level of degradation of and harm to the biodiversity object within the next 10 years. **Contributing factor:** The factor may eventually generate a certain level of impact on the influenced elements.	Severe = 3 **Stress:** Within the scope, the stress is likely to reduce the overall functionality of the biodiversity object within the next 10 years. **Threat:** Within the scope, the threat is likely to degrade and harm the biodiversity object within the next 10 years. **Contributing factor:** The factor is likely to generate a clear impact on the influenced elements.	Extreme = 4 **Stress**: Within the identified scope, the stress most likely means a serious reduction in the overall functionality of the biodiversity object, or even its loss, within the next 10 years. **Threat:** Within the identified scope, the threat is most likely to degrade and harm the biodiversity object and even cause its loss within the next 10 years. **Contributing factor:** The factor is most likely to generate a significant impact on the influenced elements and become a driving force that ultimately harms one or various biodiversity objects (at least within the identified scope).

	Low = 1	Somewhat known = 2	Not known, but theoretically knowable = 3	Not knowable = 4
Current criticality: irreversibility	**Probably disappearing in the short term = 1** It is likely that the stress/threat/ factor will disappear spontaneously (without management) in the short term (1 to 5 years), possibly implying nothing more than easily reversib-le consequences for conservation objects	**Probably not disappearing in the midterm = 2** It is likely that the stress/threat/ factor will not disappear (without management) in the midterm (6 to 20 years), but this does not imply long-term and irreversible consequences for conservation objects.	**Probably staying in the long term = 3** It is likely that the stress/threat/ factor will stay present (without management) in the long term (21 to 100 years), which also implies long-term consequences for conservation objects that are hard to reverse.	**Very high = 4** It is very likely that the stress/threat/ factor will stay present in the long term (probably for more than even a century), which also implies long-term consequences for conservation objects that cannot be reversed for decades.
Current criticality: overall (or override)	**Slightly critical = 1** The stress/threat/factor does not play a very important in role in generating the overall vulnerability of the conservation objects within the geographical scope of analysis.	**Moderately critical = 2** The stress/threat/factor plays a fairly important role in generating the overall vulnerability of the conservation objects within the geographical scope of analysis.	**Critical = 3** The stress/threat/factor plays an important role in generating the overall vulnerability of the conservation objects within the geographical scope of analysis. It is an important driver of negative change in the analysed system.	**Very critical = 4** The stress/threat/factor plays an extremely important role in generating the overall vulnerability of the conservation objects within the geographical scope of analysis. It is a major and persistent driver of negative change in the analysed system.
Past criticality	**Lower than current = 1** The past criticality (20 years ago) of the stress/threat/factor is lower than the current one.	**Equal to current = 2** The past criticality (20 years ago) of the stress/threat/factor more or less equals the current one.	**Higher than current = 3** The past criticality (20 years ago) of the stress/threat/factor is higher than the current one.	**Much higher than current = 4** The past criticality (20 years ago) of the stress/threat/factor is much higher than the current one.
Current trend of change of criticality	**Decreasing = 1** Currently, the criticality of the stress/threat/factor is tendentially decreasing.	**Stable = 2** Currently, the criticality of the stress/threat/factor seems to be fairly stable. No change is recognisable	**Gradually increasing = 3** Currently, the criticality of the stress/ threat/factor is tendentially increasing, but it is doing so rather gradually and apparently quite predictably.	**Rapidly increasing = 4** Currently, the criticality of the stress/threat/factor is tendentially increasing in a fast and accelerating way (exponentially).

	Low = 1	Somewhat known = 2	Not known, but theoretically knowable = 3	Not knowable = 4
Future criticality	**Lower than current = 1** The future criticality (in 20 years) is expected to be lower than the current one.	**Equal to current = 2** The future criticality (in 20 years) is expected to be equal to the current one.	**Higher than current = 3** The future criticality (in 20 years) is expected to be higher than the current one.	**Much higher than current = 4** The future criticality (in 20 years) is expected to be much higher than the current one.
Systemic activity: level of activity	**Passive = 1** The element within the conceptual model is influenced by more elements than it is influencing. (difference {influencing – influenced} = ‹ 0).	**Inert = 2** The element within the conceptual model is influenced by as many elements as it is influencing. (difference {influencing – influenced} = 0).	**Active = 3** The element within the conceptual model is influenced by less elements than it is influencing. (difference {influencing - influenced} = 1–3).	**Very active = 4** The element within the conceptual model is influencing other elements much more than it is influenced. (difference {influencing – influenced} = ›3).
Systemic activity: number of influenced elements	**Modestly influential = 1** The element is influencing 1 element.	**Moderately influential = 2** The element is influencing 2–3 elements	**Highly influential = 3** The element is influencing 4–5 elements.	**Extremely influential = 4** The element is influencing ›5 elements.
Knowledge	**Well known = 1** The level of knowledge about the factor/threat/stress is very high; the planning team has a precise idea of the element's characteristics, relevance and dynamics.	**Somewhat known = 2** The level of knowledge about the factor/threat/stress is high; the planning team has a fairly good idea of the element's characteristics, relevance and dynamics. Some knowledge gaps might have been identified.	**Not known, but theoretically knowable = 3** The level of knowledge about the factor/threat/stress is poor; the planning team does not have a good idea of the element's characteristics, relevance and dynamics. Some better knowledge might be available, but this is not currently possessed by the team.	**Not knowable = 4** It is impossible to obtain a good level of knowledge about the factor/threat/stress; the planning team can only formulate assumptions about the element's characteristics, relevance and dynamics. Further research would not provide better knowledge. This non-knowability is related to the fact that the element is complexly influenced by other uncertain ones, or that it represents future risks.
Manageability	**Well manageable = 1** The element is easily and directly manageable and can be influenced by strategies and activities; usually these refer to mainly local elements.	**Somewhat manageable = 2** The element is likely to be directly manageable to a certain extent, especially if more resources are made available than at present.	**Poorly manageable = 3** The element is not very likely to be directly manageable. It can be influenced instead in a meta-systemic and indirect way.	**Not manageable = 4** The element is not manageable at all. It is extremely unlikely that local management would cause any change, either directly or indirectly.

Table 20. Rating categories for ‚Knowledge'

Below is an example of the documentation of assessment results presented as a spreadsheet. It shows which biodiversity objects are affected by a given threat. The rating of the threat is documented and comments should also be inserted detailing the rationale for group decisions or indicating sources of information.

Table 21. Example documentation of assessment results

	Mountain-lowland ecosystem complex	Mountain grassland	Cloud forest	Mountain forest	Lowland forest	Rivers and streams	Large predators	Scope	Severity	Irreversibility	Past criticality	Current criticality	Current trend of criticality	Future criticality	Systemic activity: level of activity	Systemic activity: no of influenced elements	Systemic activity	Strategic relevance Knowledge	Manageability	Comments	Source	Deforestation
Deforestation	x							2	3	3	1	3	4	3	3	3	3	4	2	2		

Example

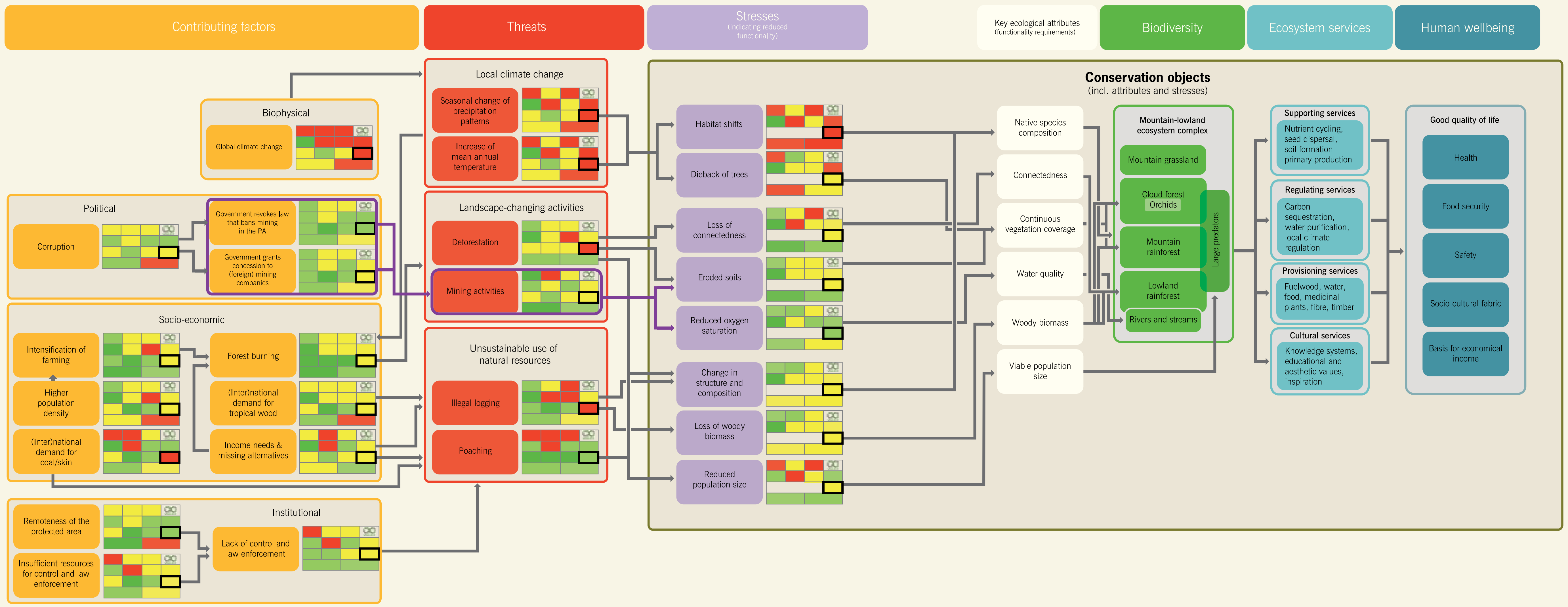


Figure 43. MARISCONIA: Conceptual model with evaluation results. MARISCONIA is an imaginary conservation site where MARISCO is being applied. The situation analysis is now complete. The diagram has been completed by adding the evaluation results of criticality, systemic activity, and strategic relevance; as well as the knowledge and manageability of each stress, direct threat and contributing factor.

Before starting the next phase on strategy formulation and evaluation, it is recommended to finesse the conceptual model's structure and create a tidy version, ideally in the form of a computerised diagram that can be printed out as a poster (see the figure below).

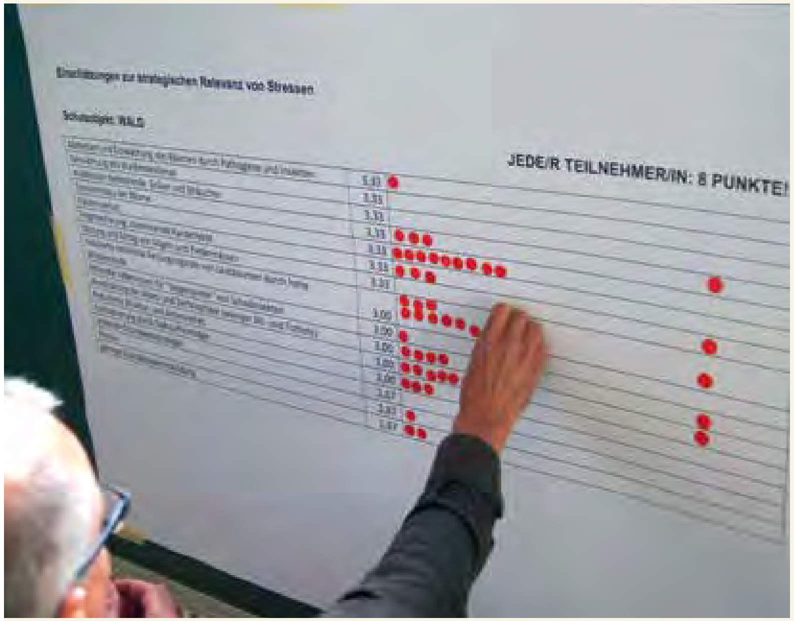
Figure 44. Validation, revision and amendment of a conceptual model that had previously been converted into a graph and printed out as a poster. The group added or changed evaluation categories and arrows.

16. Revision and validation

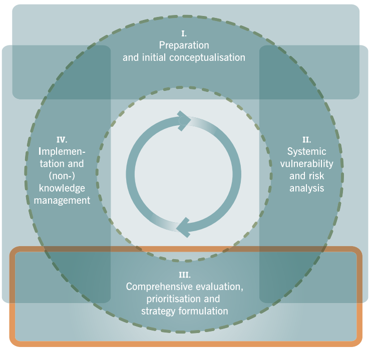
Revising and validating the conceptual model with as many stakeholders and experts as possible is recommended. In situations where work on the first two MARISCO phases lasts for longer periods – a couple of months, or even a year or more – the opportunity arises to include further knowledge and expertise beyond that existing in the planning team. Such revisions can be performed in mini-workshops or brief sessions with groups of 'external' experts. The best items to review and validate would be the conceptual model and the tables containing the rating results (criticality, manageability, etc.). New elements or arrows can be introduced and the rating results can be questioned or discussed. If the opinions of these 'external' consultees differ significantly from the original assessment, the new inputs will have to be discussed with the planning team. Whatever the case, any new input would need to be justified with arguments or evidence before it is appropriately documented.

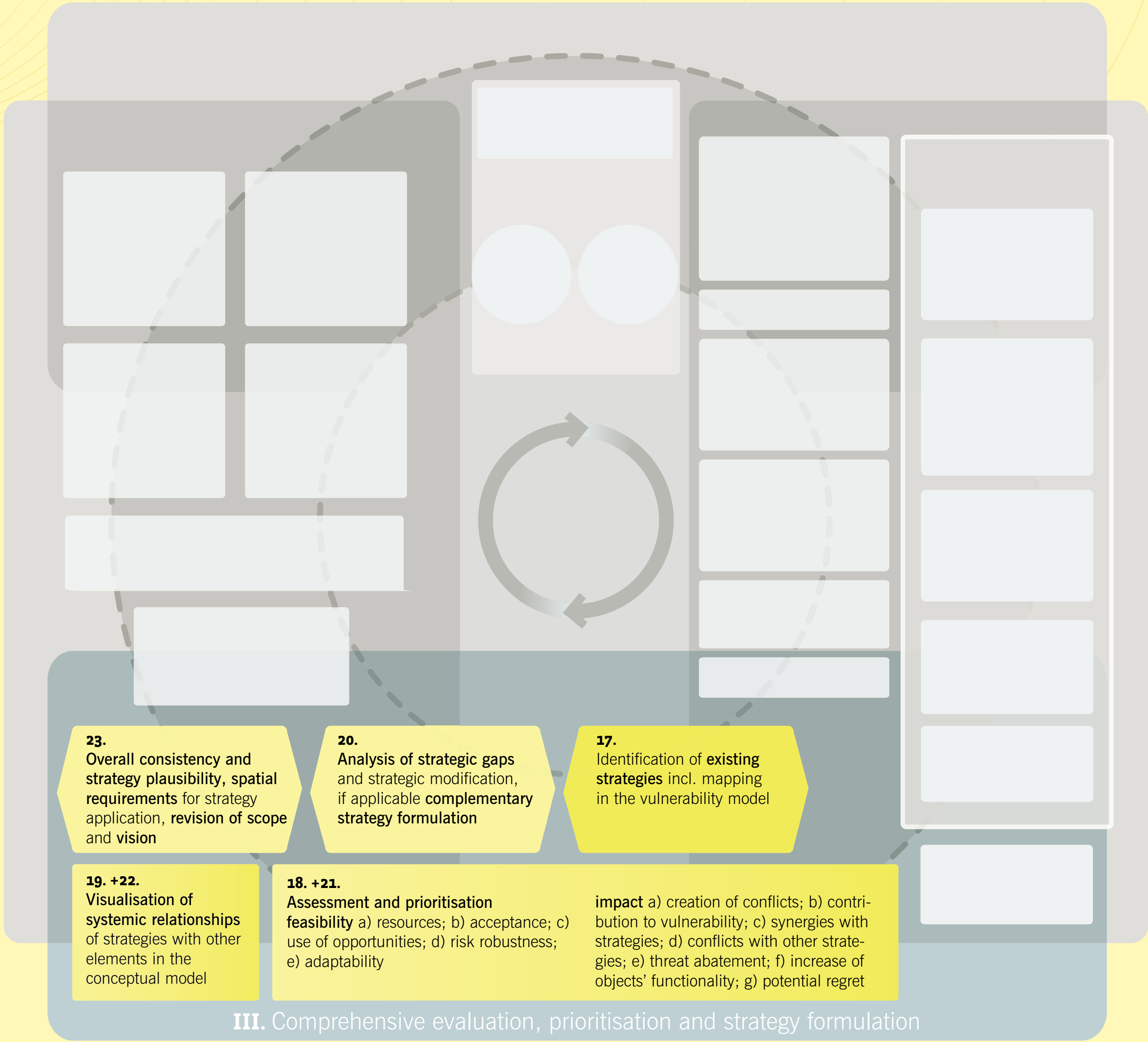
It is also interesting to confront experts with the final results of the strategic relevance rating and ask for a contrasting override assessment (see figure below). This can be performed so as to show the results of the earlier exercise or not. If the results differ significantly, they can be used to inform a critical discussion, which can enhance the process as well as the general understanding of the elements under discussion.

Figure 45. Validating the results of the strategic relevance of stresses.
In this instance, stresses, threats and contributing factors were printed out on separate posters. The sequence was defined according to the calculated strategic relevance. The majority of experts and stakeholders who participated in this analysis had not been involved in the earlier steps of the MARISCO exercise. They were invited to express their opinions by placing small stickers against the corresponding elements they regarded as most relevant. Note that this 'override assessment' did not consider present or future criticality, or other specific criteria. Experts placed a certain number of stickers (50% of the total number of elements on the poster) next to the elements they saw as most critical; lumping together all stickers on one or a few elements was allowed.



III. Comprehensive evaluation, prioritisation and strategy formulation[22]





[22] Authors: P.L. Ibisch, L. Geiger, D. Aschenbrenner and P.R. Hobson

Rationale, objectives, input and output of this part of the exercise

Rationale for this phase

Once a full situation analysis of the project area has been completed and the various threats and contributing factors have been identified, the next step is to develop a comprehensive strategic plan. An effective strategic plan includes smart objectives designed to be consistent, complementary, risk-robust and effective in effecting changes that are positive for conservation objects. There is no such thing as a perfect plan, but it is possible to formulate robust, evaluative and self-referential strategies that encourage learning and adaptive improvement when needed. It is not only conservation objects that are vulnerable to unexpected change; strategies are equally sensitive to disturbances and threats. As such, it is recommended that strategies are developed with built-in adaptive capacity. The same threats, contributing factors and risks that affect biodiversity can also impact on the effectiveness of strategies, not to mention posing other unforeseen risks in the future.

Our current understanding of biodiversity shows that the complex structures and non-linear dynamics present in nature frustrate scientific efforts to understand and interpret cause-effect patterns. Equally, managers are unlikely to find effective solutions to conservation problems if they continue to rely on evidence generated by simple linear enquiry. Often, management's response to scientific enquiry is to focus on isolated objects rather than connected processes, which leads to the generation of atomistic approaches governed by disconnected strategies. These strategies focus on the so-called 'object-systemic' level. Management would be more effective if it adopted a 'meta-systemic approach', focusing more on understanding and responding to processes driven by non-linear and interrelated dynamics, and also by the framework conditions that enable such processes. A more holistic approach would encourage self-organising change and adaptation in the managed system.[23] This kind of management would also target the synergistic interaction of as many strategies as possible, in order to generate a critical mass for transformation.

In line with previous thinking, the objectives in this phase are to:

- analyse existing strategies (where provided), evaluating their effectiveness and vulnerability;
- formulate complementary strategies to fill identified strategic gaps;
- evaluate these new and complementary strategies with the goal of reducing their vulnerability;
- understand if and how strategies – through unintended mechanisms – eventually contribute to generating risks and an increase in the vulnerability status of the conservation objects; and
- revise the overall consistency and effectiveness of the entire strategic portfolio.

[23] Ibisch, P.L., Hobson, P.R. and Kreft, S., 2012, 'The European nature conservation network Natura 2000 in meeting uncertain challenges of climate change: Applying principles of complex systems and ecosystem theory', published in: Ibisch, P.L., Geiger, L. and Cybulla, F. (eds.), Global change management: knowledge gaps, blindspots and unknowables, Nomos, Sinzheim, pp. 131-152.

Input	Output
The existing strategic portfolio.	A list of consistent and plausible conservation strategies that are derived from the conceptual model.
Knowledge from any sources about implementation, and successes and failures of existing strategies.	Results of a comprehensive strategy evaluation that facilitates their prioritisation.
Information about environmental, socio-economic, legal, political, and institutional circumstances at the conservation site and in its vicinity.	Map of the spatial requirements for effective strategy application.
	A revised geographical scope and vision for the management area.

Explanation of key terms

Strategy

A **strategy** comprises a series of decisions related to the deployment of available resources (management) and the establishment of appropriate socio-institutional conditions (governance)[24] that allows for effect action towards achieving desirable goals and objectives.

In military operations, a distinction is made between tactics and strategy. While good tactics may lead to winning single battles, a strategy is the combination of a sequence of actions made by a general that may result in the winning of a war. In biodiversity conservation, strategies are most often formulated to protect or enhance the existing status or condition of desired conservation objects. To this end, conservation practitioners often try to abate existing threats and focus their efforts on recovering the status of more or less specific targeted objects. Such a focused approach may divert attention away from ecological problems in the wider landscape and at larger scales of socio-political operations. However, it is important to always have the bigger picture in mind and to develop strategies that consistently reduce the overall vulnerability of the conservation objects and of the projects and institutions working for biodiversity conservation. In conservation, it is important to:

→ understand the involvement and interests of stakeholders to develop dynamic strategies with adaptable goals and objectives that respond to changing framework conditions;
→ to anticipate – in an empathic manner – the decisions and moves of players outside the sphere of conservation.

Using the results of the systemic situation analysis, a set of specific strategies are identified that can be inserted at virtually any points in the conceptual model.

[24] A good governance system 'responds to the principles and values freely chosen by the concerned people and country and enshrined in their constitution, natural resource law, protected area legislation and policies and or cultural practices and customary laws' (Dudley, N. {ed.} 2008, Guidelines for applying protected area management categories, IUCN, Gland, Switzerland).

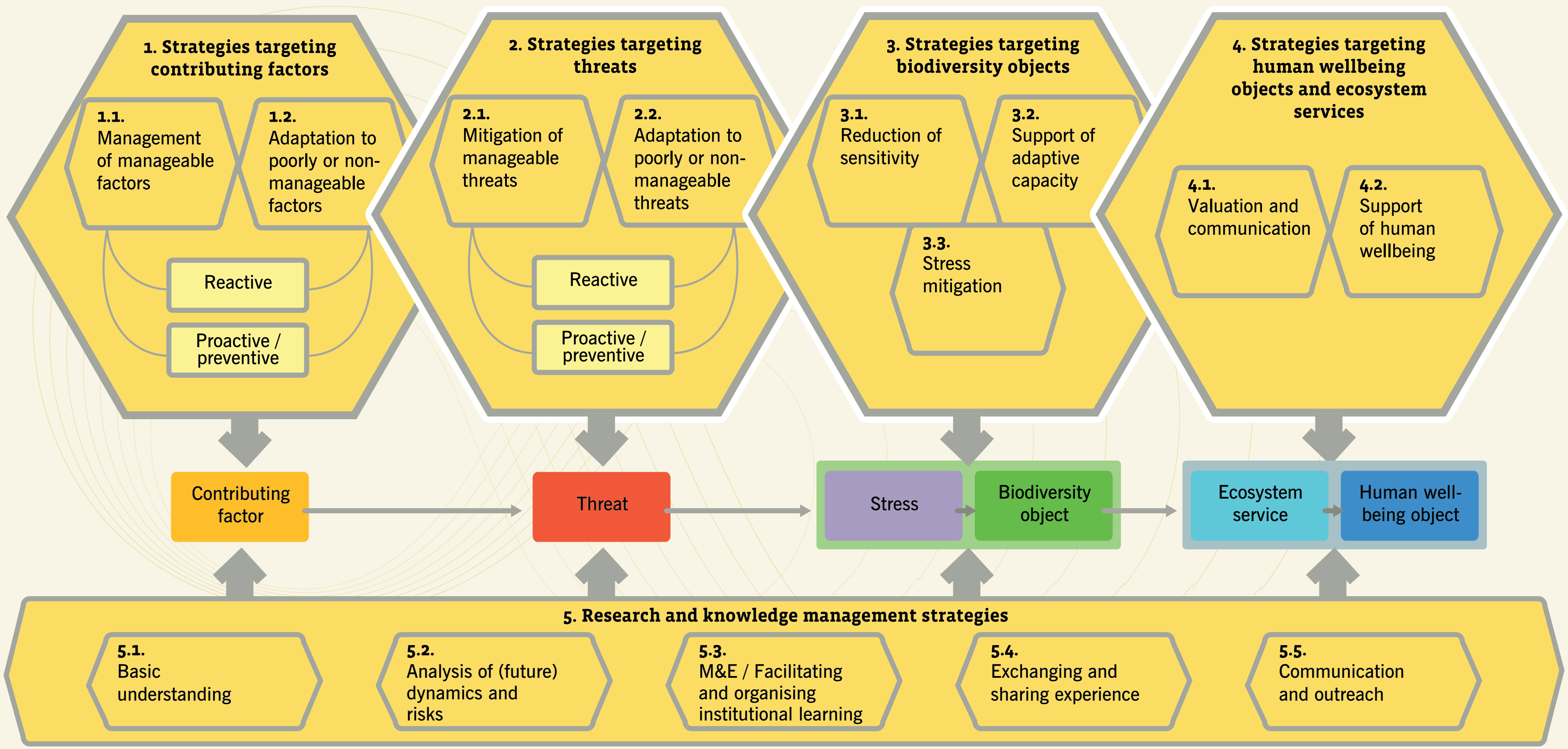


Figure 46. Classification of strategies according to entry points in the conceptual model.

1. Strategies that target a contributing factor address the so-called root causes of threats and are likely to contribute indirectly to improving the conservation objects or to decreasing their vulnerability. Strategies that are designed to tackle the root causes of problems are the most effective because they work towards real *change management*. Root-cause strategies operate at the scales of both space and time – they are reactive when dealing with immediate issues (form of mitigation) and proactive when addressing wider horizon problems that are emerging but have yet to express their effects on biodiversity. Strategies can also be differentiated according to the manageability of contributing factors. If factors are manageable (and contribute to threats) then strategic objectives would be designed to target the abatement or mitigation of the factor. If the factors contributing to threats are unmanageable, a strategy would be formulated to accommodate the problem within the system and also to promote institutional adaptation to its existence and influence. This type of strategy is likely to invite full collaboration between the actors and stakeholders that have been identified in the previous steps.

Alternatively, strategies that try to deliver people-related changes:

a. adopt restrictive-regulative approaches;

b. emphasise the importance of information, communication and education;

c. promote conditions that encourage enabling, empowerment and support.

Examples: Strategies targeting manageable contributing factors often try to change the socio-economic or political reality. For instance, the lack of acceptance and support for conservation action can be improved by awareness-raising campaigns or direct lobbying. Strategies that tackle adaptation to non-manageable factors could, for example, involve helping conservation management that is working in a political situation shaped by corruption and doing so without any harmful outcomes.

Figure 47. Environmental information in Ushanski National Park, Ukraine, helps to enlighten tourists and to develop the park as a destination, which can indirectly contribute to local people's income generation.

2. Strategies that try to reduce or eliminate threats can also be designed to operate at proactive and reactive levels, and well as to focus on mitigation or adaptation.

Examples: Strategies targeting threats would, for example, try to directly prevent, stop or reverse processes of degradation, such as overexploitation, pollution, deforestation or erosion. Typical strategies would be fencing or cleaning activities. These strategies easily fall into the trap of treating only symptoms, leaving the contributing factors to the threat unaddressed. However, these initiatives might still (temporarily) be needed to safeguard conservation objects until the underlying factors have been effectively tackled.

3. Strategies formulated to address problems perceived to have a direct effect on biodiversity objects typically encourage measures designed to mitigate stresses and reduce their sensitivity against threats or support the development of their adaptive capacity. Strategies that advocate either mitigation or adaptive management represent two rather distinct approaches to conservation; the former being reactive, the latter proactive.

Examples: Strategies working directly with biodiversity objects can be somewhat manipulative – for example, the ex-situ conservation of individuals or the translocation applied to facilitate adaptation to changing habitat distribution. Captive breeding or reproduction in nurseries can help reduce certain stresses (e. g., low population size) and also enhance adaptive capacity. The creation of new artificial habitats (habitat design, such as creating sand islands or artificial reefs) can be a proactive way of reducing vulnerability.

Figure 48. Controlling and limiting access: a control post in Sierra del Lacandón National Park, Maya Forest, Guatemala.

Figure 49. The captive breeding of a Hungarian meadow viper (Vipera ursinii rakosiensis) at Kiskunság National Park, Hungary, for later re-introduction.

Figure 50. Restoring native vegetation: replanting an area along the Deschutes River, Oregon, USA, contributes to mitigating stress in the damaged gallery forest ecosystem.

4. Strategies that directly target the improvement of human wellbeing are not strictly conservation strategies. In nearly all cases, human wellbeing outcomes are viewed as desirable secondary benefits derived from actions proposed or taken to safeguard biodiversity. That said, there are advantages for conservation in raising awareness of the goods and services provided by biodiversity among poor communities that remain heavily dependent on the living landscape and for whom conservation is not a priority. Even just communicating this dependency can be highly beneficial for conservation projects. Under certain conditions, especially when people are living below subsistence levels and do not easily prioritise biodiversity conservation, it can be of strategic importance to directly foster livelihoods or simply provide food or other key resources in order to establish the fundamental conditions required for effective conservation work.

5. Strategies that promote research and knowledge management reflect the central tenet of adaptive management to 'learning while doing' and are fundamental for effective conservation management. Applied research can improve horizon scanning, and also serve as a means of detecting new risks. Effective knowledge management underpins all monitoring and evaluation, and communication programmes. It can also help improve management by promoting exchange and learning from others.

Feasibility

Feasibility is the degree to which a strategy is likely to be implemented under the prevailing conditions within the management area. Factors likely to influence feasibility include the availability of given resources and also risks, restrictions and conflicts with or between actors and stakeholders.

Impact

The impact of a conservation strategy is related to any change within or outside the management area that

Figure 51. Satisfying basic human needs in order to build a trusting relationship: conservationists support family gardens and vegetable production in Sierra del Lacandón National Park, Maya Forest, Guatemala.

Figure 52. Ecological research can provide guidance for ecosystem management (vegetational and microclimatic studies in a nature park in Brandenburg, Germany).

can be attributed to the strategic action and that influences either directly or indirectly the conservation objects. Positive impacts are ultimately related to the maintenance or improvement of the status of the defined conservation objects. Negative impacts would lead to an increase in stresses, threats or their contributing factors.

Results webs

Results webs graphically illustrate systemically and logically linked assumptions that must be made for postulating the effects of strategies. They comprise the logical sequence of intermediate results to be achieved that, ultimately, would imply a positive impact on the biodiversity objects.

In scientific terms, a results web lays out hypothesised relationships. It is a stepwise, time-referenced assumption that should be based on the criteria evaluation of the strategies and the visual strategy analysis in the conceptual model. Possible risks, conflicts, benefits and synergies that have been identified as having the potential to interfere with the logical chains and linkages are part of the results web. Results webs are a tool for critiquing proposed strategies.

Results webs are built over the conceptual model (which acts as the underlying framework) and consist of strategies, intermediate results, and a threat reduction result, along with the latter's consequent impact on the biodiversity objects in terms of reducing or eliminating stress. While the conceptual model depicts the planning team's current assumptions regarding the situation external to the project in the conservation site, the results webs illustrate the future situation that is desired post strategy implementation. This leap in time can be indicated by using different colours. Theoretically, simple results chains can exist but, in most cases, complex conceptual models with systemic interrelations and feedback loops translate into equally complex results webs.

Goals and objectives

Goals and objectives are often used synonymously. In line with the Open Standards for the Practice of Conservation, we define goals as 'ultimate aim statements' with regard to the status of the conservation objects.

Common business and planning definitions of goal and objective[25]

Goal: An observable and measurable end result having one or more objectives to be achieved within a more or less fixed time frame.

Objective: A specific result that a person or system aims to achieve within a time frame and with available resources. In general, objectives are more specific and easier to measure than goals. Objectives are basic tools that underlie all planning and strategic activities.

Conservation goals are formal statements of the intended long-term management impact, describing a desired status for the conservation objects. Usually, they will refer to the biodiversity objects, but could also describe intended impacts on ecosystem services and human wellbeing objects. As well as referring

[25] Taken from: www.businessdictionary.com.

to the objects, goals must also be impact-oriented, measurable, time limited, and specific.

Correspondingly, conservation objectives are formal statements of the intended short- and medium-term management results. These management results are, in effect, the changes effected in the complex system to be managed that are likely to cause an improvement in the conservation objects. The accomplishment of relevant management objectives is a requirement for meeting their corresponding goals. Objectives must be management-result oriented, measurable, time limited, specific, and practical.

Monitoring

Monitoring is the periodic process of gathering data, which is then used to assess the status of defined indicators. This way, changes in certain elements or their performance can be monitored.

Comprehensive monitoring for conservation comprises several components:

- **Process monitoring** measures the progress of project implementation according to operational plans.
- **Impact monitoring** measures indicators to track the accomplishment of management goals and objectives.
- General e**nvironmental monitoring** is used to observe environmental change without necessarily being related to strategic planning or project implementation.

Working Steps

17. Identification of existing strategies and 'strategy mapping'

Rationale for this step

Commonly, MARISCO exercises are generally undertaken not at the beginning of a conservation project or when a conservation site is established, but, rather, during the ongoing period of management while existing strategies are being worked through. It is important to capture these existing strategies in order to understand how they influence the vulnerability of the conservation objects, and to know who is involved. The mapping of existing strategies in the conceptual model makes clear where in the model they relate to the various threats and contributing factors. The collection of existing strategies forms the basis for the subsequent *strategic gap analysis*.

If there is already an existing management entity and a strategic plan, it is important to understand how it has been dealing with risks and vulnerabilities.

What you need

- Flipchart.
- The conceptual model, as developed so far (ideally in an organised and printed format, see photographs on the next page).
- Yellow, hexagonal moderation cards.

Figure 53. If existing strategies are collected during the same workshop, straight after the vulnerability analysis, it is particularly difficult to keep the conceptual model sufficiently tidy for the strategy mapping. In this case (and deviating from the suggested MARISCO colour code), strategies were written on blue cards and put on a transparent overlay placed over the paper model. This useful overlay meant reverse arrows could be drawn between strategies and other elements of the conceptual model without causing permanent changes to the model itself.

Figure 54. Existing management strategies are placed close to the system elements that they are trying to influence. Here, the recommended hexagonal cards are being used for this task. Also, the conceptual model has been printed up as a large poster, which was prepared following the first workshop on vulnerability analysis.

Application procedure

Collect all existing strategies for delivery in the management area, including:

→ strategies that are being implemented at the moment;
→ strategies that are planned for the future (for example, as part of a management plan).

Write down all the existing strategies on cards. Additional information on existing strategies such as costs, responsibilities, etc. can also be included. Any strategy that is not being implemented should also be analysed and documented.

Once this task is complete, strategy titles are written down on yellow moderation cards (one strategy per card), which are then inserted into the conceptual model alongside the appropriate threats and their contributing factors. To complete the process, the strategy cards are linked to the threats and contributing factors using lines and arrows.

Example

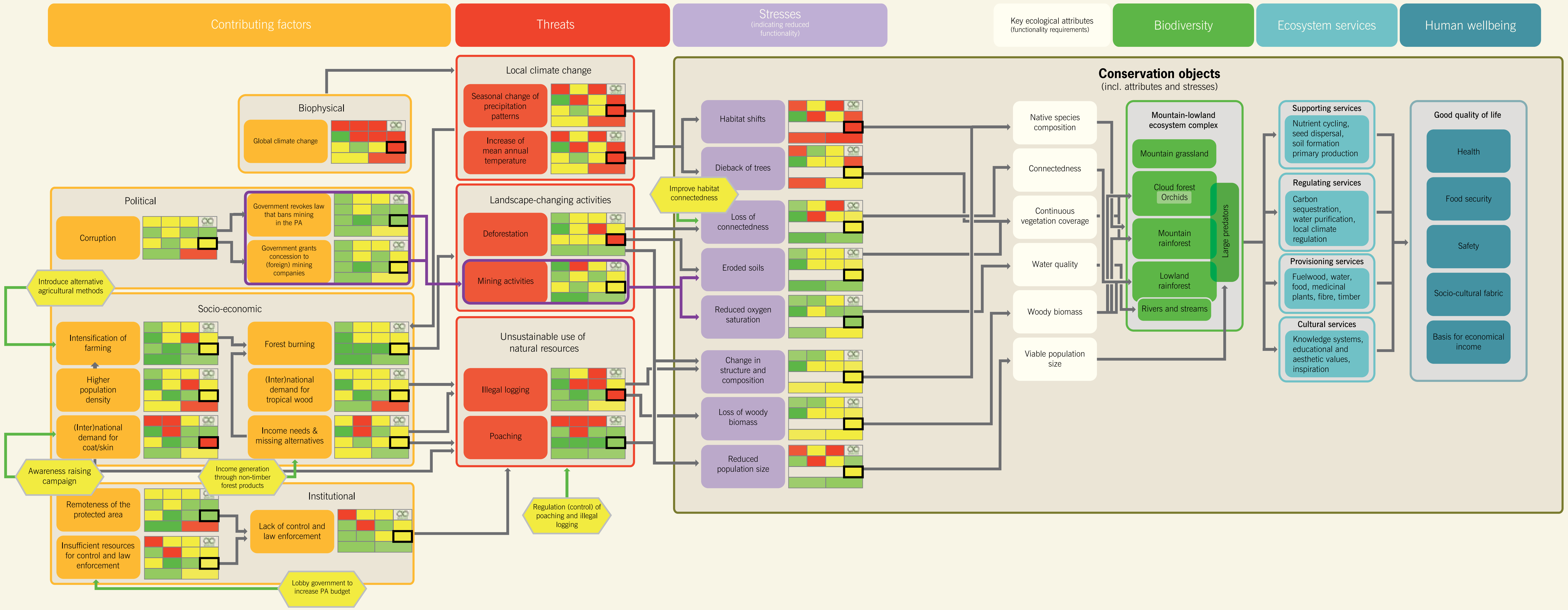


Figure 55. MARISCONIA: Strategies.
MARISCONIA is an imaginary conservation site where MARISCO is being applied. The existing strategies of the imaginary conservation site are added to the conceptual model and are connected to the elements – contributing factors, threats and stresses – that they are aiming to positively influence.

18. Assessment and prioritisation of existing strategies

Rationale for this step

Often strategies are put in place and carried out without any follow-on assessment of their feasibility and potential impact. Often, the requirements of the daily working routine do not allow for a detailed assessment of existing strategies because, for example, certain criteria are not considered or are not analysed with the necessary distance. This can lead to 'blind spot' management where practitioners have little understanding of the effectiveness of the strategies.

An evaluation of existing strategies helps:

- → to adjust the strategy design and prioritise from the portfolio of existing strategies, improving effectiveness and robustness, and
- → to avoid negative effects caused by the implemented strategies which remain unforeseen without proper reflection.

The evaluation includes two types of risk assessment:

- → an analysis of the potential failure of strategies due to existing/probable threats/risks; and
- → an analysis of risky (unwanted, hardly foreseeable) outcomes generated through implementing the strategy.

What you need

- → The conceptual model, as developed so far.
- → A list of existing strategies and some knowledge about each of them.

Application procedure

Each strategy is evaluated for both feasibility and potential impact factor through a stepwise approach. The results are documented in the form of an evaluation matrix, as shown below.

Existing strategies are best evaluated through a peer-review process carried out with external reviewers to encourage a more balanced and objective perspective. Usually, if the existing strategies are analysed by the same team that has developed or is implementing them, the evaluation results are not sufficiently objective – pre-existing assumptions get confirmed and conflicts and mistakes may not be given full consideration. However, even internal review opens up opportunities for self-reflective analysis among the teams generating strategies, and this improves the detection rate of risks that might otherwise go unrecorded.

1. Feasibility

Feasibility describes the degree to which a strategy is likely to be implemented under the prevailing conditions in the management area. It is related to the available resources but also to risks, restrictions and conflicts.

a) Necessary resources

The implementation of a strategy requires different kinds of resources, including financial, personal, time and knowledge resources. At this stage in the evaluation process, the resource availability for the implementation of the strategy is evaluated. To do this, use the selection categories set out in the following table.

No resource problems = 4	Some resources available = 3	Only limited resources available = 2	Not enough resources = 1
There are sufficient financial, personal, time and knowledge resources within the managing institution to implement the strategy.	There are some resources to at least partially implement the strategy, and it is likely that additional resources will be forthcoming.	There are only a few limited resources available for implementing the strategy, and only very small-scale and fairly isolated activities can be carried out. It will be difficult to obtain additional resources.	There are not enough resources within the managing institution to implement the strategy, and it is unlikely that additional resources can be obtained.

Table 22: Selection categories for ‚Feasibility: necessary resources'

b) The level of acceptance from relevant stakeholders

Usually, a conservation strategy affects one or more stakeholder(s), and the successful implementation of a strategy is directly dependent on the willingness of stakeholders to accept it.

All the relevant stakeholders who are affected either negatively or positively by the strategy or can support or hinder its implementation are identified and listed. It is important to take into consideration both the positive and negative effects of a strategy.

Once all stakeholders have been identified, the next step is to evaluate their levels of acceptance towards the strategy according to the categories defined in Table 23 below.

In the context of addressing the acceptance of stakeholders, developing worst-case scenarios can prove worthwhile:

- → What could happen when implementing the strategy that would negatively affect stakeholders?
- → What might cause stakeholders to act differently than expected?
- → What kinds of interactions between different stakeholders might generate unexpected changes in attitudes or actions?

Very good acceptance = 4	Good acceptance = 3	Rather low acceptance = 2	Extremely poor acceptance = 1
The strategy is accepted by (almost) all of the relevant stakeholders.	The strategy is accepted by a major part of the relevant stakeholders.	The strategy is supported by a minor part of the relevant stakeholders, but there is no rejection.	The strategy is supported by only a few of the relevant stakeholders and is rejected by most of them.

Table 23: Selection categories for ‚Feasibility: level of acceptance"

Figure 56. Strategies are evaluated according to the criteria and categories mentioned in the text. It has been shown that visualising evaluation decisions with coloured paper or stickers is useful.

Figure 57. Knowledge about existing strategies, their strengths and weaknesses, and their relevant stakeholders, is documented by labelling certain categories with specific colours or written text. In this way, working group results are permanently and visibly displayed on the walls and represent inputs for the planning exercise. If the workspaces are sufficiently large, the workshop's dynamics and delegate concentration levels can benefit from physical moving from one poster to another.

If necessary, specify different stakeholders who may be especially relevant and whose acceptance is crucial for the strategy. Then either insert the comments to this regard in the evaluation table, or evaluate the different stakeholders separately.

Very high = 4	High = 3	Medium = 2	Low = 1
It is highly likely that the strategy can make use of existing or arising opportunities such as additional resources or external support.	It is quite probable that the strategy can make use of existing or arising opportunities such as additional resources or external support.	It is not very probable that the strategy can make use of existing or arising opportunities such as additional resources or external support.	It is highly unlikely that the strategy can make use of existing or arising opportunities such as additional resources or external support.

Table 24. Selection categories for 'Feasibility: probability of benefiting from external factors'

c) The probability of benefiting from external factors (especially opportunities)

The successful implementation of a strategy is not solely reliant on the capabilities of the management team, as external factors can also play an important part. Sometimes there are opportunities that can favour or support the implementation of a strategy.

For example, these can include political factors such as new laws or state programmes with a favourable focus. Other factors can be related to additional funding or other institutions tackling similar problems.

At this stage of the process, the probability of the occurrence of such opportunities that benefit the implementation of the strategy is assessed using a rating system. The selection categories to be used are set out in Table 24 below.

Specify relevant opportunities or resources, then insert the comments to this regard in the evaluation table.

d) Probability of harmful risks

External factors not only provide possible opportunities for the successful delivery of a strategy but may also act in a negative way by posing risks to its effectiveness.

For example, harmful risks of this nature might be an insecure political situation, the unexpected cancellation of already confirmed funding, the occurrence of an extreme weather event, or unfavourable economic investments.

Where risks are identified, they need to be classified according to both the probability that they will occur and the expected potential magnitude of their impact. Table 25 below provides appropriate selection criteria that constitute the most relevant combinations of these two basic characteristics of risk.

In the context of addressing harmful risks for the strategies, it is recommended to develop worst-case scenarios that discuss the threats and risks identified in the conceptual model, and that also go beyond the

Unlikely to be affected by risks = 4	Probably not threatened by risks = 3	Probably threatened by risks = 2	Extremely threatened by risks = 1
There is (almost) no probability of risks that (could) complicate the implementation of the strategy.	There is a low probability of risks that (could) somewhat complicate the implementation of the strategy.	There is a high probability of risks that (could) complicate or even hamper the implementation of the strategy.	There is a high probability of risks that (could) significantly hamper the implementation of the strategy or even make it completely ineffective.

Table 25. Selection categories for 'Feasibility: probability of harmful risks'

model, asking which problems would theoretically be harmful for the strategies and what the likelihood is of these problems occurring.

Capture the relevant risks you identify, then insert comments to this regard in the evaluation table.

e) Adaptability to change

Uncertainty and unexpected changing circumstances present ongoing challenges for a management team and flexible responses and adaptive strategies are required. A strategy that easily adapts to these changes supports the overall risk and vulnerability management of the conservation site.

Strategies that, for instance, involve the construction of buildings or other one-time investments are often less adaptable than 'soft' strategies, e. g. those related to communication.

In the next stage of the process, the adaptability of the strategy is evaluated. Table 26 below provides the selection criteria for evaluating strategies.

Very adaptable = 4	Somewhat adaptable = 3	Not adaptable without significant additional resources = 2	Poorly adaptable, if at all = 1
The adaptation of the strategy to changing circumstances or unexpected events can be easily achieved without any additional resources.	a) The adaptation of the strategy to changing circumstances or unexpected events is likely to be achieved with some additional resources.	The adaptation of the strategy to changing circumstances or unexpected events could possibly be achieved, but significant additional resources will be needed.	The strategy is (possibly) not adaptable to changing circumstances or unexpected events.

Table 26. Selection categories for
'Feasibility: adaptability to change'

2. Impact

The impact of a conservation strategy is measured by the effects and changes both within and outside the designated management area that can be attributed to the strategic action, and that directly or indirectly generate consequences for the conservation objects. Positive impacts are related to the maintenance or improvement of the status of the defined conservation objects. Negative impacts are those leading to increases in stresses, threats and/or their negative contributing factors.

In the context of addressing the potential impacts of the strategies, it is recommended to develop worst-case scenarios based on assumptions about undesired collateral consequences. Ask the following question:

→ What could cause the strategies to generate impacts different to those desired?

And, importantly, remember:

→ **to avoid wishful thinking. Something that needs to be successful may not necessarily be successful;**
→ **to try to act as a devil's advocate;**
→ **Murphy's Law: 'anything that can possibly go wrong, does'.**

Capture the relevant problems you identify, then insert comments to this regard in the evaluation table.

a) The causation of social, political and institutional conflicts

The willingness of stakeholders to engage in the strategy implementation process is a crucial, as is the impact the strategies can have on the wellbeing of a local community. Not all impacts are considered to be beneficial as certain conservation objectives can conflict directly with stakeholders' socio-economic interests – e.g., by affecting livelihoods or the quality of social relationships. Conservation strategies might even increase existing conflicts between stakeholders or create new ones. Such conflicts can add to the vulnerability of a management programme.

The next stage in the assessment of strategies involves the evaluation of the probable social, political and institutional conflicts (benefits and negative impacts) likely to arise after the strategy has been delivered (e.g., land/tenure rights, subsidies, incentives, etc.). Table 27 below provides the selection criteria for the evaluation.

b) The causation of new risks that increase the vulnerability of conservation objects

Nearly all of your strategies might be based on partly faulty assumptions, which will only become evident in the course of implementation. This carries the potential to throw up unforeseen impacts, including biophysical damages in the management area or even direct harm to biodiversity objects.

Some examples of this are: the establishment of a breach along the border of a protected area for demarcation or control purposes that could lead to an increased fire risk or better accessibility for actors who harm biodiversity; the use of biological agents for controlling certain pests that develop negative impacts in other non-pest species; or the installation of physical barriers for protection against coastal erosion that may change water currents and create damage elsewhere.

The next stage of the evaluation attempts to capture and assess the existing or potential damage to biophysical factors in the designated area. Table 28 below provides the selection criteria to carry out this stage of the evaluation.

c) Synergies with other strategies

Carefully constructed strategies are designed to work in an integrative way with other objectives and activities within the planned area. Synergistic effects are the result of a careful planning process that actively strives for coherence in implemented strategies. The consideration of possible synergistic effects between concurrent strategies is a crucial part of (conservation) planning.

For example, a strategy that promotes the social and political organisation of local communities can develop

Very low risk of conflict generation = 4	Medium risk of conflict generation = 3	High risk of conflict generation = 2	Very high risk of conflict generation = 1
There is no or almost no probability that the strategy will give rise to any conflicts between different stakeholder groups.	It is possible that a certain amount of conflict will be generated between different stakeholder groups and that this will have the potential to influence the conservation project/site.	It is fairly likely that relevant conflicts between different stakeholder groups will be generated and that these will have the potential to influence the conservation project/site.	It is (almost) certain that relevant conflicts between different stakeholder groups will be generated, and that these will influence the conservation project/site.

Table 27. Selection categories for 'Impact: creation of social, political and institutional conflicts'

significant synergies with communication strategies or the enforcement of legal regulations.

The following step is designed to evaluate the synergies of a strategy against the criteria set out in Table 29 below.

d) Conflicts with other strategies

At another level, conservation strategies may, when deployed, act against other strategies leading to an overall reduction in the effectiveness of a strategic programme. Existing and potential conflicts between different strategies should be assessed, and then any necessary changes to counter them must be made.

Low risk of increasing the vulnerability of conservation objects = 4	Medium risk of increasing the vulnerability of conservation objects = 3	High risk of increasing the vulnerability of conservation objects = 2	Very high risk of increasing the vulnerability of conservation objects = 1
There is no risk that the implementation of the strategy will contribute directly or indirectly to the conservation objects' vulnerability in the management area.	It is not very likely that the implementation of the strategy will contribute directly or indirectly to the conservation objects' vulnerability in the management area.	There is a high risk that the implementation of the strategy will contribute directly or indirectly to the conservation objects' vulnerability in the management area.	There is a very high risk that the implementation of the strategy will contribute directly or indirectly to the conservation objects' vulnerability in the management area.

Table 28: Selection categories for 'Impact: risk of increasing the vulnerability of conservation objects'

Very high probability of synergies with other strategies = 4	High probability of synergies with other strategies = 3	Medium probability of synergies with some strategies = 2	Low probability of synergies with other strategies, if at all = 1
The strategy is very likely to develop important synergies with several other strategies.	The strategy is likely to develop important synergies with some other strategies.	The strategy will possibly develop synergies with a few other strategies.	The strategy is fairly isolated and is not likely to develop any synergies with other strategies.

Table 29. Selection categories for 'Impact: synergies with other strategies'

Low probability of conflicts with other strategies, if at all = 4	Medium probability of conflicts with other strategies = 3	High probability of conflicts with other strategies = 2	Very high probability of conflicts with many strategies = 1
The strategy is unlikely to conflict with (almost) any other strategy being implemented in the management area.	The strategy might conflict (to a certain, but not problematic degree) with other strategies being implemented in the management area.	The strategy is likely to conflict with a number of the strategies being implemented in the management area.	The strategy is likely to severely conflict with a substantial number of strategies being implemented in the management area.

Table 30. Selection categories for 'Impact: conflicts with other strategies'

Conflicts exist, for instance, when one strategy aims to maintain certain species related to early-successional vegetation and another strategy fosters free-willed ecosystem development. A strategy that improves living conditions in the management area and leads to immigration would conflict with strategies targeting human population growth.

The following criteria presented in the Table 30 below assist with the evaluation of potential conflicts between existing strategies.

e) Threat abatement effectiveness

Threat abatement effectiveness describes the degree to which a threat is alleviated or avoided by implementing a strategy. It does not measure the efficiency of a strategy, which is the cost-effect ratio. The effectiveness of a strategy can also be measured in terms of accomplishing defined objectives or running of a project to schedule (e. g. produce information material, educate consumers, hold meetings) without necessarily abating threats (see also step '22. Results webs, goal and objective setting, monitoring design'). Therefore, this step invites a critical reflection of the real impact on threats.

Monitoring the effectiveness of strategies is a science in itself and depends on the identification of appropriate indicators. If applied within a workshop, this step is viewed as an opportunity to stimulate a critical discussion, rather than provide a highly quantified assessment, which normally cannot be achieved in the course of a few hours or days. Where resources permit, a detailed effectiveness analysis is desirable.

Table 31 below presents the appropriate criteria for carrying out an evaluation of the effectiveness of a strategy.

f) Direct increases in biodiversity functionality

Certain strategies are designed to directly enhance the functionality of a biodiversity object or at least restore it to an acceptable level of favourable condition. The next stage of the analysis attempts to assess the potential change in functionality of a biodiversity object that has been subjected to the actions of a strategy. Table

Very highly effective in treating threats = 4	Highly effective in treating threats = 3	Somewhat effective in treating threats = 2	Hardly effective in treating threats = 1
The strategy is very effective: it will result in the significant and sustainable reduction, or even eradication, of several threats.	The strategy is quite effective: it will result in the large-scale reduction of at least one threat.	The strategy is not very effective: it will only result in a minor reduction of a threat, and this may only be temporary.	The strategy is (almost) wholly ineffective: it will not even indirectly effect the reduction of threats.

Table 31: Selection categories for 'Impact: threat abatement effectiveness'

Very positive for biodiversity functionality = 4	Positive for biodiversity functionality = 3	A small and rather indirect contribution to biodiversity functionality = 2	Not measurably improving biodiversity functionality = 1
The strategy will safeguard or completely restore the long-term functionality of one or more biodiversity objects.	b) The strategy will contribute to the restoration or maintenance of one or more biodiversity objects' functionality.	The strategy will make a minor contribution to the conservation or restoration of one or more biodiversity objects.	The strategy is unlikely to contribute to the conservation or restoration of any of the biodiversity objects.

Table 32. Selection categories for 'Impact: increase of biodiversity functionality'

32 below provides appropriate categories for rating the impact of a strategy on biodiversity functionality.

g) The level of potential regret

Under certain conditions, strategies might not produce their intended impacts. Even so, they may generate some secondary positive effects, which means that the failure of a strategy does not imply a total waste of invested resources. In this case, the strategy is a no- or low-regret option.

For example, a strategy could focus the adaptation of a used forest ecosystem on an expected reduction of precipitation by closing drainage channels and retaining water. If precipitation does not then decrease as expected, the measure could still prove useful in terms of

reducing the forest's vulnerability and re-establishing more natural conditions. The strategy would represent a 'no-regret' option. In another example, a big visitor centre could be created to manage an expected significant visitor flow. Later on, when the actual visitor numbers turn out to be rather low, the investment of significant resources in unused infrastructure would be deemed a 'high-regret' option.

In the next stage of the assessment, the level of potential regret is evaluated using appropriate criteria provided in Table 33 below.

A full evaluation of all the components described in the previous sections constitutes an opportunity to critically reflect on the strategic portfolio. Using the scoring system for each of the evaluations, a ranking list is generated to help inform the process of reformulating strategies. However, the final prioritised list of strategies should be used intuitively and not automatically selected solely on the basis of the outcomes of the scoring system. There will, without doubt, be cases where certain core strategies score low on the scale but are patently fundamental to achieving the desired conservation goals. When a strategy scores low, it might be worth exploring complementary strategies that could support its effectiveness and/or feasibility.

In Table 34 below and section 19 following, a synoptic view is presented of the criteria and categories for evaluative strategy rating. Ideally, workshops would generate a table similar to that shown below in the form of a wall poster or hand-outs.

No-regret strategy = 4	Medium-regret strategy = 3	High-regret strategy = 2	Very high-regret strategy = 1
The strategy will create clear collateral benefits, even if the originally intended impact is not achieved	The strategy is likely to create some positive collateral effects, even if the originally intended impact is not achieved.	The potential level of regret is high. If the originally intended impact is not achieved, the strategy will not create (significant) positive collateral effects. The strategy will also be difficult to reverse and might end up wasting resources.	The potential level of regret is very high. If the originally intended impact is not achieved, the strategy will not create positive collateral effects. The strategy will be impossible to reverse in time and would clearly end up wasting resources.

Table 33. Selection categories for 'Impact: level of potential regret'

Table 34. Overview of selection categories for strategy rating

		Excellent	Good	Problematic	Poor
Feasibility	Necessary resources	**No resource problems = 4** There are sufficient financial, personal, time and knowledge resources within the managing institution to implement the strategy.	**Some resources available = 3** There are some resources to at least partially implement the strategy, and additional resources are likely to be obtained.	**Only limited resources available = 2** Only a few limited resources are available to implement the strategy, and only very small-scale and fairly isolated activities can be carried out. It will be difficult to obtain additional resources.	**Not enough resources = 1** There are not enough resources within the managing institution to implement the strategy and it is unlikely that additional resources can be obtained.
	Level of acceptance from relevant stakeholders	**Very good acceptance = 4** The strategy is accepted by (almost) all of the relevant stakeholders.	**Good acceptance = 3** The strategy is accepted by a major part of the relevant stakeholders.	**Fairly low acceptance = 2** The strategy is supported by a minor part of the relevant stakeholders, but there is no rejection.	**Extremely poor acceptance = 1** The strategy is supported by only a few of the relevant stakeholders and is rejected by most of them.

		Excellent	Good	Problematic	Poor
Feasibility	Probability of benefiting from external factors (especially opportunities)	**Very high = 4** It is highly likely that the strategy can make use of existing or arising opportunities such as additional resources or external support.	**High = 3** It is quite probable that the strategy can make use of existing or arising opportunities such as additional resources or external support.	**Medium = 2** It is not very probable that the strategy can make use of existing or arising opportunities such as additional resources or external support.	**Low = 1** It is highly unlikely that the strategy can make use of existing or arising opportunities such as additional resources or external support.
	Probability of harmful risks	**Unlikely to be affected by risks = 4** There is (almost) no probability of risks that (could) complicate the implementation of the strategy.	**Probably not threatened by risks = 3** There is a low probability of risks that (could) somewhat complicate the implementation of the strategy.	**Probably threatened by risks = 2** There is a high probability of risks that (could) complicate or even hamper the implementation of the strategy.	**Extremely threatened by risks = 1** There is a high probability of risks that (could) significantly hamper the implementation of the strategy or even make them completely ineffective.
	Adaptability to change	**Very adaptable = 4** The adaptation of the strategy to changing circumstances or unexpected events can be easily achieved without any additional resources.	**Rather adaptable = 3** The adaptation of the strategy to changing circumstances or unexpected events is likely to be achieved with some additional resources.	**Not adaptable without significant additional resources = 2** The adaptation of the strategy to changing circumstances or unexpected events could possibly be achieved, but significant additional resources will be required.	**Poorly adaptable, if at all = 1** The strategy is (possibly) not adaptable to changing circumstances or unexpected events.

		Excellent	Good	Problematic	Poor
Impact	Creation of social, political and institutional conflicts	**Very low risk of conflict generation = 4** c) There is no or almost no probability that the strategy will give rise to any conflicts between different stakeholder groups.	**Medium risk of conflict generation = 3** d) It is possible that a certain amount of conflict will be generated between different stakeholder groups and that this will have the potential to influence the conservation project/site.	**High risk of conflict generation = 2** It is fairly likely that relevant conflicts between different stakeholder groups will be generated and that these will have the potential to influence the conservation project/site.	**Very high risk of conflict generation = 1** It is (almost) certain that relevant conflicts between different stakeholder groups will be generated, and that these will influence the conservation project/site.
	Creation of new risks increasing the vulnerability of conservation objects	**Low risk of increasing the vulnerability of conservation objects = 4** There is no risk that the implementation of the strategy will contribute directly or indirectly to the conservation objects' vulnerability in the management area.	**Medium risk of increasing the vulnerability of conservation objects = 3** It is not very likely that the implementation of the strategy will contribute directly or indirectly to the conservation objects' vulnerability in the management area.	**High risk of increasing the vulnerability of conservation objects = 2** There is a high risk that the implementation of the strategy will contribute directly or indirectly to the conservation objects' vulnerability in the management area.	**Very high risk of increasing the vulnerability of conservation objects = 1** There is a very high risk that the implementation of the strategy will contribute directly or indirectly to the conservation objects' vulnerability in the management area.
	Synergies with other strategies	**Very high probability of synergies with other strategies = 4** The strategy is very likely to develop important synergies with several other strategies.	**High probability of synergies with other strategies = 3** The strategy is likely to develop important synergies with some other strategies.	**Medium probability of synergies with some strategies = 2** The strategy will eventually develop important synergies with a few other strategies.	**Low probability of synergies with other strategies, if at all = 1** The strategy is fairly isolated and is not likely to develop any synergies with other strategies.
	Conflicts with other strategies	**Low probability of conflicts with other strategies, if at all = 4** The strategy conflicts with (almost) no other strategy that is being implemented in the management area.	**Medium probability of conflicts with other strategies = 3** The strategy somewhat – but not problematically – conflicts with other strategies that are being implemented in the management area.	**High probability of conflicts with other strategies = 2** The strategy conflicts with a number of the strategies that are being implemented in the management area.	**Very high probability of conflicts with many strategies = 1** The strategy severely conflicts with a substantial number of strategies that are being implemented in the management area.

		Excellent	Good	Problematic	Poor
Impact	Threat abatement effectiveness	**Very highly effective in treating threats = 4** The strategy is very effective: it will result in the significant and sustainable reduction, or even eradication, of several threats.	**Highly effective in treating threats = 3** The strategy is quite effective: it will result in the large-scale reduction of at least one threat.	**Somewhat effective in treating threats = 2** e) The strategy is not very effective: it will only result in a minor reduction of a threat, and this may only be temporary.	**Rather ineffective in treating threats = 1** The strategy is (almost) not effective: it will not even indirectly lead to the reduction of threats.
	Direct increase of funtionality of biodiversity objects	**Very positive for biodiversity functionality = 4** The strategy will safeguard or completely restore the long-term functionality of one or more biodiversity objects.	**Positive for biodiversity functionality = 3** The strategy will contribute to the restoration or maintenance of one or more biodiversity objects' functionality.	**A small and rather indirect contribution to biodiversity functionality = 2** The strategy will make a minor contribution to the conservation or restoration of one or more biodiversity objects.	**Not measurably improving biodiversity functionality = 1** The strategy is unlikely to contribute to the conservation or restoration of any of the biodiversity objects.
	Level of potential regret	**No-regret strategy = 4** The strategy will create clear collateral benefits, even if the originally intended impact is not achieved.	**Medium-regret strategy = 3** The strategy is likely to create some positive collateral effects, even if the originally intended impact is not achieved.	**High-regret strategy = 2** The potential level of regret is high. If the originally intended impact is not achieved, the strategy will not create (significant) positive collateral effects. The strategy will also be difficult to reverse and might end up wasting resources.	**Very high-regret strategy = 1** The potential level of regret is very high. If the originally intended impact is not achieved, the strategy will not create positive collateral effects. The strategy will be impossible to reverse in time and would clearly end up wasting resources.

19. Visualise systemic relationships of existing strategies with other elements in the conceptual model

Rationale for this step

The visual analysis complements the strategic evaluation process described in the previous section. The process of visualising the actual or potential relationships of the strategies with other elements in the conceptual model provides a deeper understanding of the complex environments in which strategies are to be implemented, and may even lead to the identification of previously overlooked risks. New risks might be those that reduce the feasibility and effectiveness of strategies. Ideally, the visual analysis should be carried out alongside the evaluation of strategies.

What you need

- → Cards with existing strategies that are mapped in the conceptual model.
- → Whiteboard markers.
- → A transparent overlay sheet, or an additional printed conceptual model.

Application procedure

Place the transparent overlay sheet over the conceptual model. Begin with one strategy and systematically draw arrows that connect the strategy with other elements in the conceptual model, specifically: contributing factors, threats, stresses, and other strategies. The connecting arrows may be drawn according to the instructions given in Table 35. If not using an overlay, the visual evaluation can be performed on an separate printed poster of the conceptual model.

This procedure is systematically repeated for every strategy. The results are used for the revision of the strategy evaluation. After the visual evaluation the overlay is taken down.

Table 35: Instructions for the visual strategy analysis

Colour	Direction	Width
Red arrow = negative impact (creates or increases problem)	Ingoing arrow = strategy is impacted	Slim arrow = low impact
Green arrow = positive impact (reduces problem)	Outgoing arrow = strategy creates impact	Wide arrow = significant impact

EXAMPLE CONCEPTUAL MODEL »MARISCONIA«

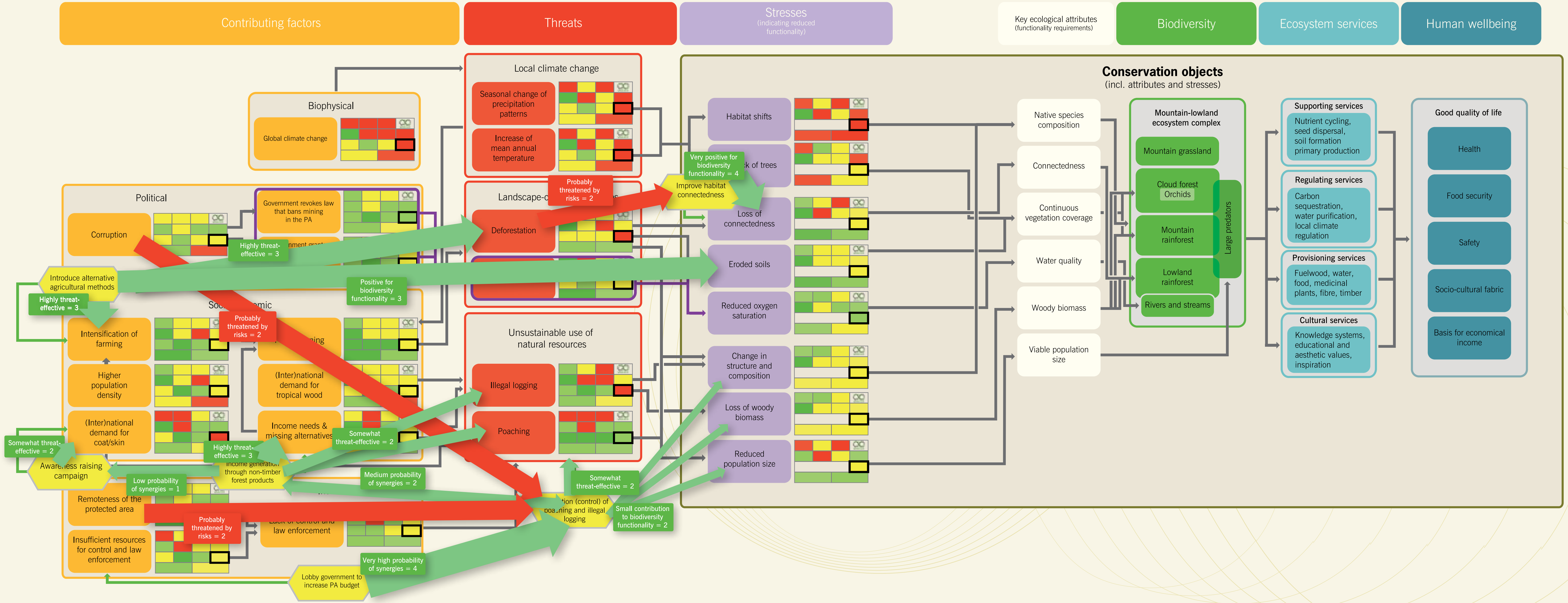


Figure 58. MARISCONIA: Conceptual model with evaluation results and visual strategy assessment.
MARISCONIA is an imaginary conservation site where MARISCO is being applied. Now, the strategies are evaluated according to plausible positive and negative impacts on elements in the system. Analysis is also conducted to ascertain if certain elements are potential risks to the effectiveness of the strategies.

Figure 59. An example of (climate-change-related: High intensity of rainfall in short periods of time; Increase of mean temperature) threats in a conceptual model with fairly high values of strategic relevance. Additionally, both knowledge and manageability have been rated low. This calls for the formulation of adaptation strategies and, eventually, for research-related strategies. The fact that a yellow sticker has been put on top of a red one illustrates that the team revisited and changed an earlier decision. It is important to encourage participants to suggest such changes whenever new evidence or interpretations become available.

20. Analysis and filling of strategic gaps: the development of complementary strategies

Rationale for this step

Once the strategies are mapped onto the conceptual model, the analysis of relationships between strategies and other elements embedded in the concept model is then more straightforward. The group is now tasked with discussing if all elements in the conceptual model with a high strategic relevance are adequately treated by the strategies. If there are any obvious gaps, the planning group can address these by modifying existing strategies or creating new ones. The visualisation exercise provides a clear picture and understanding of how strategies are interrelated and how they should work in synergy.

What you need

→ Existing strategies mapped onto the model.
→ Ranking lists of stresses, threats and contributing factors with values of strategic relevance, manageability and knowledge.

Application procedure

Identify the contributing factors, threats and stresses of high strategic relevance that are not addressed by existing strategies. Discuss if and what kind of strategies could be applied to address the critical elements. If deemed appropriate, formulate strategies that would allow for the reduction and mitigation of problems or for adaptation to risks. In the course of formulating the strategies, their manageability and knowledge assessment is taken into account. Less manageable elements call for adaptation strategies rather than change strategies. Strategies that address poorly understood elements could comprise investigative components or precautionary actions.

Figures 60 and 61 show discussions about existing strategies and their entry points in the conceptual models.

Figure 62. Brainstorming session for the identification of complementary strategies based around the conceptual models and tables with the rating results of the various elements in the model.

Figure 63. Complementary strategies have been identified and written on dark yellow hexagonal cards. In a moderated plenary discussion the proposals are then discussed and the number reduced. Many proposed strategies commonly turn out instead to be activities or sub-strategies and can thus be grouped under a few macro strategies. This is a first step towards producing a hierarchical structure of strategies.

21. Assessment and prioritisation of complementary strategies

Rationale for this step

The complementary strategies that have been formulated are then evaluated using the same criteria applied earlier to existing strategies. The aim is to anticipate as best as possible their potential effectiveness and feasibility.

Application procedure

Evaluate the modified and complementary strategies according to the methodology described on page 138 ff. Document the results in an evaluation matrix.

22. Visualise the systemic relationships of complementary strategies with other elements in the conceptual model

Rationale and procedure

This visualisation process applies the same objectives and procedure as that described on 153 ff. to the interactions among the different strategies and elements in the model, which should be assessed and illustrated.

23. The overall consistency and plausibility of strategies, the spatial requirements for strategy implementation, and the revision of the management scope and vision

Revise the consistency and plausibility of the overall strategy portfolio

Rationale for this step

This is the last revision of the model before the strategies are finally implemented. The model, which provides the foundation for the practical work as well as a steering instrument for the conservation planning process, requires a final check for consistency and plausibility before it is put into practice.

What you need

→ The latest version of the conceptual model.
→ The list of existing and complementary strategies.
→ The results of the strategy evaluation.

Application procedure

This final revision of the model should be conducted with the latest set of strategies comprising existing, adjusted and complementary strategies. For this process, both the conceptual model and the spatial analysis should be considered by the planning team.

For the final audit and revision of the strategic portfolio, it is important to complete the following tasks:

→ Ensure that all relevant elements or element groups in the model are covered by strategies. Compare the results with the map of the spatial analysis.

- Document and complete all interactions and linkages between the strategies and the elements respectively and between the strategies themselves.
- Identify any gaps that might have been overlooked during the process.

If necessary, adjust the strategies or elements in the model.

Understand the spatial requirements of an effective strategy application

Rationale for this step

As all conservation efforts target the areas of greatest change and human disturbance, it is important to be able to visualise existing and complementary strategies and any other measures taken to mitigate environmental problems in order to better analyse potential synergies, conflicts and new emerging properties that have been overlooked in the previous analysis. By including spatial analysis in the evaluation process, certain blind spots can be identified and a clearer picture of the situation emerges. This analysis will contribute to more concrete plans and spatially explicit measures.

What you need

- The map with the spatial analysis of the biodiversity objects, threats and stresses.

Application procedure

Transfer the information contained in the current strategy portfolio of existing, adjusted and complementary strategies onto the map containing the spatial analysis of biodiversity objects, contributing factors, threats and stresses. For ease of understanding, it is helpful to adopt the same colour-coding scheme for index cards as was used previously.

Ideally, the maps should help with assessing the geographically explicit state of functionality of biodiversity objects. You will need to ask:

- Where are objects?
- In sites where existing stresses are concentrated, where are threats and potential future risks located?

If there are sufficient resources, it is recommended to create spatial indices for ecosystem functionality using appropriate indicators based on available information.

You will need to ask:

- Where are the spatial priorities if good functionality is targeted?
- Where are the priorities if minimum or maximum concentrations of threats are the focus?[XXVIII]

Revise the scope and vision for the management area

Rationale for this step

The management scope and vision should be aligned with the strategy portfolio because they provide guidance and a focus for the management team. After conducting both a detailed situation analysis and the comprehensive evaluation and review of management strategies, it is likely that certain aspects of the former planning/project assumptions will have changed. As such, the initial 'scope of management' vision should be readjusted to these new circumstances or findings.

What you need

→ The initial 'scope of management'.
→ The management vision.

Application procedure

Revise the management scope according to the results of step 23 ('spatial requirements of strategy implementation'). Reflect on the current limits of the scope and consider the spatial needs for each strategy.

Useful guiding questions for this discussion are:

- Does the projected management scope include all the areas that are essential for the strategies to be implemented on site?
- If not, is it reasonable and possible to enlarge the scope?

If you change the scope, document the new limits in the existing map.
When revising the vision statement for the management plan, it is important to discuss whether it is realistic or whether some aspects – or even the general orientation of the management plan – have changed or require changing. In the evaluation, consider institutional and vulnerability aspects, as well as spatial criteria.

24. Results webs, goal and objective setting, monitoring design

a) Results webs

Rationale of this step

The purpose of results webs is to demonstrate the complex interrelationships existing within biodiversity that may require an indirect approach to problem solving. Results webs help improve our understanding of the appropriateness and consistency of strategies.

Creating results webs makes operational planning more effective. It also helps the project team to identify concrete activities to be carried out and to make decisions on any necessary subsequent action to be undertaken. Strategies are intentional operational activities designed to correct and restore the function of a system following a negative impact brought about by human disturbance.

As explained above, the conservation of biodiversity objects aims to change or eliminate threats – and even the factors that contribute to causing threats – in order to recover or safeguard the status of the biodiversity object. Any strategy that does not have a direct effect on conservation objects but, instead, influences them indirectly is based on assumptions made from postulating chains of change in the system. These 'if-then' assumptions must be understood and analysed to detect any inconsistencies in logical deduction or to identify unrealistic postulates.

All too often, planning teams propose strategies before reflecting fully on the assumptions made. As a result, scenarios are presented before the cause-effect end points have been carefully considered, which can lead to disagreements about the effectiveness of proposed strategies. In nearly all cases encountered in conservation, it is unlikely that the impact of a strategy can be predicted with any accuracy because of the complex nature of ecosystems. Many elements may react in an unexpected way or new factors and feedback loops might appear.

Results webs can help us to understand the nature of ecosystems, and particularly their inherent uncertainties. They also provide appropriate conceptual models for predicting the change that management strategies bring about in a system. As such, they enable managers to identify potential blind spots and reduce avoidable risk.

In some cases, the outcomes of a results web analysis may lead to the conclusion that existing or future strategies are unlikely to change the situation. In this case, the strategic portfolio would have to be redesigned.

What you need

- → Conceptual model including final set of strategies.
- → Large sheets of paper.
- → Blue and purple rectangular cards.

Application procedure

1. Constructing results webs

Results webs are drawn up on a blank sheet of paper that is pinned to a new board or wall, preferably alongside the existing conceptual model. The process starts by selecting a strategy from the conceptual model, copying the strategy statement on to a new yellow card, and then placing it on the left-hand side of your new results-web sheet. Now, translate the contributing factors or threats likely to be influenced by the strategy into assumed outcomes, reformulating them as positive results. Document each result/outcome on a blue moderation card. With the assumed chains of results that are predefined by the systemic relationships in the conceptual model, the corresponding results would have to be presented as 'if-then' relationships.
For example, an educational campaign would result in increased awareness among certain members of a stakeholder group. Raising stakeholders' awareness about the environment would change their attitudes or habits and lead to a desired outcome for a given biodiversity object.

Continue working systematically through the process to convert all contribute factors and threats on the left-hand side of the sheet into assumed outcomes. During the course of the activity, it is possible that other elements not thought of earlier are identified. These will need to be included in the results web.

During the construction of the 'if-then' results webs, a decision might be made to include other strategies in the web before the final strategy portfolio is deemed to be complete. However, it is best to start the analysis with simple results chains before creating more complex webs. To reflect good practice, any form of process self-evaluation should be recorded on a card and placed on the concept board alongside the strategies. As the results webs are a means of recording the team's ideas regarding the effectiveness of their strategies, this step also prepares the way for the design of an effective monitoring system.

Some strategies can represent key or 'milestone' strategies that need to be put in place before any further steps are taken.

The construction of a results web is intended to facilitate the next stages in management (including results webs operational planning) as well as help decide on the type of activities to carry out and the order in which these should be implemented. Any information generated at this stage in the process must be documented on new cards and placed next to the strategies.

Figure 64. A generic visualisation of a results chain running from intermediate result to threat and stress reduction results. In real conservation situations, diverse elements interact complexly and the corresponding interconnected 'result chains' are, in fact, results webs.

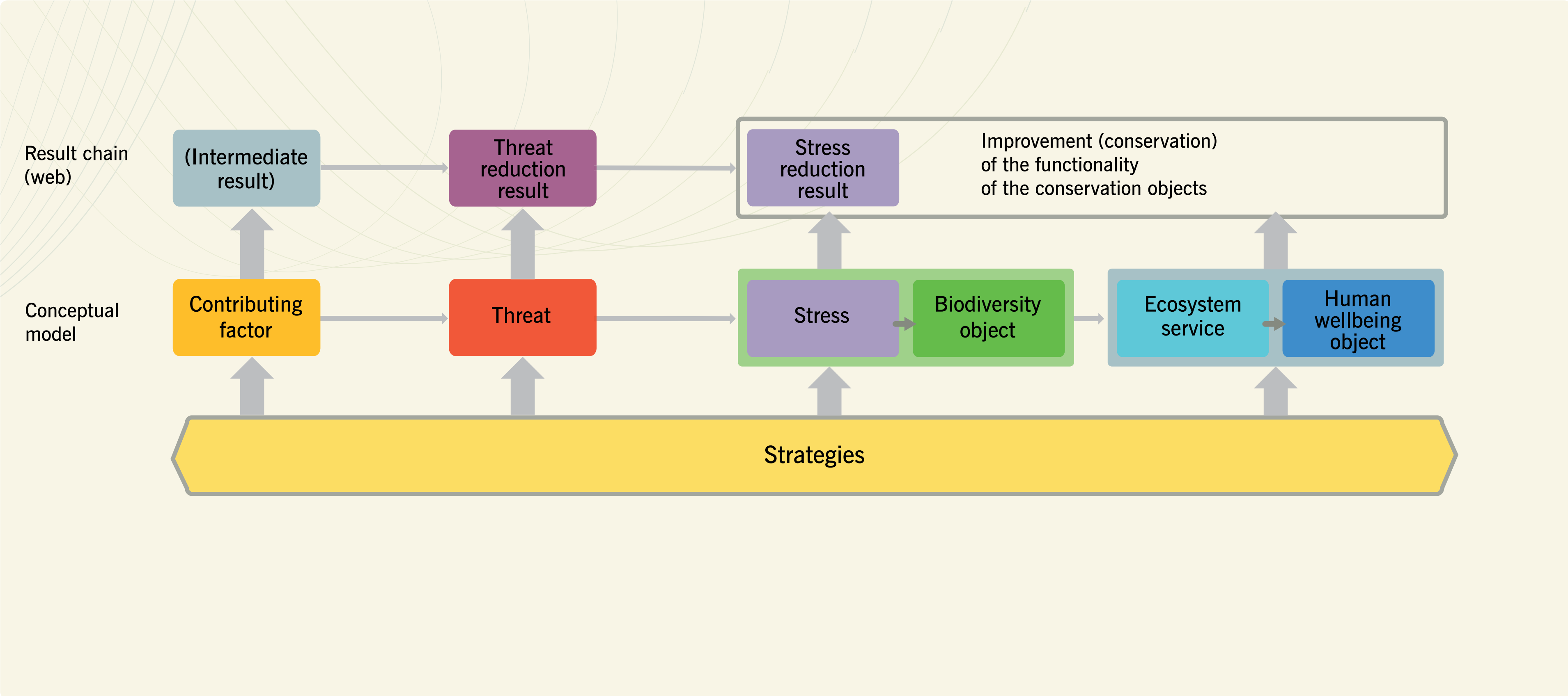


Figure 65. Creation of a results web that includes feedback loops of expected results. The pink circles show where the team feels that indicators are needed for monitoring to be successful.

The risk of insignificant action

Results webs are also recommended for the quantification of required measures, which can also support further planning and even reduce the risk of proposing strategies that are unlikely to achieve a critical mass of results. Consider this example: A managed park covering one million hectares suffers an annual deforestation rate of 2,000 hectares. The strategy for the park only allows for cooperation with 100 farmers who jointly clear 90 hectares per year. On top of this, only 30 families adopt more sustainable agricultural practices. In this example, the risk is that the action is simply not significant enough to create change.

Ideally, in the results web, the suggested and expected changes are correspondingly quantified and critically considered. To this end, the scale of problems must be assessed (e. g., How much deforestation?) and the results quantified accordingly (e. g., How much deforestation needs to be prevented each year? How many farmers would have to change their practices? How many farmers will have to be addressed by the strategy? etc.). In practice, this would mean working from the right to the left in the results-web sheet. If this leads to strategies that appear too expensive or unfeasible, they must be redesigned.

b) Goal and objective setting

The next stage in the process is to formulate goals for all the conservation objects, especially the biodiversity objects. Each biodiversity object may be allocated a goal but, where the situation allows, strategies must be produced for groups of objects or subsystems containing clusters of biodiversity objects. It is important to remember that goals must be impact oriented, measurable, time limited, and specific.

For any conservation goal to be effective, all its associated conservation objectives should correspond to threats and their contributing factors. At the same time, all objectives should be designed to be results oriented, measurable, time limited, specific, and practical.

Figure 66. MARISCONIA: Results web based on the conceptual model.
MARISCONIA is an imaginary conservation site where MARISCO is being applied. The yellow hexagons represent the strategies that need to induce positive change. The change logic is reflected by the expected intermediate results that should lead to the reduction of threats and, finally, stresses. The figure represents a simplified results web and, therefore, does not visualise strategies and results for all stresses/conservation objects. In this particular example, after completing the visual revision and validation of the strategies, an important gap related to climate change and forest fires became apparent. As a result, additional strategies were introduced.

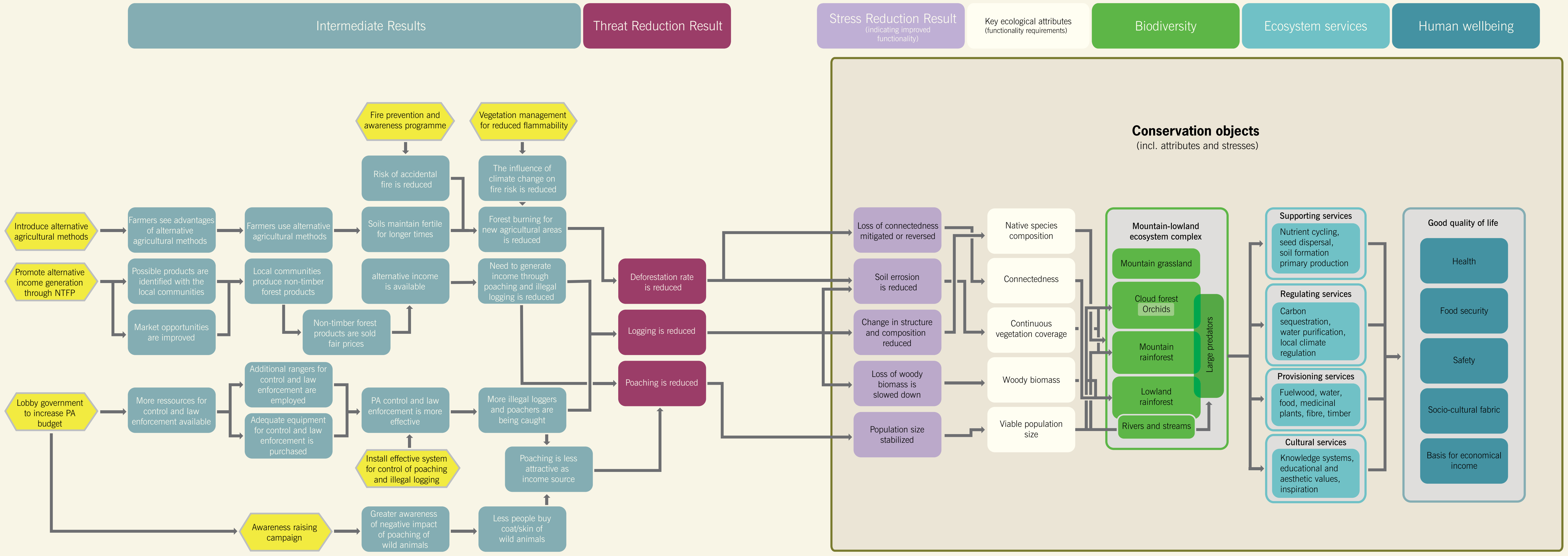
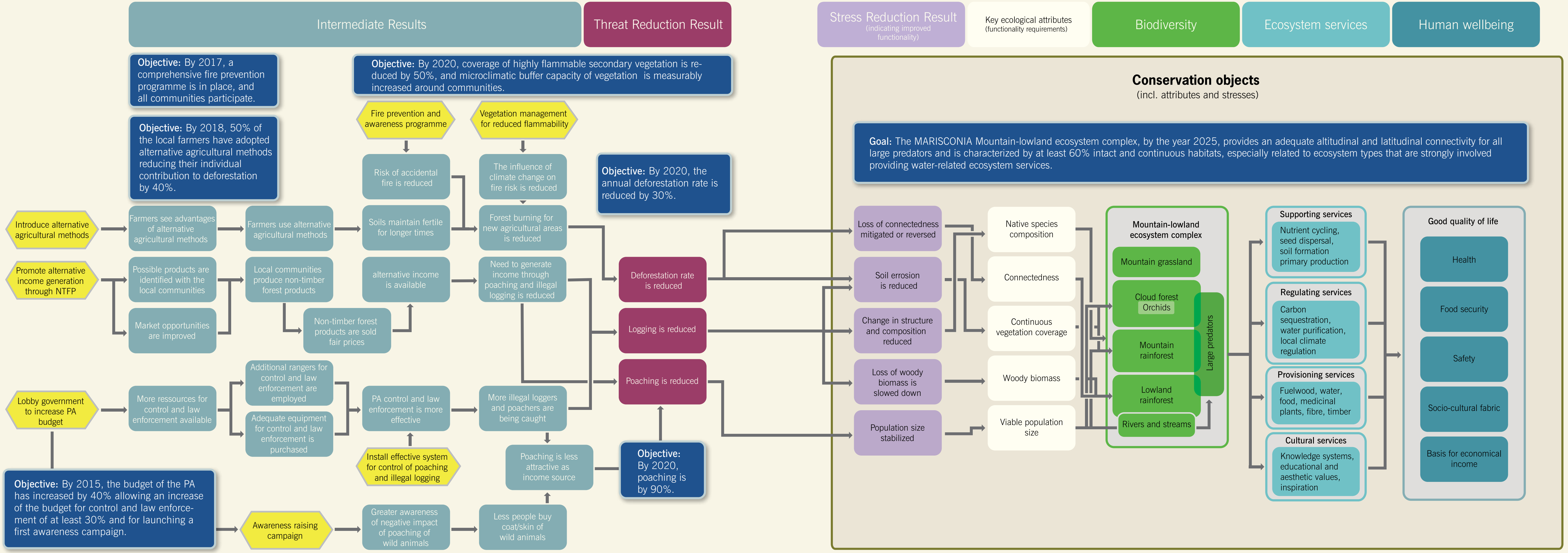


Figure 67. MARISCONIA: Results web with exemplary conservation goal and objectives. (MARISCONIA is an imaginary conservation site where MARISCO is being applied.)



c) Monitoring design

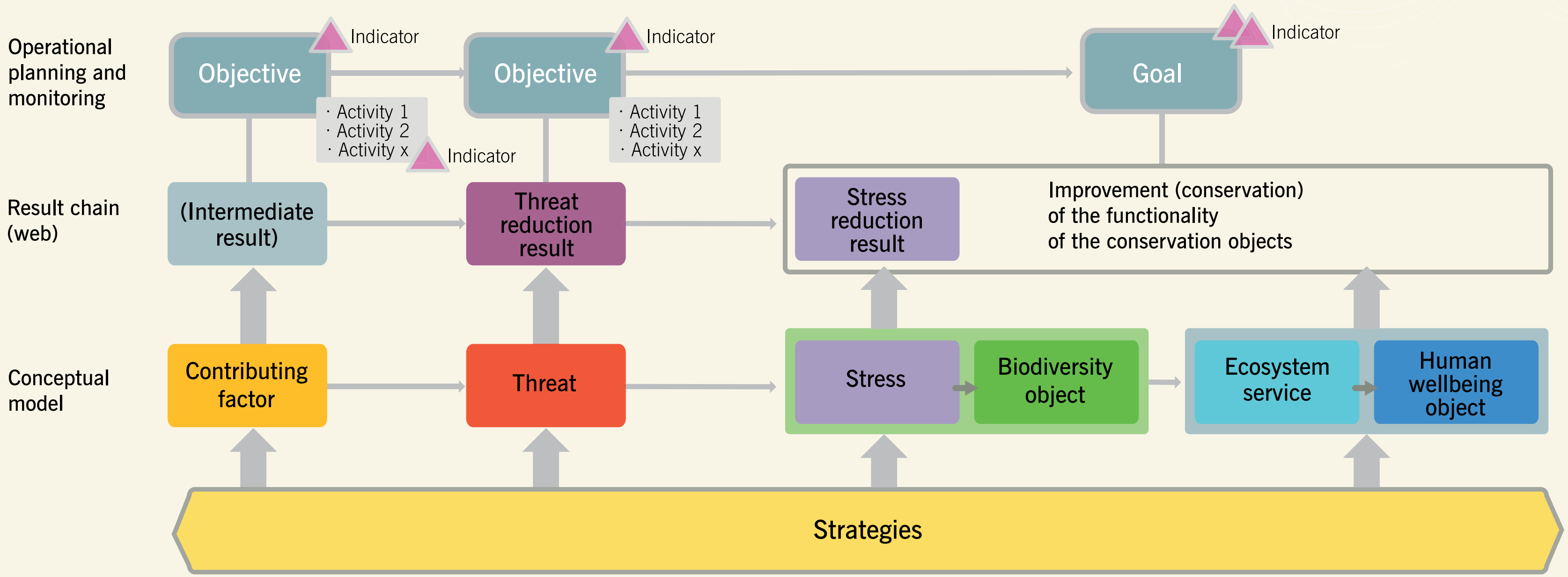
Rationale for this step

Within adaptive management, monitoring provides the basis for learning and the purposeful adaptation of your underlying concept. In other words, a sound monitoring design helps to control the (desired or otherwise) outcomes of a strategy, even where other measures have to be taken in order to achieve the desired impact on the biodiversity objects. The results webs developed in the previous step lay the ground for target-oriented learning.

What you need

→ Results webs
→ White moderation cards
→ Flipchart

Figure 68. Result chain with conservation goal and objectives as well as indicators



Application procedure

1. Definition of indicators related to the results webs

As a minimum, develop indicators for impact monitoring and also maybe process monitoring. The role of these impact indicators is to inform the managers about the meeting of objectives and goals. Formulate at least one indicator per objective/goal.

The S-U-M criteria for good indicators

Sensitive: The change in indicator values must consistently correlate with changes in the condition to be controlled, without any changes over time.

Unambiguous: It is clear from the evidence and understanding that the indicator relates directly to the condition to be managed.

Measurable: It must be possible to take reliable readings with reasonably simple and cost-efficient equipment or methods.

---

2. Define indicators for further information needs

If further information is needed beyond that provided by monitoring the objectives of the results webs, then additional indicators need to be incorporated into the model.

3. Complete the monitoring plan

Transfer the indicators (including the indicators from the functionality analysis of biodiversity objects in step 5) into a table and complete the monitoring plan with the following information for each indicator:

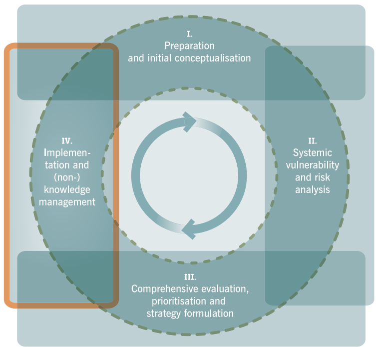
- Monitoring method: How will you measure the indicator/which method will you use?
- Responsible person: Who will do the measurement?
- Time: When will you collect the data and at what time intervals?
- Place: Where will you collect the data or take the measurement?

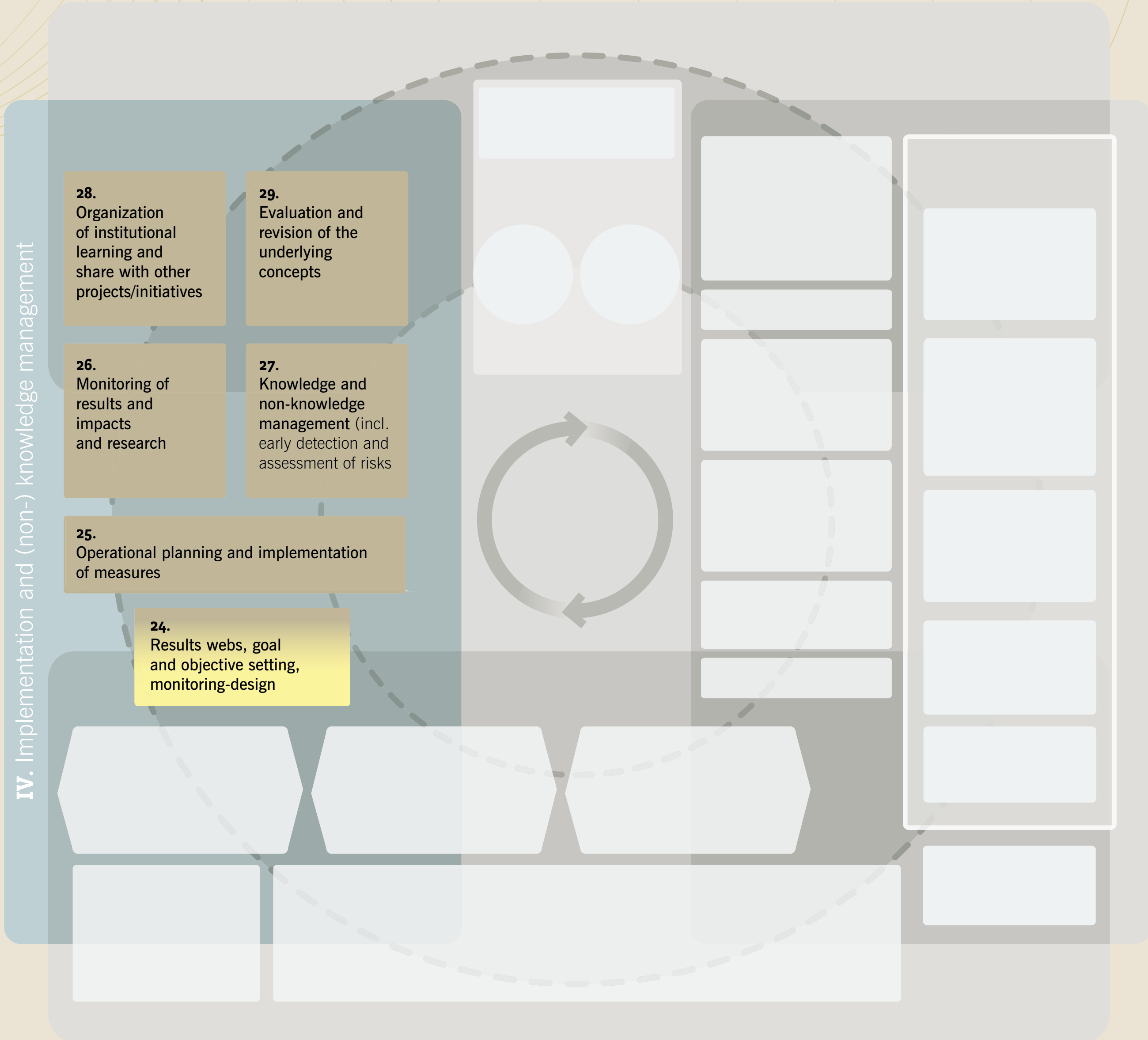
For an example of this, see Table 36 below.

Table 36. Example table for a monitoring plan

Indicator	Method	Who	When	Where
Example				
Example				
Example				

IV. Implementation and (non)knowledge management[26]





[26] Authors: P.L. Ibisch, L. Geiger, D. Aschenbrenner and P.R. Hobson

Rationale, objectives, input and output of this part of the exercise

The steps implemented so far represent an important part of an initial knowledge management exercise carried out at a conservation site. By taking these steps, it has been possible to structure the existing knowledge from various sources and improve understanding within the project team of the complex system to be managed. The acquired knowledge has been translated into a consistent and risk-robust strategy portfolio. In the fourth MARISCO phase, the strategy portfolio is implemented. All too often in conservation practice, managers tend to delegate knowledge management to researchers or to planners who, from time to time, update the management plans. The idea that good management must embrace effective knowledge management is still, it seems, undervalued.

In adaptive management, it is important to track the implementation of activities by gathering relevant information and knowledge, and also to evaluate the information gathered and ensure it is appropriate for the purposes of a goal-oriented adaptation of the underlying concept. The unpredictable nature of managing within complex systems requires vigilance and there is a need for ongoing evaluation and adaptation throughout the management period.

The evaluation process ensures that the knowledge management system is fit for purpose and provides the relevant information and knowledge for further (management) purposes.

It is also important to consider the aspect of systematic learning and experience sharing. The exchange of knowledge and experience with peers in the conservation community is crucial to ensure continual improvement in conservation practice.

The concrete objectives of this phase are to:

- → **put the planned measures into practice and to monitor their implementation;**
- → **organise knowledge management within the organisation responsible for managing the project site;**
- → **initiate a process of inter- and intra-institutional learning;**
- → **evaluate and revise the underlying concept.**

Input	Output
Strategies and activities.	An operational plan that guides the implementation of measures.
Resources of the managing entity (time, staff, money, labour), and maybe even additional resources.	Monitoring results and knowledge about the effectiveness of strategy implementation.
Knowledge about the managing entity.	Institutional structure for sound knowledge management.
Knowledge about the managing entity	A process of organisational learning (inter- and intra-institutional) is underway.
Knowledge about the managed system.	A revised conceptual model based on the evaluation of monitoring results and results from organisational learning, etc.

Steps

25. Operational planning and implementation of measures

This next step describes the implementation of the strategies and activities defined in the previous part. Before embarking on this stage of the project, the strategies and activities are converted into practical and concrete tasks. To do this, the required resources – time, money, labour and others – and the specific responsibilities within the managing entity must be defined. Preparations should also include an assessment of resources that are not yet available and that need to be put in place in order to execute tasks properly. A broad range of good practice guidance for operational planning already exists and can be used to support this process – a specific example being the Open Standards and its supporting 'MIRADI' software, which offer a detailed guide to operational planning. It is important to continue with the logic of the conceptual model and the results webs in order to maintain the consistency and coherence of the plan and actions taken.

26. Monitoring of results, impacts and research

The ongoing monitoring of operational activities is considered to be an important part of documenting and measuring the outcomes and desired effects of the strategy. The whole process of monitoring is planned and documented through the monitoring plan described and developed in step 24.

Apart from implementing measures and monitoring activities, another important task is closing the knowledge gaps that appeared during the conceptualisation and planning phase. This is achieved by designing, implementing and/or delegating structured and directed research. The object of this exercise should be to preserve the logical structure and flow of the conceptual model by identifying all recognisable gaps or blind spots. The results of the threat/factor rating for 'Knowledge' provide a good starting point. However, it is important not to get too carried away with tracking the ramifications of one investigated element. Instead, it is better to find a good balance between resource input and knowledge. Space should be left in the model diagram in case additional information surfaces at a later stage. Consider that monitoring is derived from the Latin word monere, which means remind, warn or alert. A good monitoring system acts as an early-warning system, informing managers about significant changes in the system, potential strategy failures and the loss of functionality in the conservation objects. Ideally, the system begins monitoring problems before they manifest or become significant, which requires early risk horizon-scanning. Risk search and recognition is very much related to the management of (non-)knowledge – which is, in fact, the next step in this process.

Figure 69. A key monitoring task is the time-consuming compilation and documentation of data. Often, monitoring systems are not implemented due to a lack of resources or a lack of documentation habits. Looking ahead, monitoring implementation and risks will be made easier through modern, user-friendly mobile applications for on-site documentation. The applications will include options for text and photo documentation, will automatically record geographical coordinates, and will be able to interact with digitised project plans and conceptual models. [xxx]

27. Knowledge and non-knowledge management

The management of knowledge and non-knowledge is a crucial task because it provides the basis for developing a learning and adaptable institution. It encompasses not only the collection and storage of information, but also the organisation and preparation of an adequate infrastructure for storing, using, adapting and further developing available knowledge at any time and by all relevant persons. Knowledge management refers to information and knowledge itself, and also to information about knowledge sources and methods and how it was generated or processed (meta-information).

Knowledge management should also embrace non-knowledge (see below), guiding new research questions and the assessment of the relevance of unknowns (which can be knowable or unknowable). Proactive knowledge management integrates 'horizon-scanning', which is the search for and classification of future risks.

Ensuring that managing entities employ someone to take care of (non-)knowledge management is highly recommended.

Managing the unknown

Managing today's abundance of information and knowledge has become a challenging endeavour in itself. Non-knowledge refers to everything that conservation site managers could, should or would wish to know, but do not or cannot know. It also includes the knowledge that relevant stakeholders do not have or refuse to acquire. In the process of developing the conceptual model and applying the MARISCO steps (including the assessment of knowledge related to the various elements of the model) the planning team will have identified problems caused by lacunae in knowledge and capacities or by intentional ignorance and, ideally, they will have been addressed in the strategic portfolio.

An especially relevant form of non-knowledge management is that of dealing with risks and more or less unknown potential threats (see also the first, conceptual part of the manual).

During implementation of the strategic portfolio, regularly carrying out exercises of non-knowledge mapping is recommended as it can help to finesse the conceptual model and improve the structure of research portfolios. The starting point for such an exercise would be the conceptual model itself and values of knowledge defined by the planning team. Guiding questions for such an exercise would be:

› What do we not know about the managed system and why not?
› Which categories of non-knowledge can be applied (according to figure above)?

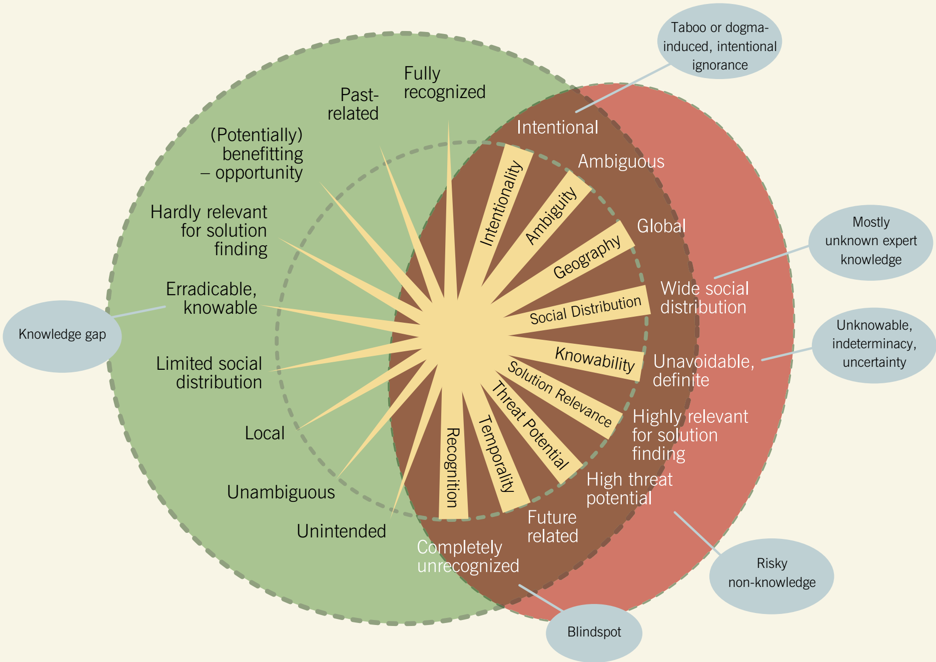


Figure 70. Map of non-knowledge: the manifold categories of non-knowledge.[XXIV]

28. Organisation of institutional learning and sharing with other projects/initiatives

Constant learning is required throughout the whole planning process to gather knowledge about the project site and about implementation methods and approaches. At the same time, it is also necessary to specifically address any mistakes that arise, unforeseen aspects, wrong assumptions, and creative solutions. This also lays the ground for knowledge sharing with others, creating a productive basis for collaboration with other institutions.

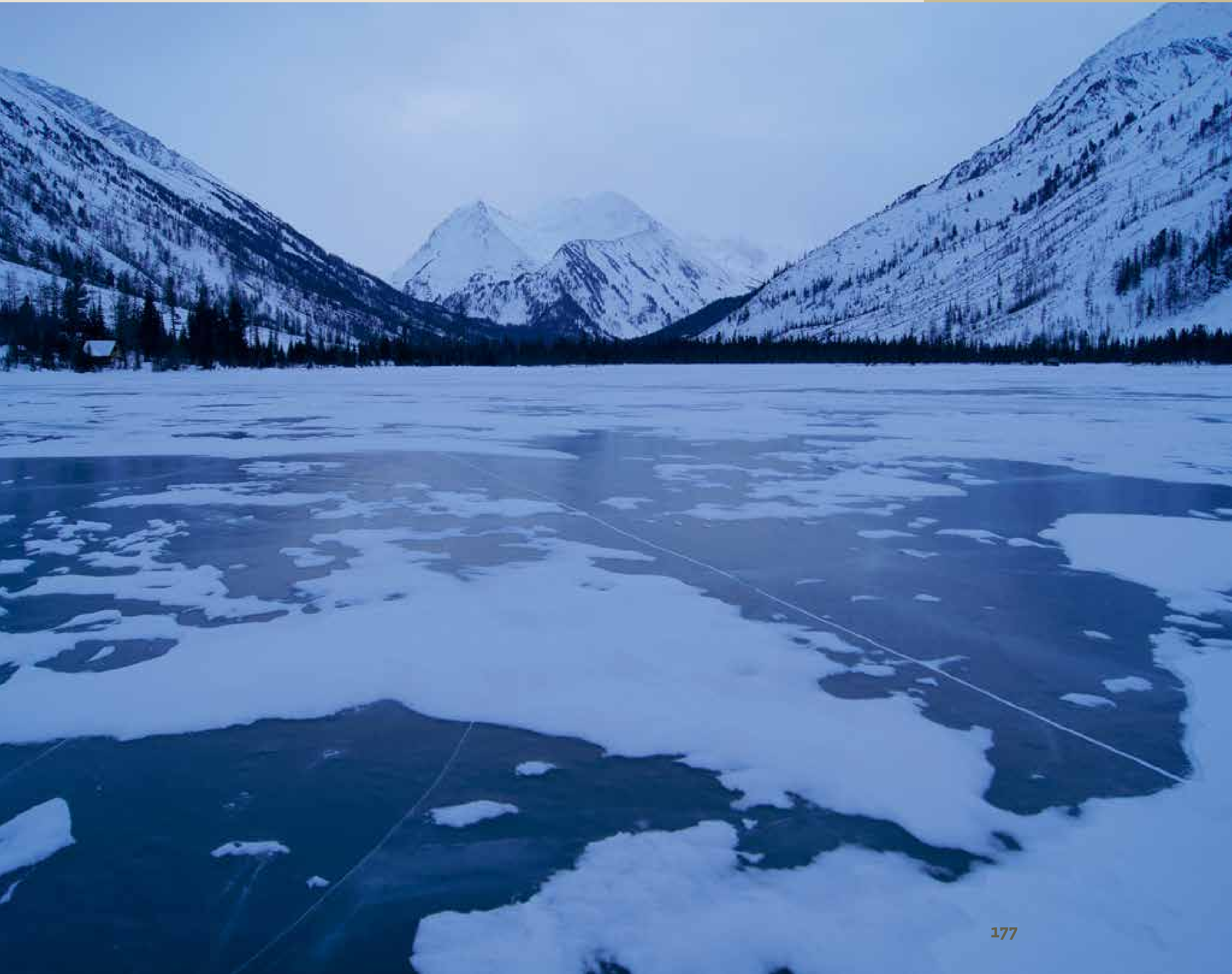
There is no standard recipe for organising institutional learning. Every institution needs to figure out the most suitable way for them to integrate these learning processes into their daily work routine. However, in this context, an internal exchange about the course of the management process as well as the functioning, structure and development of the managing entity is crucial. This process of exchange will only be productive if all members of the management project team take part without any bias or prejudice. Furthermore, the success of such an exchange depends on the willingness to critique existing management practices and adapt them, where necessary. A prerequisite for achieving this kind of communication is the social conditions prevailing within the management project. Through a programme of active learning and participation the team should aim to develop and improve its practice, which includes interpersonal skills like giving and receiving constructive criticism and face-to-face communication.

Alongside this senior-level project-team learning, there also needs to be a free exchange of scientific and technical knowledge. Collaborative sharing of knowledge between partners in the national and international institutions involved in conservation plays a big part in promoting good practice in local projects.

29. Evaluation and revision of the underlying concept

Achievements and lessons learned, processed and made available through monitoring and knowledge management are analysed in order to find out what the specific adaptation needs are. The conceptual model is then adapted according to the findings of this evaluation.

The evaluation exercise is the last activity in the MARISCO management cycle but it is not quite the last step in the management process. In any cyclical management approach, rather than being just an end-of-cycle duty, evaluation is an ongoing exercise that runs throughout the project. Conservation site management is a continual, adaptive process without an end point. Regular reviewing and modification are the hallmarks of adaptive management. Evaluation and revision intervals depend on the scale of the project or management period. In many cases, an evaluation is expected every two years. For smaller or shorter projects, the interval between reviewing the management plan may be much shorter – sometimes up to twice a year. In practice, this also means that different steps of this cycle need to be practised at the same time. In the course of a project or a management period, the management team will most probably implement strategies and activities, and carry out monitoring activities to track the progress of implementation and the status of the biodiversity objects. At the same time, it will evaluate sets of monitoring results prior to adapting the management plan and conceptual model.



Annex 1: Master copies of the moderation cards used in the conceptual model

MARISCO card (template for stresses)

<table>
<tr><td rowspan="4"></td><td>1.
Criticality
scope</td><td>2.
Criticality
severity</td><td>3.
Criticality
irreversibility</td><td>MARISCO</td></tr>
<tr><td>4.
Past criticality
(20 years ago)</td><td>5.
Current
criticality
(→ 1&2&3)</td><td>6.
Trend of change
(of current
criticality)</td><td>7.
Future
criticality
(in 20 years)</td></tr>
<tr><td colspan="3"></td><td>11.
Strategic
relevance
(→ 5&6&7)</td></tr>
<tr><td colspan="2">12.
Manageability</td><td colspan="2">13.
Knowledge</td></tr>
</table>

MARISCO card (template for threats and contributing factors)

1. Criticality *scope*	2. Criticality *severity*	3. Criticality *irreversibility*	
4. Past criticality (20 years ago)	5. Current criticality (→ 1&2&3)	6. Trend of change (of current criticality)	7. Future criticality (in 20 years)
8. Systemic activity *level of* *activity*	9. Systemic activity *no of* *influenced* *elements*	10. Systemic activity (→ 8&9)	**11.** **Strategic** **relevance** (→ 5&6&7)
12. Manageability		13. Knowledge	

Annex 2: Checklist for the preparation and organization of MARISCO workshops[27]

a) Preparation and invitation of participants

- ▢ Define aim and target group of the workshop (e.g., input for management plans, capacity building, training, inter-institutional relationships).
- ▢ Send out invitations well ahead of time and according to local customs, eventually include partners or local stakeholders as workshop hosts.
- ▢ Eventually take care of accommodation, transport and other logistics.
- ▢ If necessary, ensure availability of well-prepared, high- quality translator(s).
- ▢ Translate relevant documents into native language of the participants.

b) Logistical and technical preparation

- ▢ Revision of available documents (e.g., management plans, scientific studies, newspaper articles).
- ▢ Rapid Ecosystem Diagnostics Analysis by the coaches (e.g., revision of Google Earth images, field trip, ideally including interaction with stakeholders).
- ▢ Take photographs of the conservation site situation to be included during the input presentations.
- ▢ Identify and book adequate venue (ideally one large plenary room with flexible/moveable equipment, chairs, a few tables, movable boards (ideally 6, 1x1.5m), huge plain wall space (minimum 7 m wide and 2.5m high).
- ▢ The movable boards can be used to separate breakout groups and for peer review, also to create some dynamics in the workflow of the group.
- ▢ Make sure the room is protected against noise, heat, direct sunlight or other unfavourable weather conditions.
- ▢ Equipment like projector, cable extensions, pointer, screen and speakers (e.g. if you plan to show the MARISCO trailer see *http://www.centreforeconics.org/publications-and-products/adaptive-conservation-and-vulnerability-marisco/*) should be checked before the beginning of the workshop.

c) Accommodation and catering

- ▢ Try to ensure the continuous participation of the participants (e.g. facilitated by retreat in remote venues).
- ▢ Organize minimum number of joint meals.
- ▢ Provide permanent service of hot and cold beverages (coffee, tea, water, etc.) in the workshop room.
- ▢ Make sure that catering (e.g. coffee break) is provided at time.
- ▢ Make sure adequate transport is provided, if a different location for lunch is considered.

[27] Prepared by Axel Schick and Pierre L. Ibisch

d) Materials (for a typical workshop with about 15–25 participants)

MARISCO PHASE 1:

- Maps of the conservation site in poster format (large enough to be revised in plenary) including the following themes:
  - Conservation site at different scales including roads, rivers, settlements, etc. as cues for orientation; also in a regional context, showing neighbouring conservation sites, etc.
  - Land-use, vegetation, ecosystem types; property rights; protected areas; indigenous communities; population density
  - Threats (Deforestation; mining and oil concessions, etc.)
  - Information of the distribution of flagship/ umbrella species if available.
- Be prepared for participants to draw in the maps.
- Input regarding ecosystem conservation objects: local demand for ecosystem services, biodiversity objects, human demand, etc.
- 10 sheets of flipchart paper (e.g. agenda, 'parking lot' of ideas, etc.)
- 60 ordinary moderation cards (Vision).

MARISCO PHASE 2:

- Input material regarding socioeconomic, political and cultural information.

Materials for the elaboration of the conceptual model

- 30 sheets of brown packing paper (1.5 x 1.7 m); background of the conceptual model
- Ordinary moderation cards (10 x 15 cm):
  - 60 green (Biodiversity objects)
  - 60 light green (Ecosystem services)
  - 60 blue (Human well-being)
  - 60 white (Key ecological attributes).
- MARISCO cards (see template Annex I):
  - 80 purple (Stresses)
  - 80 red (Threats)
  - 120 orange (Contributing factors).

Consider bringing more cards if working with different groups of participants.

- Round coloured stickers (15 mm); 500 to 600 of each colour:
  - Dark green
  - Light green
  - Yellow
  - Red.
- Legends:
  - 2 Criticality (ideally separated in two blocks; block 1 Current Criticality (Scope, Severity, Irreversibility), block 2 (Current, Past and Future Criticality, as well as current trend of criticality)
  - 2 Systemic activity + Management and Knowledge.
- Additional materials:
  - Standard moderation suitcase
    - 2 boxes of pins (150 to 200 each)
    - 1 pair of scissors
    - 15 rolls of masking tape (2.5 cm wide)
    - Markers (20 to 30 black, 5 green, 5 blue, 5 red)
  - Eventually special materials if you consider any games that facilitate establishing a good learning environment (ball, etc.[28]).

[28] A recommendable source is The Systems Thinking Playbook by Linda Booth Sweeney and Dennis Meadows (The Systems Thinking Playbook: Exercises to stretch and build learning and systems thinking capabilities, Chelsea Green Publishing, 2010; book with companion DVD available). Very valuable collection of games including general tips for creating a good (systemic) learning environment.

MARISCO PHASE 3:

- Conceptual model printed as large as possible (ideally 1.5 x 4 to 6 m). During the design of the model, consider that the height will be the limiting factor, due to plotter sizes.
- Moderation cards:
  - 80 hexagonal yellow (Existing strategies)
  - 80 hexagonal light yellow (Complementary strategies)
  - 60 rectangular pink (Result webs objects)
  - 60 rectangular grey-blue (Result webs results)
  - 30 round/elliptical cards of any colour (Result webs indicators).
- 10 sheets of brown packing paper (Strategy evaluation background); eventually bring 20 additional sheets if planning to build complete result webs for the whole model
- Materials used during the Phase 2 (Stickers and (MARISCO) cards to include and evaluate missing/new elements (Stresses, Threats, Factors, etc.).
- 2 legends for the evaluation of the strategies, printed out as big as possible to ensure legibility.
- Additional materials:
  - Standard moderation suitcase
    - 2 boxes of pins (150 to 200 each)
    - 1 pair of scissors
    - 10 rolls Masking tape (2.5 cm wide)
    - Markers (20 to 30 black, 5 green, 5 blue, 5 red)
  - Eventually special materials if you consider dynamics (ball, etc.).

e) Coaches

- Minimum 2 coaches (ideally being able to alternate moderating different methodological steps and accompanying/coaching breakout groups, but also to monitor the performance of the coaching partner, to check for eventual errors/gaps and to assist with writing cards, passing stickers, etc.).
- Required coach skills and knowledge compromise:
  - A rough idea of the conservation site (see EDA p. 56 ff.)
  - Sound knowledge of ecosystem theory and functioning, the concepts of the methodological steps and their rationale, strategic planning of conservation strategies and measures; eventually knowledge of good practices (e.g agriculture, etc.).
  - Ideally native language skills, however coaching with translators is possible (extra time for translation has to be scheduled if simultaneous translation is not available).
  - It is always recommendable that the working team works in its native language, also the writing up of the conceptual model should be done in native language, eventually with translation in small letters for the coaches.
  - Very good moderation skills, being able to handle big and heterogenic groups (able to deal with aggressive, dominant participants, conflicts, etc.).
  - Good time management skills and flexibility for spontaneously adopting the sequences of the methodological steps.
  - Empathy, patience and intercultural sensibility; skills to patiently push the processes, without

forcing the participants to take decisions. Being prepared to stimulate and guide certain technical discussions.
- Fast understanding of situations and up-coming ideas.

f) Schedule and time management

- Maximum working hours per day depend on cultural and climatic conditions.
- Calculate enough time for the presentation of the participants and the introduction of the methodology (see below: input presentations).
- Calculate sufficient time for wrap ups and peer reviews (if work is done in several breakout groups).
- Typically days will be structured by one lunch break and two coffee breaks (lunch: 60 to 90 min; coffee breaks: 20 to 30 min).
- The breaks are used by the coaches for restructuring certain elements (e.g. the conceptual model, grouping of factors, etc.) and also for the preparation of the upcoming methodological steps.
- Adapt workflow (and eventually sequence of methodological steps) of the day, taking into account problematic time zones (like after lunch hours) ideally are used for more interactive and creative work (eventually some additional dynamics).
- Ideally use a variety of different working forms (presentations, breakout groups, peer-reviews and plenary sessions).

g) Input presentations

- Input presentations should provide theoretical and methodological background and stimulate discussions and reflections.
- Each methodological step requires an introduction, mostly including practical examples.
- Longer and more formal presentation usually using PowerPoint presentation would cover the following topics:
  - General overview of ecosystem functionality, vulnerability, climate change.
  - Overall theory and methodology
  - Strategies.
- Initial input presentations ideally include lots of pictures of the conservation site and during later phase pictures of the working showing the participants themselves.

h) Intermediate and final report

- If the work process is structured in several workshops (recommended) the coaches should provide an intermediate report summarizing methodological steps and workshop results to enable the revision and validation.
- Reports would comprise photographs of the conservation objects, threats and contributing factors, as well as photographs of the workshop (participants) and important results.
- Send the conceptual model in digitized format (PDF) to allow zooming into the model.
- The final report should summarize the results of the workshop(s), the future steps and conclusions of the coaches; eventually also recommendations.
- Consider printing and distributing the report(s) for people without access to computers (e.g. indigenous communities).

Editors and authors

All the below-listed authors of this publication work for the Centre for Econics and Ecosystem Management, a joint centre established by Eberswalde University of Sustainable Development (Germany) and Writtle College, a partner of Essex University (UK).

Daniela Aschenbrenner (MSc in Global Change Management): Freelance in conservation management, with a special focus on adaptive management (daschenbrenner@hnee.de).

Dr. Peter R. Hobson: Principal lecturer in biodiversity conservation at Writtle College and Eberswalde University of Sustainable Development. Co-director of the Centre for Econics and Ecosystem Management (www.centreforeconics.org). His research interests include the ecosystem resilience and functionality of forests and other, semi-natural landscapes with a view to mitigating against the impacts of climate change.

Prof. Dr. Pierre L. Ibisch: Chair of Nature Conservation at the Faculty of Forest and Environment, Eberswalde University of Sustainable Development. Co-director of the Centre for Econics and Ecosystem Management (www.centreforeconics.org). Currently holding a research professorship for 'Biodiversity conservation and natural resource management under global change' and, among others things, he is conducting research projects and consultancy work on the adaptation of conservation to global change.

Laura Geiger (MSc in Global Change Management): Employed researcher working on risk management in conservation projects and on a case study of Sierra del Lacandón National Park, Guatemala (lgeiger@hnee.de)

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Endnotes

I) www.conservationgateway.org/Files/Pages/conservation-action-plann.aspx

II) http://www.conservationmeasures.org/about-cmp & https://miradi.org/openstandards. Latest version of the Open Standards guide: http://www.conservationmeasures.org/wp-content/uploads/2013/05/CMP-OS-V3-0-Final.pdf

III) Ibisch, P.L., J. Geyer, L. Schmidt, V. Pokynchereda and V. Gubko (eds), Carpathian Biosphere Reserve: challenges and solutions for protected area management in Ukrainian Transcarpathia, Shaker, Aachen, 2011.

IV) Ibisch, P.L., B. Kunze and S. Kreft, 'Biodiversitätserhaltung in Zeiten des (Klima-) Wandels: Risikomanagement als Grundlage eines systemischen nichtwissenbasierten Naturschutzes'; in: Ministerium für Infrastruktur und Landwirtschaft (MIL) des Landes Brandenburg, Landeskompetenzzentrum Forst Eberswalde (LFE) (ed.), 'Wald im Klimawandel – Risiken und Anpassungsstrategien', Eberswalder Forstliche Schriftenreihe Band 42, 2009, pp. 44–62.

Ibisch, P.L., P.R. Hobson and S. Kreft, 'The European nature conservation network Natura 2000 in meeting uncertain challenges of climate change: Applying principles of complex systems and ecosystem theory'; in: Ibisch, P.L., L. Geiger and F. Cybulla (eds), Global change management: knowledge gaps, blindspots and unknowables, Nomos, Sinzheim, 2012, pp.131–152.

Kunze, B., S. Kreft and P.L. Ibisch, 'Naturschutz im Klimawandel: Risiken und generische Handlungsoptionen für einen integrativen Naturschutz'; in: Vohland, K., F. Badeck, K. Böhning-Gaese, G. Ellwanger, J. Hanspach, P.L. Ibisch, S. Klotz, S. Kreft, I. Kühn, E. Schröder, S. Trautmann and W. Cramer, 'Schutzgebiete Deutschlands im Klimawandel – Risiken und Handlungsoptionen', Naturschutz und Biologische Vielfalt, Bundesamt für Naturschutz, Bonn, 2013, pp. 123–152.

V) Kreft, S., F. Tucci, M. Schluck, L. Strixner, I. van Ahee, M. Bienek, N. Linke and P.L. Ibisch, 'Indexbasierte Vulnerabilitätsabschätzung für Schutzgebiete und Ableitung von Handlungsoptionen'; in: Vohland, K., F. Badeck, K. Böhning-Gaese, G. Ellwanger, J. Hanspach, P.L. Ibisch, S. Klotz, S. Kreft, I. Kühn, E. Schröder, S. Trautmann and W. Cramer, 'Schutzgebiete Deutschlands im Klimawandel – Risiken und Handlungsoptionen', Naturschutz und Biologische Vielfalt, Bundesamt für Naturschutz, Bonn, 2013, pp. 153–176.

VI) Ibisch, P.L., K. Columba, S. Reichle, R. Vides and H. Justinianano (eds), 'Plan for the Conservation and Sustainable Development of the Chiquitano Dry Forest', Pantanal and Bolivian Cerrado (abridged version), Editorial FAN, Santa Cruz, Bolivia, 2000, (ISBN 99905-66-15-1).

Ibisch, P. L., C. Nowicki, and N. Araujo, 'Regional biodiversity conservation in the Bolivian Amazon – Do the current protected areas cover the priority areas?'; in: Bondrup-Nielsen, S., N. Munro, G. Nelson, J.H.M. Willison, T.B. Herman and P. Eagles (eds), Managing protected areas in a changing world. Proceedings of the Fourth International Conference of Science and the Management of Protected Areas, SAMPAA, Canada, 2002, pp. 553–576.

Ibisch, P.L. and C. Nowicki, 'Biodiversity patterns, conservation planning and science – general reflections and examples from the tropical developing country Bolivia'; in: S.-W. Breckle, B. Schweizer and A. Fangmeier (eds), Results of worldwide ecological studies, Verlag Günter Heimbach, Stuttgart, 2004, pp. 181–197, (ISBN 3-9805730-2-8.).

Ibisch, P.L., 'Notes concerning gaps in protection in Bolivia'; in: Ibisch, P.L., and G. Mérida (eds), Biodiversity: the richness of Bolivia. State of knowledge and conservation, Ministerio de Desarrollo Sostenible y Planificacion/Editorial FAN, Santa Cruz, 644 S., 2004, pp. 382-397, (ISBN 99905-66-33-X).

Ibisch, P.L. and N. Araujo, 'Regional conservation and biological corridors'; in: Ibisch, P.L. and G. Mérida (eds), Biodiversity: the richness of Bolivia. State of knowledge and conservation, Ministerio de Desarrollo Sostenible y Planificacion/Editorial FAN, Santa Cruz, 644 S., 2004, pp. 407–417, (ISBN 99905-66-33-X).

Ibisch, P.L., C. Nowicki, N. Araujo, R. Müller and S. Reichle, 'Bolivia: targeting ecological processes and functionality, not the "living dead"'; in: Dudley, N. and J. Parrish (eds), Closing the gap: creating ecologically representative protected area systems. A guide to conducting the gap assessments of protected area systems for the Convention on Biological Diversity, Secretariat of the Convention on Biological Diversity, Montreal, Technical Series no 24, 2006, pp. 83–84.

Ibisch, P.L., N. Araujo and C. Nowicki (eds), Visión de Conservación de la Biodiversidad del Corredor Amboró-Madidi, FAN/WWF/TNC/CI, Editorial FAN, Santa Cruz de la Sierra, Bolivia, 2007, (ISBN 99905-66-37-2).

Araujo, N., R. Müller, C. Nowicki and P.L. Ibisch (eds), Prioridades de conservación de la biodiversidad de Bolivia, SERNAP, FAN, TROPICO, CEP, NORDECO, GEF II, CI, ZNC, WCS, Universidad de Eberswalde, Editorial FAN, Santa Cruz, Bolivia, 2010, (ISBN 978-99905-66-51-2).

VII) Geyer, J., I. Kiefer, S. Kreft, V. Chavez, N. Salafsky, F. Jeltsch and P.L. Ibisch, 'A classification of stresses to biological diversity caused by global climate change', Conservation Biology 25, 2011, pp. 708–715.

VIII) Ibisch, P.L. and S. Kreft, 'Anpassung an den Klimawandel: eine systematische Analyse von Handlungsoptionen für den Naturschutz', Anliegen Natur 32, 2008, pp. 3–23.

IX) Chaired by Steffen Reichle, TNC.

X) Siete Iglesias and Tinajillas-Río Gualaceño Ecological Areas of Municipal Conservation, Ecuador (2013); Cahuita and Manuel Antonio National Parks, Costa Rica (2011-2012); Reserva Comunal El Sira, Peru (2011); Jiu Lian Shan Mountain National Nature Reserve, Poyang Lake Nanji Wetland National Nature Reserve, Nan Feng Mian Provincial Protected Area, Jiangxi Province, China (2010).

XI) Sierra del Lacandón National Park, Petén, Guatemala.

XII) Program Implementing the Biodiversity Convention, Division Environment and Climate Change, Section 4710 – Biodiversity, Forests, Natural Resources.

XIII) Ibisch, P.L. and C. Nowicki, 'Aplicación del método: Manejo Adaptativo de Riesgo y vulnerabilidad en Sitios de Conservación (MARISCO) en la Amazonia peruana', Análisis de la vulnerabilidad y estrategias para la adaptación al cambio climático en la Reserva Comunal El Sira – Perú. Experiencias con la metodología en el Proyecto "El Sira – GIZ", Perú, 2011, (legal deposit number of the National Library of Peru: 2011-14981); produced for the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH project 'Proyecto Biodiversidad y Cambio Climático en la Reserva Comunal "El Sira"'.

Ibisch, P.L. and C. Nowicki, 'Application of the method: Adaptive Risk and vulnerability Management at Conservation Sites (MARISCO) in the Peruvian Amazon', Vulnerability analysis and strategies for climate change adaptation in the El Sira Community Reserve, Peru. Experiences using the methodology in the El Sira-GIZ project, Peru, 2012. Produced for the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH project 'Proyecto Biodiversidad y Cambio Climático en la Reserva Comunal "El Sira"'.

Geiger, L., S. Kreft and P.L. Ibisch, 'Reducing blindspots: MARISCO, a planning approach that integrates risk management into biodiversity conservation'; in: Ibisch, P.L., L. Geiger and F. Cybulla (eds), Global change management: knowledge gaps, blindspots and unknowables, Nomos, Sinzheim, 2012, pp. 153–212.

XIV) 'Global Change Management' programme, 2011 and 2012; Sierra del Lacandón National Park, Guatemala, as case study site.

XV) 'Conservation Management under Global Change' programme, together with representatives of British conservation sector, 2012; Area of Outstanding Natural Beauty, Suffolk Coast and Heaths, UK, as case study site.

XVI) Training courses held in 2013 in Shkoder, Albania, for students from various universities, in the framework of activities sponsored by DAAD (the German Academic Exchange Service) for academic reconstruction in southeast Europe.

XVII) County of Barnim, German Federal State of Brandenburg.

XVIII) In the context of the development a management plan for the planned transboundary reserve in the Altai Mountains (project funded by the German Ministry for the Environment, Nature Conservation and Nuclear Safety).

XIX) Holling, C. S. (ed.), Adaptive Environmental Assessment and Management, Chichester, Wiley, 1978.

XX) We base our concept of ecosystems and ecology on modern systemic approaches, as presented by, for example, Jørgensen, S.E., B. Fath, S. Bastianoni, J. Marques, F. Müller, S. Nielsen, B. Patten, E. Tiezzi and R. Ulanowicz, A new ecology: systems perspective, Elsevier, Burlington, MA, 2007.

Compare also:

Ibisch, P.L., P. Hobson, and A. Vega, 'Mutual mainstreaming of biodiversity conservation and human development: towards a more radical Ecosystem Approach'; in: Ibisch, P.L., A. Vega E. and T.M. Herrmann (eds), Interdependence of biodiversity and development under global change. Technical Series No. 54, Secretariat of the Convention on Biological Diversity, Montreal, 2010, pp. 15–34, (ISBN 92-9225-279-8; http://www.cbd.int/doc/publications/cbd-ts-54-en.pdf).

Hobson, P. and P.L. Ibisch, 'An alternative conceptual framework for sustainability: systemics and thermodynamics'; in: Ibisch, P.L., A. Vega E. and T.M. Herrmann (eds), Interdependence of biodiversity and development under global change. Technical Series No. 54, Secretariat of the Convention on Biological Diversity, Montreal, 2010, pp. 126–147.

Ibisch, P.L. and P. Hobson, 'The integrated anthroposystem: globalizing human evolution and development within the global ecosystem'; in: Ibisch, P.L., A. Vega E. and T.M. Herrmann (eds), Interdependence of biodiversity and development under global change. Technical Series No. 54. Secretariat of the Convention on Biological Diversity, Montreal, 2010, pp. 148–182.

Hobson, P. and P.L. Ibisch, 'Strategic sustainable development: a synthesis towards thermodynamically efficient systems and post-normal complex system management'; in: Ibisch, P.L., A. Vega E. and T.M. Herrmann (eds), Interdependence of biodiversity and development under global change. Technical Series No. 54, Secretariat of the Convention on Biological Diversity, Montreal, 2010, pp. 183–195.

XXI) Freudenberger L., P.R. Hobson, M. Schluck and P.L. Ibisch, 'A global map of the functionality of terrestrial ecosystems', Journal of Ecological Complexity 12, 2012, pp. 13–22, (doi: 10.1016/j.ecocom.2012.08.002).

XXII) Most sentences in this paragraph were extracted from Hobson, P.R. and P.L. Ibisch, 'Learning from nature for sustainability: an econical approach to (non-) knowledge management'; in: Ibisch, P.L., L. Geiger and F. Cybulla (eds), Global change management: knowledge gaps, blindspots and unknowables, Nomos, Sinzheim, 2012, pp. 223–251.

XXIII) Figure modified after Hobson, P.R. and P.L. Ibisch, 'Learning from nature for sustainability: an econical approach to (non-) knowledge management'; in: Ibisch, P.L., L. Geiger and F. Cybulla (eds), Global change management: knowledge gaps, blindspots and unknowables, Nomos, Sinzheim, 2012, pp. 223–251.

XXIV) Ibisch, P.L., P. Hobson and A. Vega, 'Mutual mainstreaming of biodiversity conservation and human development: towards a more radical ecosystem approach'; in: Ibisch, P.L., A. Vega E. and T.M. Herrmann (eds), Interdependence of biodiversity and development under global change. Technical Series No. 54, Secretariat of the Convention on Biological Diversity, Montreal, 2010.

XXV) Citation from IDS In Focus Policy Briefing 9.2 – After 2015: '3D Human Wellbeing', June 2009, (http://www.ids.ac.uk/files/dmfile/IF9.2.pdf), after McGregor, J. A., 'Researching wellbeing: from concepts to methodology'; in: Gough, I. and McGregor, J. A. (eds), Wellbeing in Developing Countries, Cambridge, Cambridge University Press, 2007.

XXVI) Citation from Millennium Ecosystem Assessment (2005), 'Ecosystems and Human Well-being: A Framework for Assessment': http://www.millenniumassessment.org/documents/document.48.aspx.pdf.

XXVII) Citation from Millennium Ecosystem Assessment (2005), 'Ecosystems and Human Well-being: A Framework for Assessment': http://www.millenniumassessment.org/documents/document.48.aspx.pdf.

XXVIII) Examples for corresponding index-based assessments (on a global scale):

Freudenberger, L., P. R., Hobson, M., Schluck, S., Kreft, K., Vohland, H., Sommer, S., Reichle, C., Nowicki, W., Barthlott and P. L. Ibisch, 'Nature conservation: priority-setting needs a global change', Biodiversity and Conservation 22, 2013, pp. 1255–1281.

Freudenberger L., P.R. Hobson, M. Schluck and P.L. Ibisch, 'A global map of the functionality of terrestrial ecosystems', Journal of Ecological Complexity 12, 2012, pp. 13–22.

XXIX) Figure modified after Ibisch, P.L. and P.R. Hobson, 'Blindspots and sustainability under global change: non-knowledge illiteracy as a key challenge to a knowledge society'; in: Ibisch, P.L., L. Geiger and F. Cybulla (eds), Global change management: knowledge gaps, blindspots and unknowables, Nomos, Sinzheim, 2012, pp. 15–54.

XXX) A corresponding mobile application is currently developed by the Centre for Econics and Ecosystem Management (project leader Laura Geiger).

"Conservation is expected to draw up strategies and deliver measurable outcomes in this environment of uncertainty and unknowns. Importantly, MARISCO affirms and demonstrates that this is possible and that uncertainty and risk are common factors for consideration when planning for adaptive management. MARISCO can facilitate adaptation to climate change, but only if it is integrated into a broader concept of ecosystem-based climate management and ecosystem-based sustainable development. It is underpinned by a strong philosophy and theoretical platform that includes ecosystem and complex systems theories, as well as non-equilibrium thermodynamics. It represents a visualised systematic process designed for collecting, ordering and documenting both knowledge and non-knowledge related to biodiversity, threats and drivers of change, as well as the conservation management for a given site".

BMZ Federal Ministry for Economic Cooperation and Development

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

of the Federal Republic of Germany

Assisted by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Centre for Econics and Ecosystem Management

HNE Eberswalde
Hochschule für nachhaltige Entwicklung (FH)
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