Food and Agriculture Organization of the United Nations

"Conservation and Sustainable Management of Turkey's Steppe Ecosystems Project"

GCP/TUR/061/GFF

GUIDELINES FOR BIODIVERSITY MONITORING

Required citation:

FAO and MAF. 2020. The Guidelines for Biodiversity Monitoring. Prepared by Michael Jungmeier and Nihan Yenilmez Arpa to lead of technical guidance by Peter Pechacek. Conservation and Sustainable Management of Turkey's Steppe Ecosystems Project. Ankara, Food and Agriculture Organization of the United Nations (FAO) Country Representative Office in Turkey and Turkish Ministry of Agriculture and Forestry (MAF) 76 pages. Ankara

ISBN [insert number]

Food and Agriculture Organization of the United Nations

"Conservation and Sustainable Management of Turkey's Steppe Ecosystems Project"

GCP/TUR/061/GFF

GUIDELINES FOR BIODIVERSITY MONITORING

January, 2021

Guidelines for Biodiversity Monitoring

ACKNOWLEDGEMENTS:

The Guidelines for Biodiversity Monitoring was prepared by Michael Jungmeier and Nihan Yenilmez Arpa to lead of technical guidance by Peter Pechacek in the scope of the Conservation and Sustainable Management of Turkey's Steppe Ecosystems Project which is carried out in cooperation with the Food and Agriculture Organization of the United Nations (FAO) and the Ministry of Agriculture and Forestry General Directorate of Nature Conservation and National Parks (GDNCNP), General Directorate of Plant Production (GDPP), and General Directorate of Forestry (GDF) and with the financial support of the Global Environment Facility (GEF).

Additional contributors and reviewers are listed below.

Ministry of Agriculture and Forestry General Directorate of Nature Conservation and National Parks (GDNCNP): Mustafa Bulut, Tuğba Usta, Nurcihan Mercan Erdoğan, Osman Uğur Akınç, Ömer Faruk Aslan, Ümit Bolat, Abdulsamet Haçat, Serhat Erbaş, Fatih Köylüoğlu, Zeynep İpek Ekmen Nural

General Directorate of Forestry GDF): Türkan Özdemir

Ankara University Agricultural Faculty Landscape Architecture Department: Nilgül Karadeniz

Graphic Design: Güngör Genç

Editing: David McDonald

The General Directorate of Nature Conservation and National Parks of the Ministry of Agriculture and Forestry has led the preparation process of the guidelines. We are especially thankful to Mr. İsmail Üzmez, the General Director of Nature Conservation and Natural Parks and Mr. Mustafa Bulut, the Deputy General Director,

We would like to thank Mr. Viorel Gutu, Central Asia and Turkey Representative of the Food and Agriculture Organization of the United Nations (FAO); Ms. Ayşegül Selışık, Deputy Representative for Turkey; and the Program Manager Mr. Sheikh Ahaduzzaman, Program Officer and Safak Toros Communication Specialist for their support and thanks to the Global Environment Facility (GEF) for financial contribution.

Published by:

The Food and Agriculture Organization of the United Nations (FAO) Country Representative Office in Turkey
and
Ministry of Agriculture and Forestry (MAF)
Ankara, 2021

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

BD	Biological Diversity
BDC	Biological Diversity Convention (UN)
BIP	Biodiversity Indicators Partnership
CREAM	Clear- Relevant- Economic- Adequate- Monitorable
DPSIR	Driving Forces, Pressures, State, Impact, Response
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
gha	global hectare
GIS	Geographic Information Systems
GPS	Geographic Positioning System
IPBES	The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union on Conservation of Nature
LDN	Land Degradation Neutrality
LPI	Living Planet Index
METT	Management Effectiveness Tracking Tool
MAF	Ministry of Agriculture and Forestry
NGO	Non-governmental organization
RAPPAM	Rapid Assessment and Prioritization of Protected Area Management
SMART	Specific- Measurable- Attainable- Realistic- Time bound
SPSS	Statistical Package for the Social Sciences
UNCCD	United Nation Convention to Combat Desertification
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCPA	World Commission on Protected Areas
WDPA	World Database on Protected Areas
WWF	World Wide Fund for Nature

LIST OF FIGURES

LIST OF TABLES

LIST OF BOXES

Executive Summary

The steppes of Turkey's Anatolia region host ecologically important yet vulnerable ecosystems that cover nearly 40 percent of the country. The Conservation and Sustainable Management of Turkey's Steppe Ecosystems Project focuses on appropriate management and conservation of the steppes of Sanliurfa province, which is known for the richness of its biodiverse steppe ecosystems. Located in Eastern Turkey, the Sanliurfa steppes are subject to wildlife habitat loss, unsustainable land practices and adverse effects of climate change. Developing a monitoring programme and preparing a monitoring guide for project implementation sites to support the sustainability of these ecosystems are among the priorities of this project.

Purpose and use of the guidelines

This document is one of seven guidelines developed to provide standards and recommendations for management of the country's natural assets. The Guidelines for Biodiversity Monitoring is intended for conservation scientists, managers and stakeholders involved in the management of ecosystems. It specifically provides support for natural resource managers, protected area planners, decision-makers and managers, staff of the Ministry of Agriculture and Forestry (MAF), NGOs and universities, with a view to elaborating adequate and realistic monitoring plans for individual steppe protected areas, in order to establish a working monitoring system for steppe ecosystems.

The Guidelines provide a methodology and structure to set up clear indicators and targets for a comprehensive monitoring system for ecosystems. They offer a working basis for national and local experts and specialists, and support the steps towards a comprehensive monitoring scheme. They constitute the first stage in a longer process of defining clear objectives and indicators for individual pillars of monitoring for the ecosystems and their components.

Contents

The Guidelines consist of three chapters. Chapter 1 provides the context and the essential principles of monitoring. Chapter 2 explains the monitoring cycle, including monitoring needs, objectives and programmes, and the implementation and evaluation of monitoring programmes. Chapter 3 describes the general features of monitoring programmes, specifically environmental monitoring, biodiversity monitoring, socio-economic and grazing monitoring, and management effectiveness monitoring. A glossary of terms and a list of documents for further reading are can be found at the end of the Guidelines.

Introduction

Within the framework of the project **Conservation and Sustainable Management of Turkey's Steppe Ecosystems**, seven sets of guidelines have been developed to provide standards and recommendations for the sustainable management and conservation of the country's natural assets. The present document is the second set in the series.

The full list of guidelines is as follows:

- **The Guidelines for Establishing Protected Areas outline the standards for the establishment process, from site proposal to final establishment of the site (including ministerial and presidential approval).**

- **The Guidelines for Protected Area Management Planning outline the standards and methods for the management planning of established protected areas.**

- **The Guidelines for Biodiversity Monitoring outline the standards and methods for the development of monitoring systems at the protected area level.**

- **The Guidelines for Engaging Stakeholders in Managing Protected Areas outline the standards and recommended practices for engaging stakeholders in the participatory planning and management of protected areas.**

- **The Guidelines for Assessing the Management Effectiveness of Protected Areas outline the standards and methods for assessing the effectiveness and efficiency of protected area management.**

- **The Grazing Management Planning Guidelines outline the standards and methods for transitioning Turkey's grazing management practices to align with globally defined ecological sustainability.**

- **The Guidelines for Grazing and Livestock Monitoring outline the standards and methods for monitoring animal performance and the impact of livestock on the ecosystem.**

All the guidelines refer to both national and international standards and are closely linked, as shown in Figure 1.

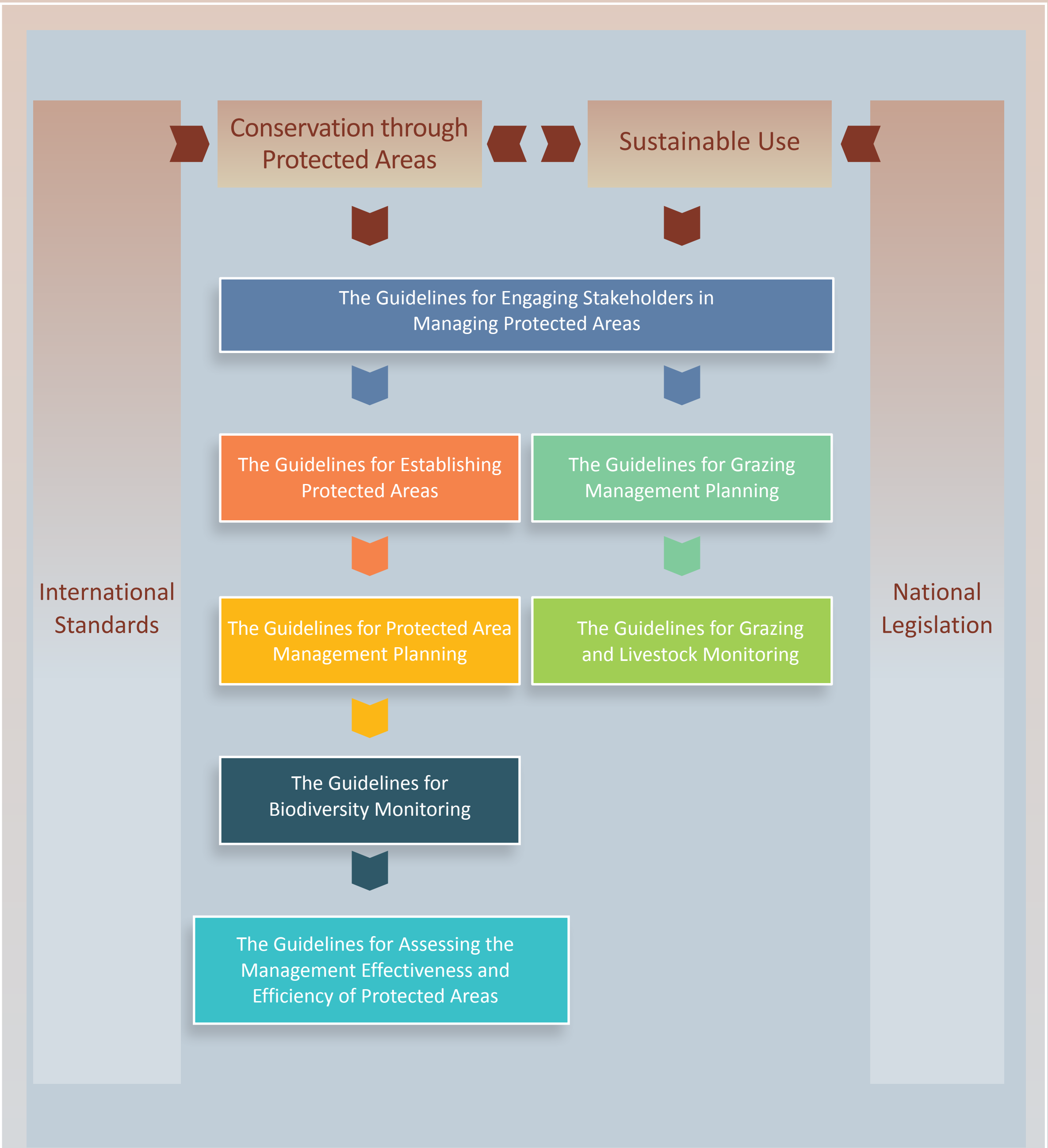
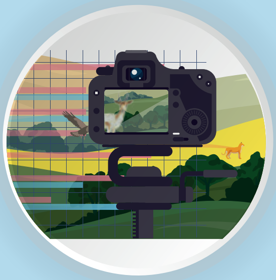


Figure 1. Overview of the seven guidelines and their interrelations

CHAPTER 1

THE GENERAL APPROACH TO MONITORING

1. THE GENERAL APPROACH TO MONITORING



1.1 The concept of monitoring

Monitoring is defined as "the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective" (Elzinga et al., 2009). Monitoring can be more rigorously defined as "intermittent (regular or irregular) surveillance undertaken to determine the extent of compliance with a predetermined standard or the degree of deviation from an expected norm" (Hellawell, 1991). Monitoring is often loosely regarded as a programme of repeated surveys in which qualitative or quantitative observations are made, usually by means of a standardized procedure (Hill *et al.*, 2005).

In summary, monitoring can:

- establish whether standards are being met
- detect change and trigger responses if any of the changes are undesirable
- contribute to diagnosis of the causes of change
- assess the success of actions taken to maintain standards or reverse undesirable changes and, where necessary, contribute to their improvement (Hill *et al.*, 2005).

The aim of any monitoring programme is to detect change systematically (Goldschmid, 1991). It helps document and understand the development of a site without specific interventions but also serves to ascertain the impact of any interventions and actions. Monitoring allows the success of programmes and projects to be measured against overall set goals.

Monitoring is an important part of any plan prepared for protected ecosystems. The first stage is to define precisely what is needed in terms of an effective monitoring programme, understanding that most monitoring activities protect the values of the resource and strengthen management effectiveness.

According to relevant legislation, specific objectives determined in planning documents and management plans, and the conservation priorities of individual protected areas, management of the areas in question includes setting up monitoring programmes to observe and evaluate changes within the established boundaries and to evaluate the effectiveness of management and measures taken.

However, a holistic approach to the management of protected ecosystems requires the determination of the most appropriate and effective monitoring methods for management planning and implementation of management activities.

This is a continuous process whereby plans are prepared, implemented and updated in accordance with the impacts determined through monitoring. The process is cyclical with assessment conducted at regular intervals in order to determine the progress made in reaching goals and any developments in the implementation process. The results of monitoring indicate which direction to go, inform management decisions and help to update management plans in an appropriate way. Ideally, monitoring should be a regular action and accompany implementation of the management plan (Mercan Erdoğan, 2014).

Monitoring requires long-term commitment, adequate resources and stability; however, historically, monitoring has been viewed as an expensive addition (Lee, McGlone and Wright, 2005). Institutional capability is also important for monitoring. In some cases, resources can be provided by the organization itself, but in most situations, they must be outsourced because the available capacity is insufficient for monitoring. Figure 2 lists the parameters necessary for a monitoring process to help determine available capacity.

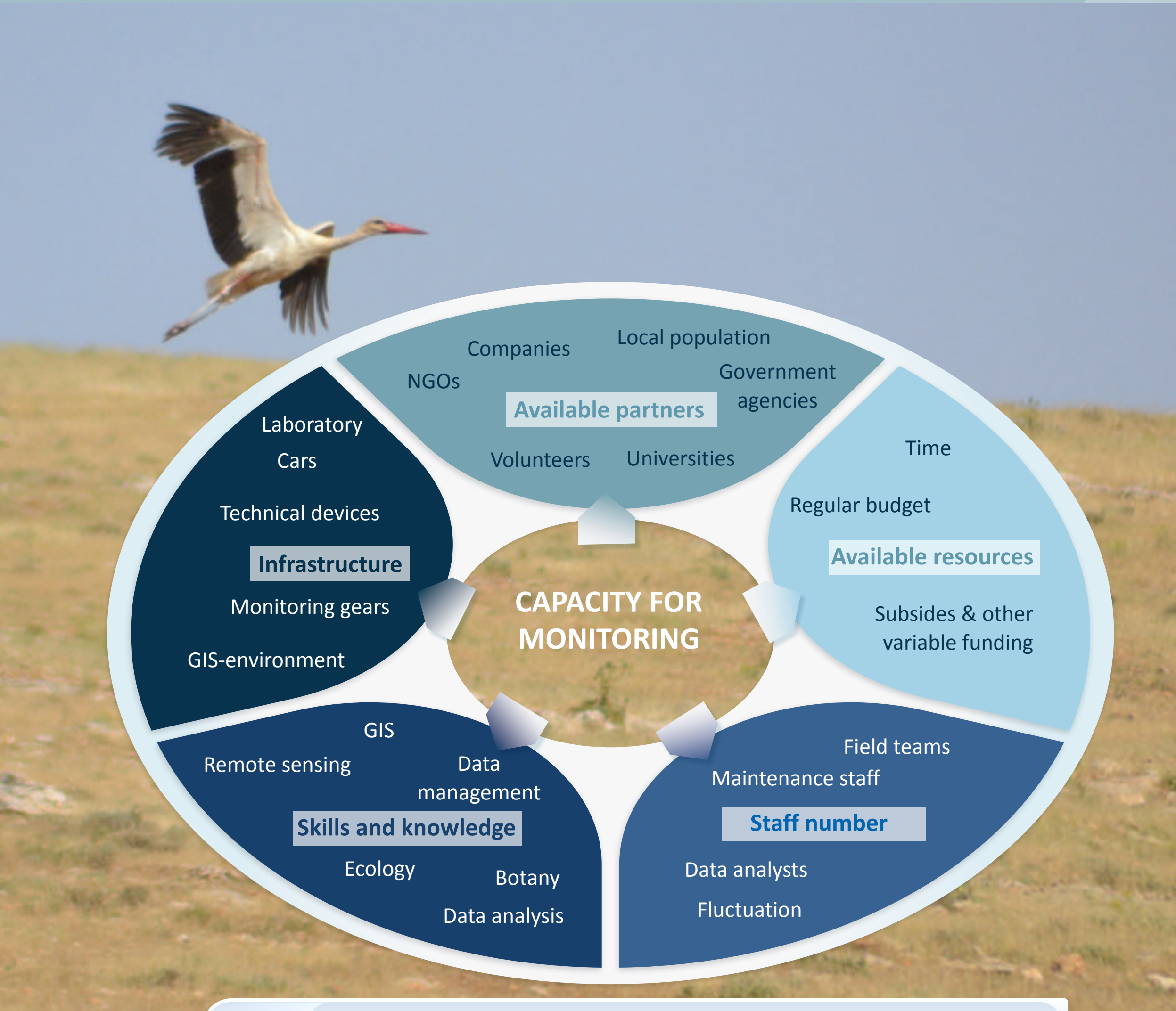


Figure 2. Capacity for Monitoring: Evaluation of available resources

For this reason, organizations try to avoid extensive monitoring, and practice shows that there is a tendency to prefer less expensive and shorter-term monitoring programmes. In such conditions, fast and less expensive monitoring programmes should be prepared; otherwise, monitoring will become the main activity of the management team and will rise in cost. For this reason, monitoring should be clear, understandable, efficient in terms of time management and applicable. The prioritization process for set-up, frequency of reporting and existing resources, budget and requirements for implementation connected with annual monitoring activities, should be taken into account (Caughlan and Oakley, 2001). Basic information about the calculation of costs when creating a monitoring programme is given in Table 1. Steps for choosing the most effective methods from a cost perspective are presented in Figure 3.

Table 1. Basic information on the calculation of costs in a monitoring programme

STEPS	**Mode of calculation**
Phase 1: Investment, preparation, and prototype	
Concepts (goals, methods, outcome)	Number of workings days * daily fee
Infrastructure and equipment (if relevant)	Cost of item/ device * number
Prototype and first investigation (first analysis & revision	Amount of workings days * daily fee
Phase 2: Ongoing costs, regular (yearly basis)	
Collection of data and fieldwork	Number of working days * daily fee * frequency
(Interim) analysis of data	Number of working days * daily fee * frequency
Report and documentation	Number of working days * daily fee * frequency
Phase 3: Wrap-up	
Final analysis	Number of working days * daily fee
Final documentation	Number of working days * daily fee

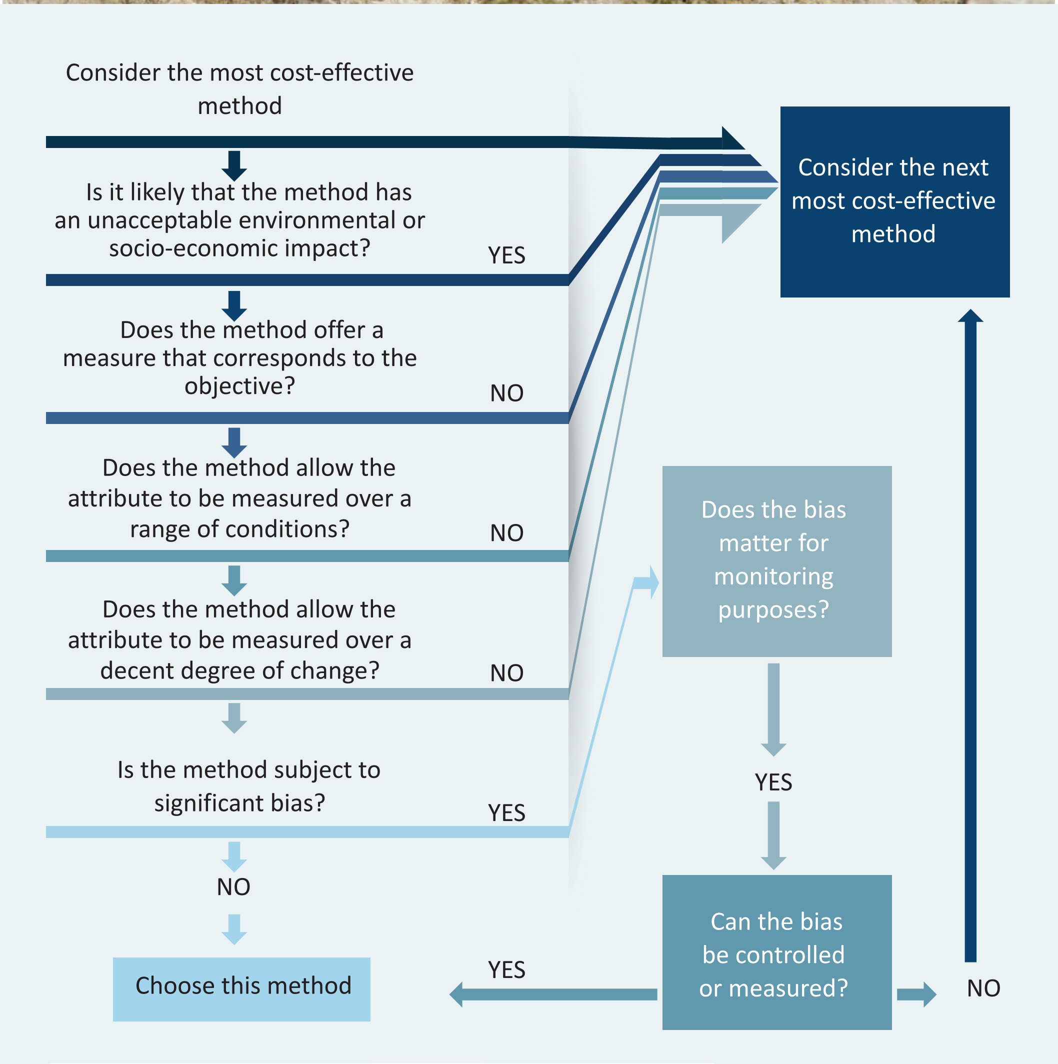


Figure 3. Selecting the most efficient methods

While the general framework of a monitoring programme is impacted by cost, time and capacity, the monitoring process and results will be strongly affected by the monitoring plan. The preparation process for the monitoring plan should thus determine clearly what to monitor, including the particular features, monitoring time and frequency, and methods of measurement and testing, and present the work plan for each of these activities. The process should also establish indicators and related methods for subsequent steps. Generally, a monitoring programme is planned and implemented by the management and staff of organizations and institutions related to protection of the ecosystem, key stakeholders and specialists in the field. The data are usually obtained from three main sources:

- **Data produced by monitoring teams themselves.** These are data produced by particular departments to which experts in data gathering and analysis were assigned.
- **Data obtained from outside organizations.** These are monitoring data gathered by research organizations according to their work purposes and tasks, other institutions and universities. Organizations that plan to conduct monitoring based on data from outside organizations, might need to sign special contracts with such organisations.
- **Data obtained by obtaining the services of consulting service providers.** The task of gathering and analysing data is given to outside experts or organizations. Data are gathered and presented by outside units.

No matter where the data come from, the department intending to use them should ensure coordination of data gathering, analysis, storage and interpretation.

Each monitoring programme consists of three components: management, research and documentation. The main scope of a programme is represented by the triangle shown in Figure 4.

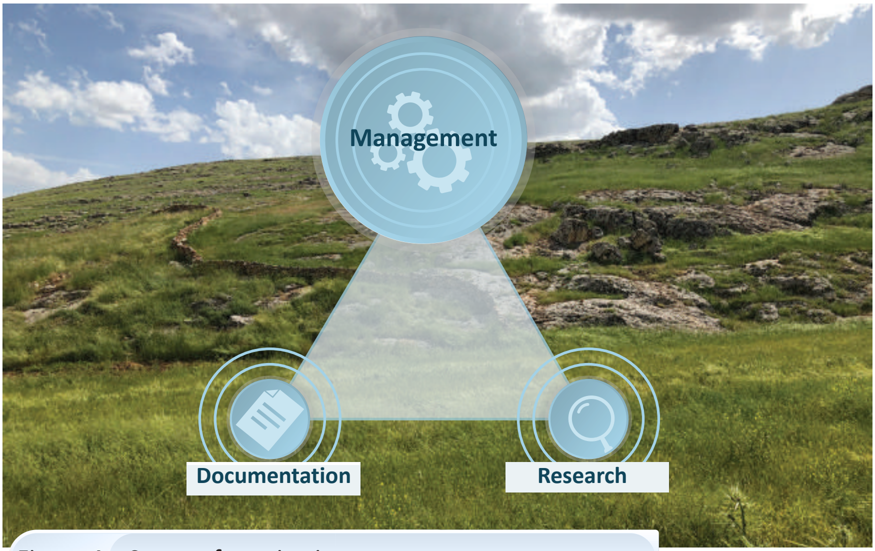


Figure 4. Scope of monitoring

Data management plays an important role in gathering, assessing and documenting data as well as in obtaining clear results and increasing the effectiveness of monitoring. Research and documentation help to changes in conditions or systems over time and identification of the problems in the past, management coordinates implementation and processes effectively that help to achieve the intended goals.

Research makes monitoring easier by ensuring the collection of different types of data during the monitoring programme. Documentation helps to reveal results by recording data, evaluating it as qualitative and quantitative, and conducting data analysis. Management coordinates both research and documentation at these stages, and in accordance with the results, may restart the process again. This might occur because deficiencies and/or additional information found at the documentation stage could lead to a recommendation for re-investigation. This, in turn, might lead to changes in the monitoring programme. From the point of view of monitoring efficiency, it is therefore important for management to look at the process as a whole.

Issues connected with monitoring as well as the usage of monitoring results may vary in accordance with the goals and priorities of the organizations and institutions. The general purposes of monitoring results within the sphere of ecosystem protection are to:

- assess the status of threats and conservation targets
- evaluate the effectiveness of measures
- document the status of individual habitats or populations
- provide a basis for (inter)national reporting
- provide a working basis to develop targeted action plans or measures
- inform and improve management practice through an adaptive management process
- lobby for funding for specific, required actions
- detect threats and negative changes at an early stage.

1.2 Basic principles of monitoring

Monitoring is an essential component of any successful management activity. Managers need the information generated to improve their management, and donors and stakeholders need results to ensure accountability. Monitoring is also a multi-dimensional process. For this reason, before setting up a monitoring scheme, it is important to clarify the answers to following basic questions (Jungmeier, 2015):

- **What for.** What are the goals and aims of the monitoring? Which changes should be observed? How many years will be needed as a minimum to produce relevant results?
- **What.** What is the focus in terms of content and which questions should be answered? What are the indicators, baseline values, targets and means of measurement?
- **How.** Which organizational framework sets the conditions for monitoring activities in the protected areas? How should it be organized, and which requirements will be imposed on the monitoring team? Who should be involved? Should any national or international standards, requirements or formats (data, reports) be considered?
- **How much.** Which resources are available or can be raised for monitoring and evaluation activities? What are the minimum resources needed to collect data to achieve the goals? What are the maximum available resources? What infrastructure and personnel costs (working days per year) are likely to occur?
- **How long and how often (frequency).** What should be the date and frequency of data collection? Depending on the topic, different dates and frequencies will be needed. The basic principle is as infrequently as possible and as often as needed. Generally, the frequency in the first years of investigation will be higher.
- **For whom (target groups).** Who will be the users of the data? What formats and detail of data will they need? It is crucial to consider the monitoring data needs of the final users in order to adequately elaborate the results.

Identifying monitoring questions is a critical and difficult step. It can be accomplished through an interdisciplinary approach with experts knowledgeable of the issues at the appropriate level (e.g. landscape, ecosystem, species, genetics, etc.) and should be considered an iterative process that is adapted as new information becomes available. Monitoring questions should be prioritized and grouped according to the data needed, as available resources for monitoring will likely be limited (Gaines, Harrod and Lehmkuhl, 1999).

In addition to understanding the process and obtaining a clear picture of the monitoring framework, the key principles of a monitoring programme are ownership, engagement of stakeholders, a focus on results, and the effectiveness of monitoring and programme objectives.

When implementing monitoring it is necessary to follow some basic principles in order to increase the effectiveness of the process and the quality of the results. Table 2 lists these principles.

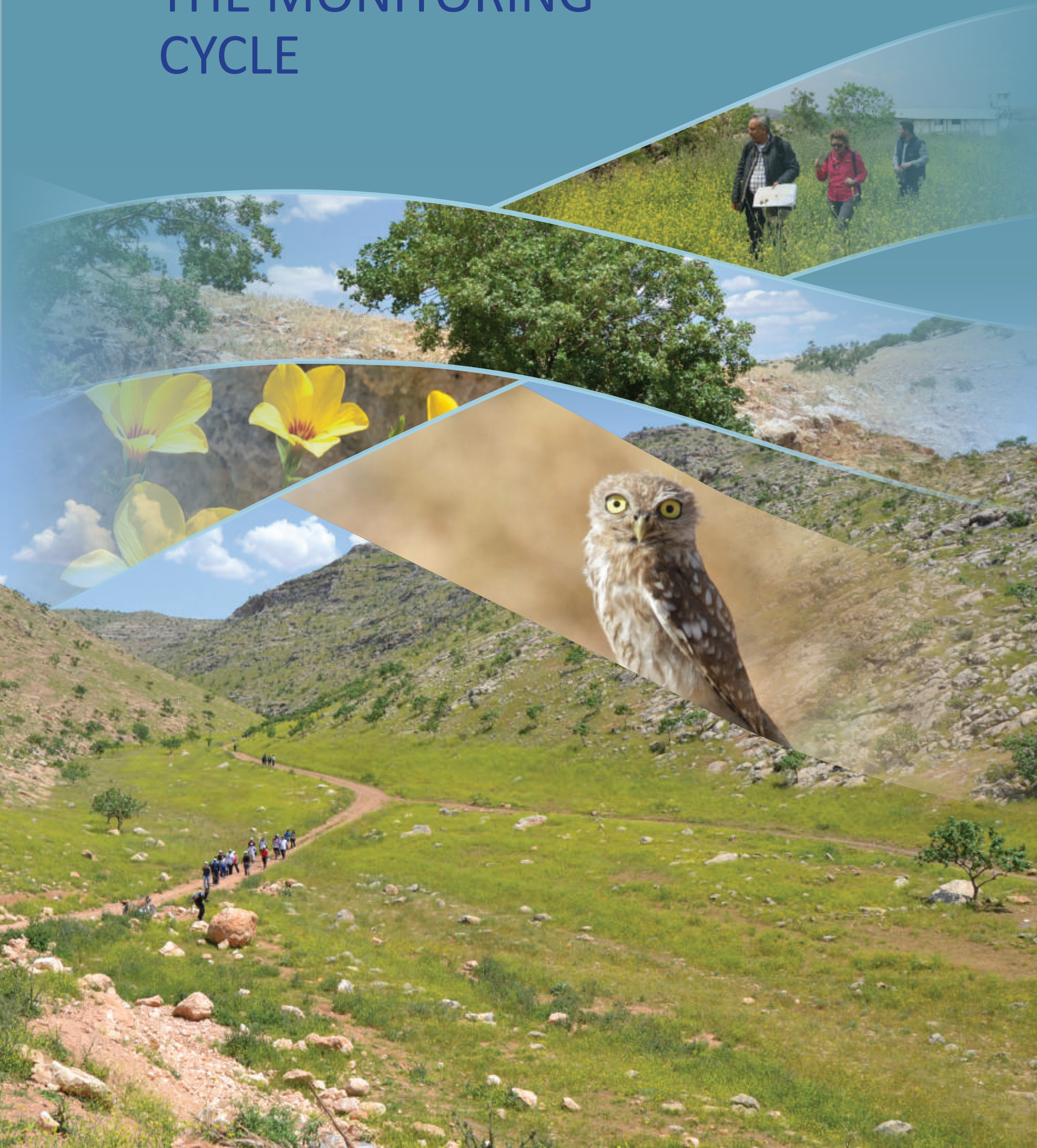
Table 2. Basic principles to follow during the monitoring process,

Principle	Definition
Simple design	The number of indicators for data collection should be limited and the effort needed for implementation should be minimized.
Precise goals	The basic programme goals should be precise.
Effective indicators	The indicators used should be simple, precise, understandable, relevant to the issue, measurable, trustworthy, related to goals and possible to collect.
Internal consistency	Indicators should be strongly connected to objectives.
Integration	Monitoring should be integrated into practice.
Feedback circle	The monitoring results should provide an opportunity to develop the capacity for and give direction to the decision-making process.
Focused on learning	Indicators should be linked to the basic problems that need to be managed, and the experience earned should provide an opportunity to learn.
Flexibility	The monitoring programme should be revisable on the basis of the results.
Participation	Stakeholders should be effectively involved in the monitoring process, and activities that build capacity should be developed for effective participation.
Database	A database should be established to store all the data.

Source: Friberg (2010)

CHAPTER 2

THE MONITORING CYCLE



2. THE MONITORING CYCLE

The monitoring process can be divided into five main steps as shown in Figure 5.

1. Monitoring needs
2. Monitoring objectives
3. Monitoring programmes
4. Implementation of monitoring programmes
5. Evaluation of monitoring programmes and data storage.

The steps proceed one after the other with the result of each step forming the basis of its successor. Monitoring programmes should be developed with monitoring needs and objectives in mind.

Figure 5. Monitoring cycle

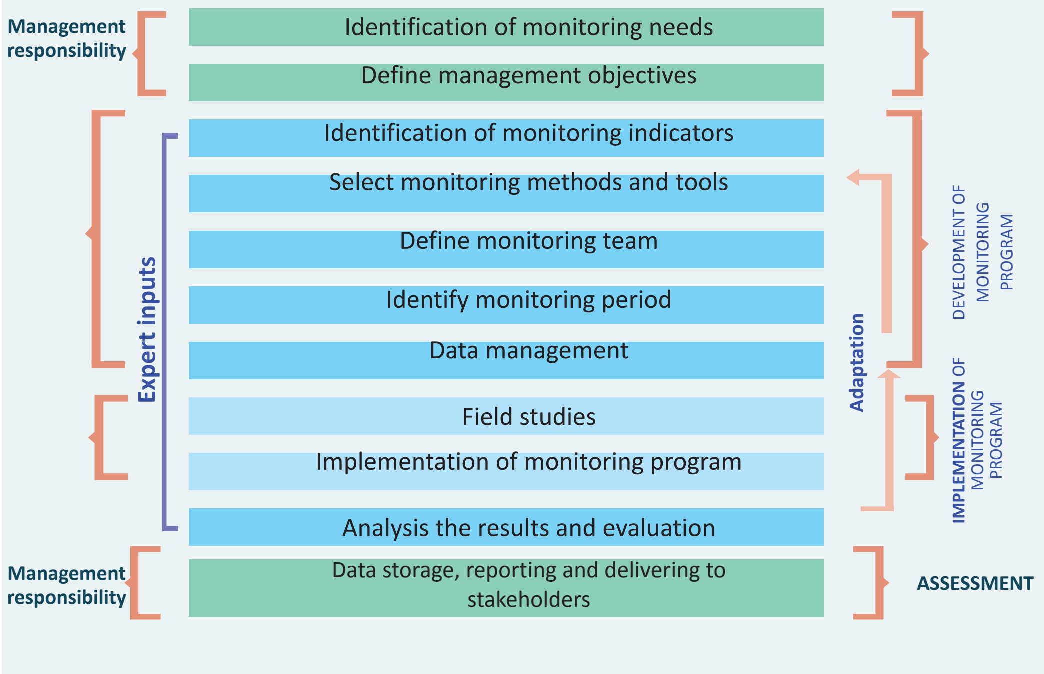


Figure 6. Flow chart of monitoring process

Source: Adapted from Tucker *et al.* (2005).

2.1. Step 1. Monitoring needs

The most important step of the monitoring process is to define clearly and precisely the objectives of the monitoring programme. Consideration of demand and the necessary tasks (goals, legal framework, management focus, priorities), available data (inventories and existing monitoring data), and resource limits will determine the monitoring needs and focus.

Available data should be considered during monitoring processes. Frequently collected data or special programmes can be used. Inventories or existing monitoring data should be reflected and will provide the baseline.

Regardless of the approach used, the defined needs should contribute to the maximum protection objectives of the managed area or ecosystem.

2.2. Step 2. Monitoring objectives

Monitoring objectives should be simple, clear and based on needs, threats, interventions, existing data, legislation, international and national obligations, and management plan strategies. The objectives of monitoring are:

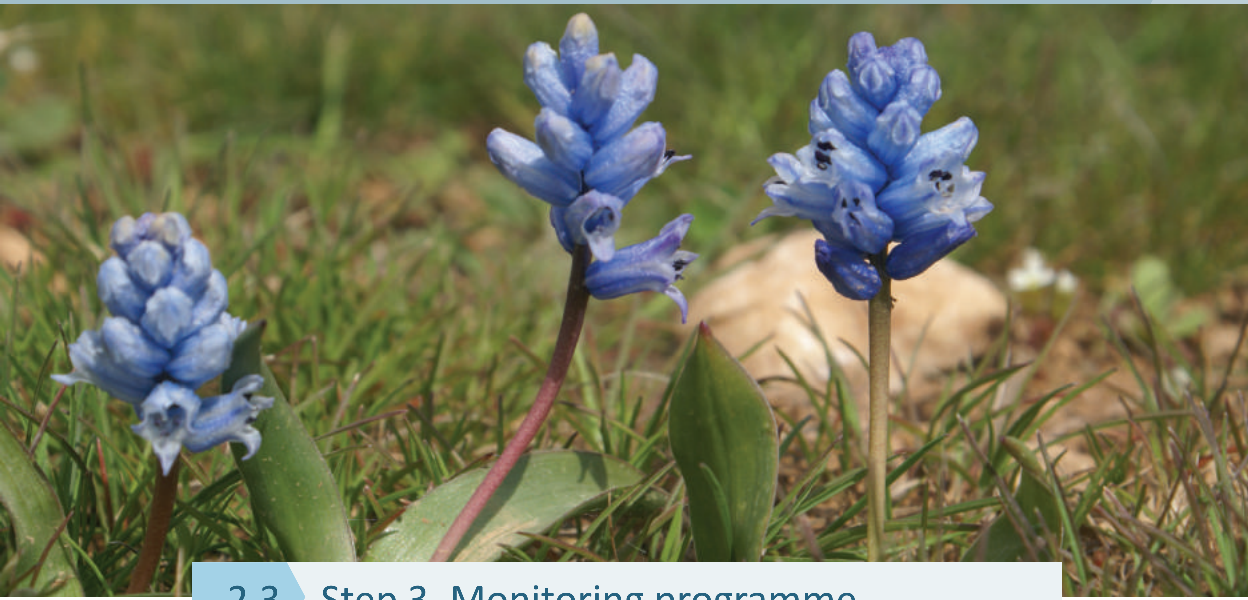
- to investigate the state of the species/ ecosystem to be monitored
- to identify protection achievements of species/ ecosystem to be monitored
- to identify the threats and risks towards the species/ ecosystem to be monitored
- to provide information for the future revision of the plan
- to provide information for the evaluation of the management plan or its prescriptions.

Monitoring is a multi-dimensional process that serves several different purposes. The objectives may vary according to the monitoring programme implemented. Generally, the objectives of monitoring are as follows: focus of monitoring in order to consult management about progress and developments, to ensure the collection of basic data through observation. and using the data obtained to achieve the envisaged goals., (Mercan-Erdoğan, 2014; Lee *et al.,* 2005).

The value and importance of resources and the protection priorities of the area in question constitute the basic elements for monitoring. Before establishing an ecological monitoring programme, it is therefore essential to define the basic value of resources and other unique aspects of the area (Tucker *et al.,* 2005). These unique features can be grouped as characteristics specific to the general landscape, biological diversity, and socio-economic and socio-cultural assets. These traits are summarized in Table 3.

Table 3. Basic unique traits of an ecosystem

General landscape characteristics	Biological diversity	Socio-economic and socio-cultural assets
Soil	Biogeographical systems	Historical and cultural heritage sites
Geology/geomorphology	Ecosystem and habitats	Socio-cultural values and unique traits
Hydrology and hydromorphology	Flora and fauna	Socio-economic systems
Climate	Agricultural biological diversity	Tourism and recreation
Structure of land usage	Invasive and radiative species	Stakeholders
		Alternative sources of income



2.3. Step 3. Monitoring programme

A monitoring programme is closely related to the managerial objectives and priorities of the area of monitoring. Generally, monitoring programmes for an ecosystem focus on monitoring biological diversity. However, recent monitoring programmes have also included a focus on management effectiveness.

In these guidelines, the monitoring programme consists of four elements: environment, biological diversity, socio-economics and management efficiency (Figure 7). The following systems were used to identify these elements: the SANParks Biodiversity Monitoring System, which focuses on 10 different biodiversity monitoring programmes for all protected areas,[1] the Swiss Biodiversity Monitoring Model,[2] Austria's Kalkalpen National Park management goal-oriented monitoring model, and the monitoring system for the Gesäuse National Park and Salzburger Lungau and Kärntner Nockberge Biosphere Reserve.

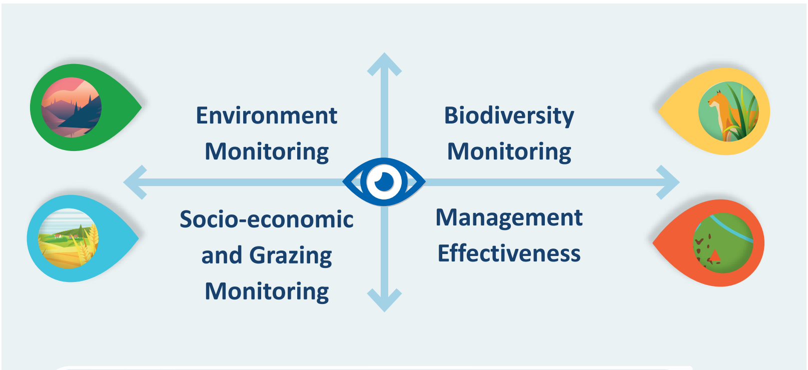


Figure 7. Ecosystem monitoring programmes

1. https://www.sanparks.org/conservation/scientific_new/cape/programmes/default.php
2. http://www.biodiversitymonitoring.ch/en/home.html

The Salzburger Lungau and Kärntner Nockberge Biosphere Reserve uses four dimensions for its monitoring programme: ecological, economic, social and managerial (Huber et al., 2018). Monitoring in Austria Gesäuse National Park focuses on management and scientific work and includes monitoring of implementation (management efficiency) as well as scientific monitoring (species, habitats and natural processes). Monitoring in Kalkalpen National Park is also four-dimensional and focuses on the following groups: environmental monitoring (general environmental conditions), monitoring of the National Park (how landscape and ecosystems change over time), monitoring of species (changes in populations of key species) and management monitoring (issues to be solved, management efficiency). The Swiss Biodiversity Monitoring Model is based on monitoring the conditions of land usage and the efficiency of ecology and management (Huber *at al.* 2018).

The steps below are followed to develop each monitoring programme:

1. Determination of the monitoring indicators
2. Definition of the monitoring methods and tools
3. Definition and establishment of the monitoring team
4. Determination of the period of monitoring
5. Data management.

1. Monitoring indicators. The first step in the development of the monitoring programme is to identify the indicators. These function as the cornerstone of monitoring. Primarily, monitoring must rely on data series of countable indicators. The list of possible indicators to monitor is long, and each area should select a set of indicators of significance for their objectives, management and evaluation (Perez, 2011). In regard to indicator development, it is important, first, to clarify the objectives to be achieved, against which progress should be measured. The indicators are then selected in order to measure whether the monitoring objectives are being achieved or not. The indicator-setting process requires management to focus on relevant key information. Suitable indicators need to be defined, discussed, proofed and redefined through a participatory process with experts.

The following elements should be taken into consideration when developing indicators:

- national legal and policy requirements
- national monitoring schemes and standards
- the objectives for the steppe ecosystem (as laid out in the management plan)
- international requirements and reporting obligations (e.g. WDPA, UNESCO, Ramsar, etc.)
- environment parameters
- ecosystem specifications
- biodiversity (fauna and flora)
- socio-economic parameters
- management effectiveness.

Basic information such as types of monitoring indicators and their essential qualities, unique aspects, quality assessment and the indicator determination process, are described in detail In Box 1.

Box 1. Setting up indicators and objectives

Indicators are essential instruments for monitoring and evaluation. They function as quantitative and qualitative variables that provide a simple and reliable means to measure achievements, to reflect changes linked to interventions and to help assess the performance of an organization against a stated outcome, (Kusek and Rist, 2004).

There are different types of indicators:

- **Direct indicators** correspond precisely to results at any performance level set to achieve specific goals.
- **Indirect or "proxy" indicators** are used to demonstrate change or results where direct measures are not feasible. They are often used to answer "soft" socio-economic questions.
- **Quantitative indicators** are commonly believed to be measurements of cold, hard facts and rigid numbers. Their validity, truth and objectivity are taken as unshakeable facts. **Qualitative indicators** are subjective, unreliable and difficult to verify. They are more difficult to ascertain because they probe the whys of situations and the contexts of people's decisions, actions and perceptions.

Indicators are expressed as percentages, ratios or absolute numbers. Any indicator must also meet the following essential conditions.

- **Substantial:** the indicator reflects an essential aspect of an objective in very precise terms.
- **Independent:** since development and immediate objectives will be different, and each indicator is expected to reflect evidence of achievement, the same indicator cannot normally be used for more than one objective.
- **Factual:** each indicator should reflect fact rather than subjective impression. It should have the same meaning to project supporters and informed sceptics.
- **Plausible:** the changes recorded can be directly attributed to the project.
- **Based on obtainable data:** indicators should draw upon data that are readily available or that can be collected with reasonable extra effort as part of administration of the project.
- **Scientifically valid:** a) there is an accepted theory of the relationship between the indicator and its purpose, with agreement that change in the indicator does indicate change in the issue of concern; and b) the data used are reliable and verifiable.
- Responsive to change in the issue of interest
- **Easily understandable:** the indicator can be easily understood a) conceptually in terms of how the measure relates to the purpose, b) in terms of its presentation, and c) in terms of the interpretation of the data.
- **Relevant to user's needs**
- **Used:** the indicator can be utilized for measuring progress, for early warning of problems, to understand an issue, and for reporting, awareness-raising, etc.

Assessing the quality of an indicator

In monitoring, quality assessment refers to the extent to which the obtained data achieve the objective (Caughan and Oakley, 2001). A well-formulated indicator can be assessed by subjecting it to "SMART" or "CREAM" criteria, as follows:

S	Specific	**C**	Clear
M	Measurable	**R**	Relevant
A	Attainable	**E**	Economic
R	Realistic	**A**	Adequate
T	Time bound	**M**	Monitorable

2. Monitoring methods and tools. Choosing the most appropriate method for measuring each key feature and its attributes or pressures is another critical step in planning a monitoring programme. Essentially, one should aim to use the most cost-effective method that provides an adequate assessment of whether the conservation objective for the feature (i.e. its state) or the management objective (i.e. relating to pressures) is being met. Very often the most cost-effective method may be the simplest, but this is not always the case. Well-planned and implemented scientific studies may over the long term provide better value for money than very simple subjective methods that might produce results of little value. The crucial point is that the method should not produce unacceptable environmental or socio-economic impacts.

Monitoring methodology is strongly dependent on needs, specific indicators and management objectives. Scientific monitoring often uses standardized methods to track long-term changes on key topics, taking into consideration available resources. Monitoring methodology should be defined with experts, and should include a monitoring scheme, sample sizes and frequency. The selected method must produce a measurement that is consistent with the objective for each feature and its attributes.

It is therefore necessary to first agree on the target species, ecosystems and indicators. Once the monitoring goal, content and indicators have been agreed, methods can be discussed. Unlike project monitoring, ecological monitoring methodology is strongly dependent on specific indicators and management objectives. Thus, methods always need to be elaborated with the respective specialist given the range of hundreds of potential methodologies (which can even vary between individual beetle species). An example of the decision tree for prioritizing species and habitats in monitoring is given in Figure 8. Additionally, an example of monitoring change in vegetation succession is given in Table 4.

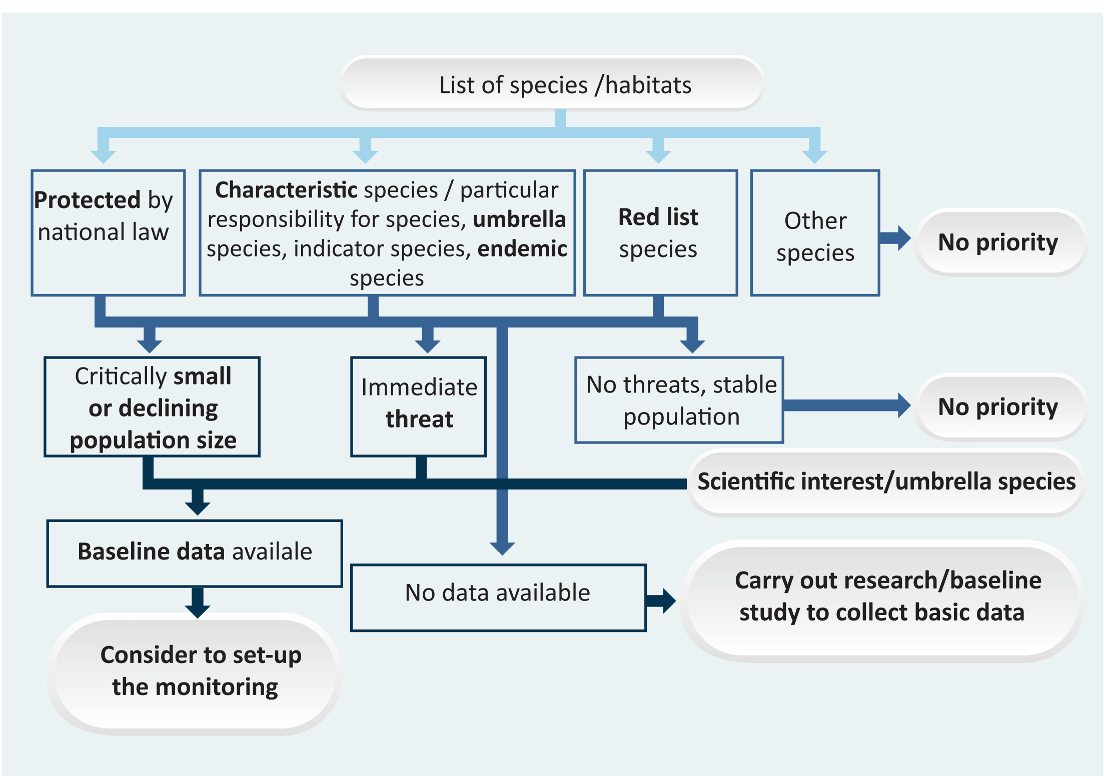


Figure 8. Decision tree on prioritizing species and habitats for monitoring

Table 4. Example of monitoring vegetation succession, Karacadağ case

Name of park/site	Vegetation succession in fenced areas of Karacadag Steppe (Şanlıurfa, Turkey)
General description (situation, problem, question)	The Karacadag Steppe contains "archaic" landscapes shaped by intensive grazing. A small fenced area established by the forestry unit in 2009 provides evidence of potential "natural" development: fenced sites show secondary succession towards more diverse plant communities (peri-annual grass species, chamaephytes, herbs); planted trees (almond, oak, pistachio) are indicative of a climate allowing shrubs and trees to grow; and historical and naturally occurring vegetation, habitats and ecosystems present noticeable differences. Investigation of the site should provide evidence of the extent to which the grazing regime impacts vegetation communities and patterns.
Indicator(s) precise description following SMART or CREAM	The key indicator is the change in the number of plant species/plot in differently used areas (fenced/not fenced) over a time span of 50 years.
Purpose (expected results and their use)	Interpretation of the results will improve understanding of the landscape history ("biography") of the steppe. This is crucial to develop and shape the conservation regime (strictly protected non-intervention area, and area with continuation of extensive grazing).
Methods (sample design, techniques, intervals, intended analysis)	An inventory is made of the number of plant species in 30 fixed plots 5 x 5 metres in size. The plots are arranged in three transects representing the different elevations of the site and the varied usages (non-grazed with planted trees, non-grazed non planted, extensively grazed outside the fence). The corners of the plots are marked with magnetic cones and tagged using GPS. All plants in the plot are inventoried (name, abundance in seven classes) without physically entering the space, and documented photographically. During the first 10 years the survey is performed once per year over the same phenological period of time. Thereafter, the survey interval is extended to every second year. Data and meta-data (sampling person, date, specific weather conditions, remarks) must be stored properly, backed-up and retained in printed form. In addition, the statistical analysis must be conducted using an appropriate programme.
Data handling (formats, archives, backup)	To be defined at a later stage
Responsible institution(s)/ responsible person(s)	To be defined at a later stage. The person in charge must possess a thorough knowledge in order to be able to identify and determine the different species at all phenological phases.
Required resources/ estimated costs (see spread sheet)	120 magnets cones, 1 GPS, tape measure (50 m), camera, laptop. SPSS/ personal costs

Name of park/site	Vegetation succession in fenced areas of Karacadag Steppe (Şanlıurfa, Turkey)
Utilization of data (ownership, access, regular analysis, reports)	To be defined at a later stage
References (related projects, national and international interfaces)	Aslan, M. 2015. Succession of steppe areas after fire in the gap region of Turkey. *Bangladesh Journal of Botany*, 44(4): 489–497. Fırıncıoglu, H.K., Seefeldt, S.S. & Sahin, B. 2006. The effects of long-term grazing exclosures on range plants in the central Anatolian region of Turkey. *Environmental Management*, 39(3): 326–337. Fırıncıoglu, H.K., Seefeldt, S.S., Sahin, B. & Vural, A. 2009. Assessment of grazing effect on sheep fescue (*Festuca valesiaca*) dominated steppe rangelands, in the semi-arid central Anatolian region of Turkey. *Journal of Arid Environments*, 73(12): 1149–1157. Tukel, T. 1984. Comparison of grazed and protected mountain steppe rangelands in Ulukiqla, Turkey. *Journal of Range Management*, 37(2): 133–135.

3. Monitoring team. Generally, the monitoring team should consist of experts on the topic in question, administrative and technical staff from the area where monitoring will take place, and key local stakeholders. At the assessment stage, a list of stakeholders should be prepared, and steps taken to ensure the efficient participation of key stakeholders. Detailed information on stakeholder engagement is given in the **Guidelines for Engaging Stakeholders in Managing Protected Areas** prepared within the framework of the present project.

In general, the following experts should be involved in determining the appropriate monitoring methodology (Table 5).

Table 5. Proposed expert profile for monitoring

Environmental monitoring	Biodiversity monitoring	Socio-economic monitoring	Management effectiveness monitoring
Environmental monitoring expert (geographer, regional planner, GIS expert etc), database expert	Botanist, mammologist, ornithologist, amphibian, entomologist, database expert, GIS expert (depending on the biodiversity values), etc.	Demographer, socio-economic expert (sociologist, agricultural engineer, tourism expert) Grassland expert/ agricultural engineer (agricultural economist), database expert, GIS expert, etc.	Monitoring and evaluation experts

4. Monitoring period. Following selection of the relevant indicators and methodology, the experts define the monitoring period and frequency based on needs and requirements. The monitoring period will be dictated by the characteristics of the feature/ area/ subject being monitored, and will vary according to the subject and theme. While biodiversity and environmental monitoring depend strictly on ecological and environmental conditions, the monitoring period for social and managerial subjects can be flexible.

Frequency of monitoring is a key factor affecting cost. The likely rate of change, as a result of natural events and management interventions, is of key importance in deciding how often to carry out monitoring visits. For example, as major changes in forest habitats are nominally very slow in the absence of disturbance, it may be appropriate to visit at five-year intervals. Conversely, bird populations can vary considerably from year to year, which may necessitate annual surveys, if resources allow (Tucker *et al*., 2005).

Unexpected events can also affect biodiversity features. Monitoring programmes should therefore incorporate sufficient flexibility to cope with unforeseen, potentially rapid and catastrophic events (e.g. storms and fires). Additionally, very basic inspections may be needed to detect such events to enable additional monitoring to be designed to establish the condition of a site (Tucker *et al*., 2005).

5. Data management. A comprehensive monitoring programme requires coordinated work to integrate all necessary data into the system. The data management system should include details on how often and where to obtain the data, who will collect the data, which methods to use, who will analyse the data, where the data will be stored and who will have access. Procedures for data management should be clearly defined and those responsible for data management and their responsibilities should be clearly identified, with this information shared among all concerned in written form.

The best approach for data management is to appoint a monitoring coordinator/supervisor. In some cases, it may be necessary to establish an internal monitoring unit. The unit or coordinator responsible for the monitoring programme will ensure the general coordination of all processes including sharing the results of monitoring and implementation processes. Interaction and communication between the coordinator and other members of the monitoring team and the data flow system should be presented in the form of clear, understandable flow charts.

2.4 Step 4. Implementation of monitoring programmes

By this stage, all information about monitoring goals, indicators, issues to monitor, methods and tools, the monitoring team and the monitoring period should be available; observation forms and other tools should be prepared; and all components and participants should be ready for implementation of the monitoring programme. How the monitoring programme is implemented in coordination with the team of experts and related stakeholders will affect the success of monitoring. It also provides an opportunity to gather more information and increase the eventual usability of the results.

The following tasks must be undertaken during implementation of the monitoring programme:

- Set up a monitoring work plan.
- Compile existing information and group it in accordance with monitoring objectives.
- Prepare bases and registration forms for activities.
- Provide and prepare the necessary tools and equipment.
- Identify stakeholders and organize the first informational meeting.
- Organize technical training for teams related to ecosystem management and protection.
- Organize short-term awareness raising and training for users and beneficiaries of the ecosystem.

In order to implement the monitoring programme, specially designed forms will be needed to encourage consistency and reduce unnecessary detail. Such forms should be easy to read and must ensure that all necessary data are collected. It is vital that all relevant sections of survey forms are completed at the time of the survey and checked immediately afterwards.

A sample form for implementation of a monitoring programme is given in Box 2. Two other sample monitoring sheets are shown in Tables 6 and 7.

Box 2. Format and headings for a monitoring record

Recorder, version and date:

Monitoring objectives

- Reasons for monitoring
- Users of the monitoring data/conclusions
- Conservation objectives for the key feature
- Location of the feature, monitoring population/area and sub-units
- Frequency of measurement

Measurement method

- Observation/data types
- Method
- Timing of observations
- Potential causes of bias and rules for standardization

Sampling scheme

- Complete census or sample survey
- Temporary or permanent sample location
- Method for sample location
- Number of samples

Monitoring requirements and organization

- Personnel responsible and time required
- Experience/training necessary
- Licence and access permission requirements
- Equipment required
- Data recording and storage
- Data analysis procedures
- Reporting format and procedures:
- Costs: capital (equipment) and annual recurrent

(including staff time and travel, etc.)

Health and safety

- Any particular risks associated with carrying out the fieldwork and requirements for any special equipment or measures to be taken to reduce risks.

References

- Contributors to the work
- References

Source: Tucker et al. (2005).

Table 6. Monitoring sheet, Sample 1

Monitoring site	
General description (situation, problem, question)	
Indicator(s) (precise description following SMART or CREAM)	
Purpose (expected results and their use)	
Methods (sample design, techniques, intended analysis)	
Time frame and intervals	
Data handling (formats, archives, backup)	
Responsible institution(s)/person(s)	
Required resources/estimated costs (see spreadsheet) Utilization of data (ownerships, access, regular analysis, reports)	
References, related projects (national and international interfaces)	

Table 7. Form for monitoring data registration, Sample 2

Section A: Observation details			
Date (day, month, year)			
Observation details			
Name of the lead observer			
Other observers/interns			
Primary sample cell			
Monitoring unit of protected area			
Nearest settlement, village /district		Height – min (m)	
Inventory square number		Height – max	
Coordinates (pilot point)		Spectrum	
Details of visit			
Beginning time		Ending time	
Weather conditions			
Temperature			
Cloudiness			
Wind direction			

Section B: Observations				
Lead observer	Day	Inventory square	Nearest settlement	Transect no.
Beginning coordinates		Ending coordinates		Length (m)
Beginning time		Ending time		Duration
Area no.	Observation no.	Coordinates	Heights	
Observed species				
Habitat				
Type of area				
Topographic features				
Others				
Influence				
Comments				

Data documentation is another issue to consider during the implementation process. Keeping an area diary for this purpose can be an effective tool to prevent data loss. The following details should be noted in the area diary:

- date, day, information about the person registering the data
- name of the area for monitoring
- location, coordinates, direction (if necessary) of the area for monitoring
- photographs and/or GPS records
- time and duration of monitoring (if necessary and important)
- general sketch of the area for monitoring
- general information about the issue and/or condition of monitoring
- special cases encountered during monitoring
- special conditions observed in the environment
- other particular observations
- information and data obtained during interviews with participants
- general impression.

In some cases, a sample may be collected during monitoring. However, the method used applied and the data to be recorded may vary.

It is also important to produce a **monitoring work plan** that summarizes all actions in the monitoring programme. For each action, the work plan lists the conservation or management objective, where and when the monitoring is to be undertaken, the associated costs, who will carry undertake the task, and what methods and tools are to be used. Table 8 provides a sample work plan (Tucker *et al.,* 2005) adapted from the **Guidelines for Biodiversity Assessment and Monitoring for Protected Areas.**

Table 8. Sample monitoring work plan

Item	Measurements	Related objectives	Methods and tools	Timing and frequency of monitoring	Location	Responsibility	Annual Cost (x1,000 TL)
M1	Extent of astragalus habitats	X	Satellite data/ GIS analysis	2019 onward, every three years	3 key steppe area	GIS team. ministry field offices, expert team	100
M2	Steppe species richness	X	Satellite image/ GIS analysis, Fixed plot photographs, permanent monitoring plot	Every three years	3 key steppe area	Contractor/ conservation offices	250
M3	Steppe indicators bird species richness		Time species counts in permanent blocks	2019, five-year rolling programme	3 key steppe area	Expert team, ministry field offices	300
...	.....	......	.....	.....	.....	.....	....

2.5 Step 5. Evaluation of monitoring results and data storage

Following implementation of the monitoring programme, the results will need to be evaluated in order to define monitoring needs for the next period. The first step in this process is an assessment of the quality and completeness of the available data, with efforts made to fill any data gaps, where possible. This will involve selection of an appropriate statistical method and programme to conduct the evaluation and data analysis. Classical statistics uses parametric, non-parametric and exact tests to identify the probability that a null hypothesis is correct (Tucker *et al*., 2005).

Many of these tests can be carried out using software available via the Internet. Some useful statistical resources exist in the public domain and offer pointers to resources for other types of analysis. These may be helpful for planning other monitoring or interpreting results. Such resources range from simple tools for single analyses to management decision-making aids to help the user make wider use of monitoring results. Government institutions can also offer access to their software and/or databases to aid evaluation and analysis of the results. A common tool used to analyse monitoring data is the geographical information system (GIS). Another statistical programme that mainly supports social-economic and cultural values is the Statistical Package for the Social Sciences (SPSS).

After evaluation and analysis of the monitoring results, the final outputs must be presented in report form and communicated to key stakeholders. The manager of the protected area, for example, will require written reports and maps with an analysis of the extent of progress in reaching the conservation objectives. The report should include a summary and may incorporate recommendations for management actions based on the interpretation of results. Findings and results of the analysis should be clearly reflected and supported by visual elements, graphics and templates.

Evaluation is not static, however; it is ongoing process that regularly reveals positive and negative influences on the ecosystem, presents results and achieved objectives in final reports, and takes place on a periodic basis.

As the results of each evaluation will be used as a starting point for the next monitoring programme, great attention should be paid to the process of analysis, evaluation and reporting. Generally, monitoring and evaluation are closely related to management plan objectives, with management plans prepared for 10-year periods. Monitoring plans are prepared in connection with management plans, providing an opportunity to compile the management plan, assess the success of previous periods and update accordingly. If necessary, the monitoring programme can be revised on the basis of a final evaluation.

It is important to evaluate and store the results of the monitoring programme in order to ensure sufficient appropriate data for future activities. Once the data have been transmitted to the designated place for storage, quality control should be conducted prior to any form of data analysis. In this regard, it is important to prepare in advance forms for field observations, data quality and design of the data storage facility.

CHAPTER 3

ECOLOGICAL MONITORING COMPONENTS FOR ECOSYSTEMS

3. ECOLOGICAL MONITORING COMPONENTS FOR ECOSYSTEMS

vBasic monitoring activities can be split in four types that differ in form and content: **environmental monitoring, biodiversity monitoring**, **socio-economic monitoring** and **management effectiveness monitoring together with management measures,** (Figure 9).

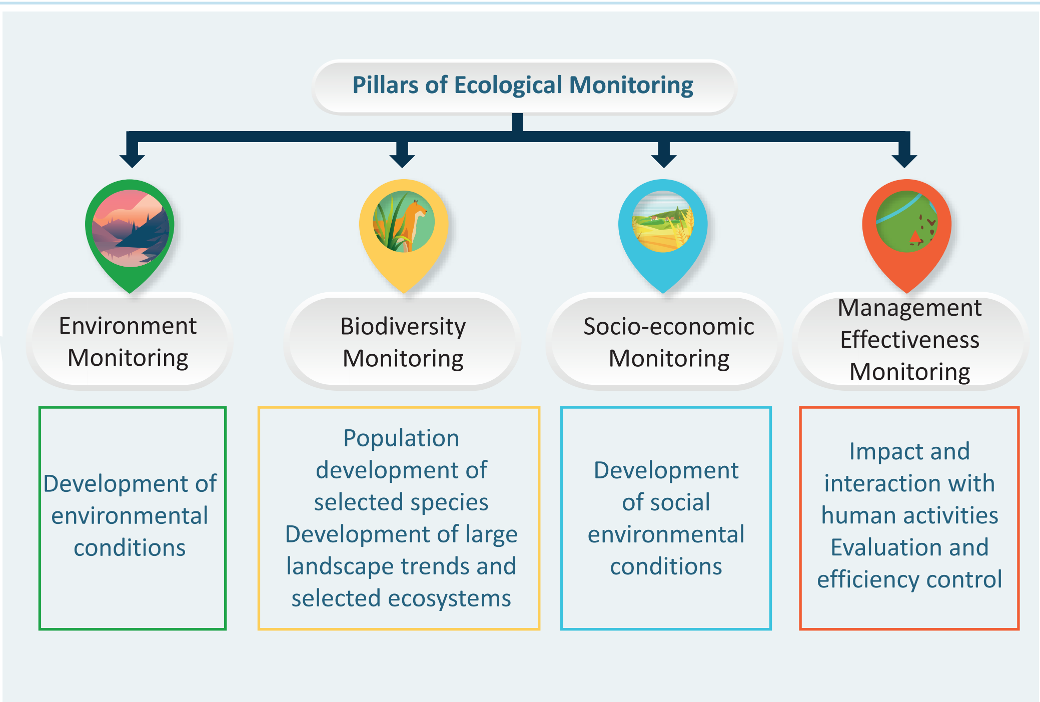


Figure 9. Four pillars of ecological monitoring
Source: Uppenbrink (1998) and Huber *et al.,* (2018).

All the monitoring types shown in Figure 9 can be implemented at global, national, regional/ local or project level, and require knowledge of international and national standards as well as a carefully elaborated process that includes objectives, indicators, and methods and results with specific guidelines followed by training. Implementation of monitoring activities involves the following stages: set-up, the ongoing process, and analysis and archiving of the data.

Each monitoring programme needs to establish individual key topics, indicators and monitoring frequency as well as monitoring methods and tools. Table 9 presents sample key topics, indicators and monitoring frequency for four monitoring programmes, to provide a picture of the general framework of ecological monitoring. Detailed explanations for each monitoring programme are also given in this section of the guidelines.

Table 9. Key topics, indicators and frequency of monitoring programmes

Monitoring programmes	Key topics	Indicators	Frequency
Environmental monitoring	Land use change	Steppe area, forest area, agricultural area, construction sites, etc. Effects on water pollution and water resources, air monitoring, fire, drought, and natural disasters, etc.	Annual, seasonal
	Climate change	Temperature, rainfall, precipitation, winds, etc.	Monthly, seasonal
Biodiversity monitoring	Key species	Population changes and their causes	Monthly/ annual, seasonal
	Priority habitats	Area coverage of steppe habitats, area coverage of semi-desert habitats	Monthly/ annual, seasonal
Socio-economic and grazing monitoring	Demography	Population size, average household size, age and gender distribution, education level, age groups, migration rate	Monthly/ annual, seasonal
	Socio-economy	Number of people working in main economic activities, agricultural production patterns and amount, per capita income, income generated by agricultural activities, number of livestock per household	Monthly/ annual, seasonal
	Visitor management	Number of visitors, distribution of visitors, visitor satisfaction level, visitor impact and capacity	Monthly/ annual, seasonal
	Tourism and recreation	Positive and negative effects, employment status, contribution to the promotion and protection of ecosystems, number of environmentally friendly practices, green certification status	Seasonal/ annual
	Livestock and grazing	Number, species and distribution of livestock in pasture, duration of grazing period, area grazed by livestock in relation to total area, density of livestock per hectare within the protected area, number of reported legal infringements, herd size, number of nomads and herds using grasslands	Monthly/ annual, seasonal
Management effectiveness monitoring	Management effectiveness and measures	Legal status of the area, ecological boundary demarcation, existence of management plan, existence of resource inventory, existence of protection systems, existence of research, existence of resource management, staff numbers, staff training, equipment and infrastructure	Each 3 or 6 months, annual

3.1. Environmental monitoring

The environmental monitoring process involves data collection and evaluation, and the conversion of these data into a usable form for presentation. It is based on estimations of environmental conditions and employs appropriate evaluation methods and research tools (Zielińska, 2010).

Environmental monitoring reports on changes in landscape ecology, the integrity of the ecosystem and the condition of the natural environment, focusing on situations where the environment is reacts to pressures (Slocombe, 1992).

The fragility and sensitivity of ecological systems at the global, regional, national and site level is frequently linked to changes in the usage and status of the land. Examples include pressures of urbanization and construction, the conversion of natural habitats into agricultural land, intensive mining activities, over usage of natural resources and inappropriate methods of collection of the natural assets and natural elements. Taken together with **global warming** and **climate change**, these pressures have a significant impact on ecosystems.

According to the report of the International Platform on Biodiversity and Ecosystem Services (IPBES, 2019), changes in land usage are the primary factor in biodiversity extinction. Accordingly, changes in landscapes such as forest, agricultural and residential areas function as key indicators in evaluating land usage conditions (Sims *et al.,* 2017). Other useful indicators for environmental monitoring include impacts on water resources, water and air pollution, fire, drought and other natural disasters.

Ecological systems are highly susceptible to climate change. Changing rainfall patterns and climatic conditions can lead to changes in whole ecosystems. Monitoring of climate data is therefore indispensable to recognize potential negative developments for species and ecosystems, and to provide a sound basis for climate change adaptation and mitigation measures.

Consideration of a number of **foundational principles** during environmental monitoring, and feedback related to this process, especially with regard to planning and management for areas with valuable natural resources, can have a positive effect on the process and its outcomes. Box 3 lists some of these principles.

Box 3. Foundational principles for environmental monitoring and feedback on this process

- **Transparency and rationality.** Clarify why and how the results of monitoring and evaluation will be used.
- **Focus.** Gather key information concerning the achievement of basic and long-term objectives, and supplement these data with information on the achievement of short-term objectives.
- **Data consistency.** Collect data in accordance with protected area management objectives and integrate them into standard practice.
- **Balance.** Ensure that data collection is not be too costly and is appropriate to the goals.
- **Update.** Regularly assess whether the data being collected are still necessary.
- **Trustworthiness.** Ensure that other organizations and institutions beside the implementing organization are able to evaluate the monitoring indicators independently. Indicators should be SMART, Simple, Measurable, Achievable, Realistic and Time-bound, (Zielińska, 2010).

Monitoring indicators. Main indicators for measuring land use changes include steppe areas, forest areas, wetland areas, agricultural areas and construction sites. In addition, water and air pollution, fire, drought and so on, can be used as indicators for measuring changes in land usage. Indicators for measuring climate change may include changes in temperature, rainfall, precipitation and wind, among others.

Monitoring methods and tools. Monitoring methods and tools for land use changes in steppe areas, forest areas, agricultural areas, construction sites, and so on, include GIS and remote sensing, statistical data assessment, aerial photographs, drones, mapping, comparison with previous data, chemical analysis, field base survey and assessments, and focus group interviews. Potential monitoring methods for climate change include data collection from local observation stations and comparison of rainfall, temperature and precipitation changes over the last 20 years (if available) and preparation of maps.

Monitoring staff. An environmental monitoring programme requires environmental monitoring and database experts including geographers, regional planners, biologists, agricultural engineers, landscape architects, GIS experts and so on.

Monitoring period. The monitoring period may change due to the specificity of monitored parameters. Climate change indicators should be monitored on a monthly basis, while land use change indicators should be monitored annually and seasonally.

Data management. The data management system will consist of several stages including data gathering, recording, evaluation, analysis, storage, reporting and dissemination.

A sample framework for environmental monitoring together with its indicators, monitoring methods, monitoring staff, monitoring period and data management is given in Table 10.

Table 10. Environmental monitoring programme

Environmental topics	Indicators	Monitoring methods	Monitoring staff	Monitoring period	Data management
1. Land use changes	Steppe area Forest area Agricultural area Wetland area Construction site, etc. Water pollution and impact on water resources, air pollution, fire, drought and natural disasters, etc.	GIS and remote sensing Statistical data assessment Satellite-based remote sensing applications Aerial photography with the help of drones and other new technological devices Mapping Comparison with previous data Chemical analyses Local monitoring and observations Focus group interviews	Environmental monitoring expert (geographer, regional planner, biologist, agricultural engineer, landscape architect, GIS expert, etc.) Database expert	Monthly, annually and seasonally	Data gathering, recording, evaluation, analysis, storage, reporting and dissemination
2. Climate change	Monthly parameters on: Temperature Rainfall Precipitation Wind, etc.	Data collection from local observation stations Preparation and comparison of rainfall, temperature and precipitation changes through maps Focus group interviews	Environmental monitoring expert (geographer, regional planner, GIS expert, etc.) Database expert	Monthly	Data gathering, recording, evaluation, analysis, storage, reporting and dissemination

3.2. Biodiversity monitoring

Biodiversity monitoring is a systematic process focused on the measurement of current changes in elements of biological diversity in line with effective management objectives (GDNCNP-Biodiveristy Monitoring and Assessment Report, 2012).

Biodiversity monitoring assesses population changes and their causes throughout the life cycle, and measures attributes such as germination and mortality rates, growth, size, density and distribution. It can also be used to help establish the factors determining the distribution and abundance of species and predict the future structure of populations (Mercan-Erdoğan, 2014).

Generally, biodiversity monitoring programmes focus on genetic diversity, species, habitats or their combinations. The choice of elements to monitor and the selection of approaches are closely related to the monitoring programme's goals and the available financial resources. Elements that can be subject to biodiversity monitoring include the following (GDNCNP-Biodiveristy Monitoring and Assessment Report, 2012): the current status of biodiversity elements and related trends

- sustainable usage of biodiversity
- threats to biodiversity
- ecosystem goods and services and ecosystem integrity
- the state of traditional information, innovation and practice
- the situation with regard to access and benefit sharing
- the status of resource transfers.

A principal function of any protected area is the protection of characteristic features and endangered species that live within the area's boundaries, particularly endemic and globally threatened species. Targeted monitoring of individual key species provides a constant overview of population trends as well as basic information for the development of supportive conservation measures. **Species monitoring** is thus a key activity for any protected area and should be conducted appropriately. Species chosen for monitoring can be divided into five categories: ecological indicators, key species, umbrella species, flagship species and sensitive species (Mercan-Erdoğan, 2014). Indicators, monitoring methods and tools are defined individually for each category.

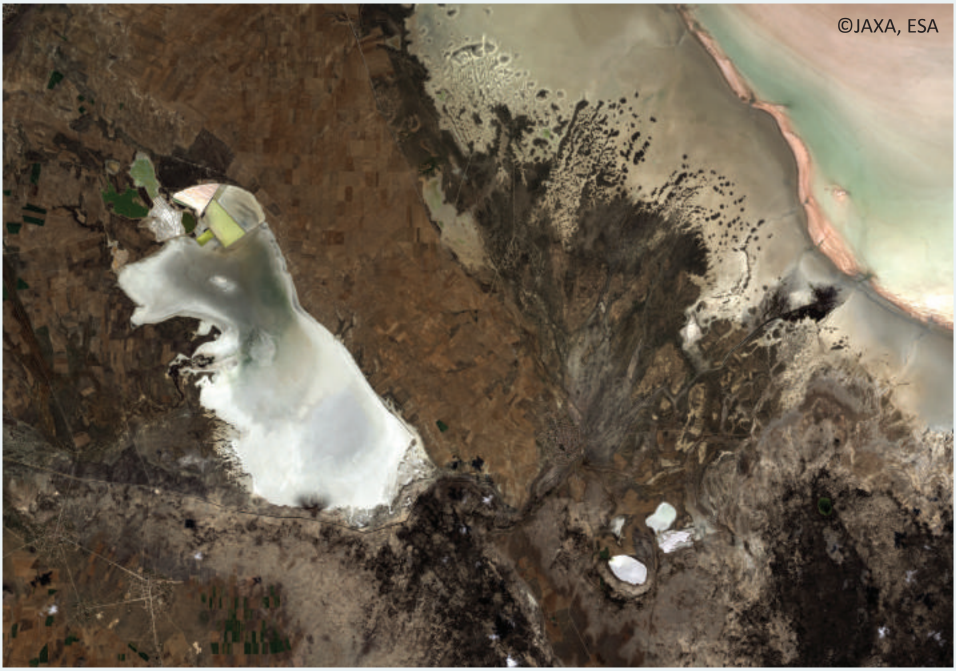
Another important aspect of biodiversity monitoring is **habitat monitoring**. The pressures and threats facing biodiversity can increase on a daily basis. Loss of habitat and habitat integrity, in particular, are seriously affected by changes in land usage. In addition to grazing and non-sustainable land usage, the development of infrastructure, construction and the conversion of natural areas to agricultural land all play a major role in processes of fragmentation and the extinction of habitats.

In the light of such intense pressures and threats, the need for a monitoring programme for priority habitats is self-evident. In general, costs for the monitoring process – and for biodiversity monitoring – should be minimized to avoid exerting undue pressure on the process. This means using monitoring resources effectively, selecting appropriate monitoring goals and, in many cases, opting for low-cost methods. For these reasons, it is important to use existing data.

There are numerous global datasets available on habitats with different spatial resolutions. However, the most interesting and promising global data source is the recent Sentinel 2 mission. Table 11 presents a brief summary of information on Sentinel data.

Table 11. Types of available satellite images and their characteristics

Category of data type	Costs	Resolution	Description of content and attributes	Data provider
Rapid eye	Commercial	5 m	RGB + Red Edge + NIR	Planet
World View 2–4	Commercial	0.5 m (WV2); 0.31 m (WV3 and 4)	9 bands (RGBY, NIR1/2, Pan, Coastal)	Digital Globe
Planetoscope	Commercial	3 m	4 bands (RGB, NIR)	Planet
Skysat	Commercial	0.8–1 m	5 bands (RGB, NIR, pan)	Planet
GeoEYE 1	Commercial	0.4 m (pan) 1.65 m (multispectral)	1, 3, 5, 7, 9 and uninterrupted band tiff images	Digital Globe
Sentinel 2	Free	10/20 m	13 bands	ESA
Landsat 8	Free	30 m	9 bands + 2 thermal infrared	NASA



Monitoring of elements such as process, the status of usage of biodiversity resources, threats, ecosystem services provided by biodiversity, traditional knowledge about biodiversity, access to biodiversity resources and sharing of benefits is essential for biodiversity monitoring (following (GDNCNP-Biodiveristy Monitoring and Assessment Report, 2012). However, such monitoring focuses mostly on species and habitats.

Monitoring indicators. The main indicators for ecosystems are key species and priority habitats. There are many criteria to guide determination, evaluation and selection of indicators which contribute to the monitoring of biological diversity. According to the Biodiversity Indicators Partnership (2010 Biodiversity Indicators Partnership. 2010; Stanwell-Smith et al., 2011), successful indicators should be:

- scientifically valid
- based on existing data
- adaptable to changes
- understandable, and
- suitable for the needs of the user.

Other important applications of indicators include raising awareness, reporting, understanding problems, providing early warning about issues and measurement processes (Mercan-Erdoğan, 2014).

The selection of species and habitats which will form the basis of monitoring is dependent on available resources and the priorities and capacity of the implementing organization. There is thus a need to prioritize species and habitats for monitoring in cooperation with decision-makers and experts, who will need to decide how best to make use of the limited resources.

Information about globally defined biodiversity indicators, such as the Living Planet Index, the Ecological Footprint and the Red List Index, are given in Box 4, Box 5 and Box 6, respectively.

Box 4. Living Planet Index

The Living Planet Index (LPI) is an indicator of the state of global biodiversity. LPI showcases changes in global biodiversity by examining a total of 9,014 populations of 2,688 species of mammals, birds, reptiles, amphibians and fish in different biomes and regions. The *Living Planet Report 2018*, published by the Worldwide Fund for Nature (WWF) and the Zoological Society of London, draws on more than 16,700 populations from the Living Planet Database, including information on more than 4 000 species of mammals, birds, reptiles and amphibians. The report underscores the scale of natural loss and highlights the 60 percent drop in populations of living species.

The Living Planet Index contains information about approximately 107 populations of 57 species in Turkey. A large proportion of the country is located inside three globally important biodiversity hotspots: the Caucasus, Mediterranean and Iran-Anatolia regions. This vast area is home to more than 160 mammals, over 460 birds, at least 10 000 plants – one-third of which are endemic, 364 butterfly species, 141 reptile and amphibian species, and 405 fish species. However, in accordance with world trends, the Living Planet Index for Turkey decreases as the Ecological Footprint rises (increasing from 1.2 in 1996 to 1.9 in 2020) (WWF Turkey, 2018).

Box 5. Ecological Footprint

The Ecological Footprint adds up all the ecological services people demand that compete for space. It includes the biologically productive area (or biocapacity) needed for crops, grazing land, built-up areas, fishing grounds and forest products (https://wwf.panda.org/knowledge_hub/all_publications/ecological_footprint2/).

Forest areas that act as sinks for carbon dioxide emissions which cannot be absorbed by oceans also fall within its scope. Ecological Footprint and biological capacity are measured using the global hectare (gha).

In Anatolia, one of the first settlements of human civilization, centuries of intense anthropogenic pressure have significantly changed natural ecosystems. Human influence gained momentum in the 1950s and reached its peak in the 2000s. While there was a quantitative rise in forest areas over the last 50 years, wetlands lost almost half of their area during the same period, and the number and species of birds visiting them declined rapidly. Streams lost their natural structure, shores surrendered to construction, and the spread of maquis, meadows and pastures, which are relatively rich in terms of endemism, increased rapidly. Drought has also increased with climate change.

As a result of developments in agricultural input, field irrigation and rise in productivity per hectare, especially in agricultural areas, the total global biological capacity increased from 9.9 billion to 12 billion gha between 1961 and 2010. However, the global population also increased from 3.1 billion to approximately 7 billion people over the same period, leading to a decrease in biological capacity per person from 3.2 to 1.7 gha. Simultaneously, the Ecological Footprint per person increased from 2.5 to 2.7 gha. Thus, while biological capacity has increased globally, the amount in circulation is significantly lower.

The world population is predicted to reach 9.6 billion in 2050 and 11 billion in 2100, a trend that will see the amount of biological capacity per person decline further. It also will become more difficult for biological capacity to grow in the face of soil degradation, freshwater deficits and rising energy costs (WWF Turkey, 2014).

Box 6. Red List Index

The Red List Index tracks the average extinction of species over time. Its data clearly indicate that populations of endangered groups are becoming increasingly at risk.

According to the Red List, IUCN species can be divided into eight categories by degree of danger: *extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, low priority* and *data deficient*.

According to IUCN, 2 percent of species in the world are already extinct, 7 percent of species are critically endangered, 10 percent are endangered and 19 percent are on the brink of being endangered. Near threatened, vulnerable, endangered and critically endangered species make up 44 percent of all species. Species in these categories therefore urgently need protection on a global scale. If measures are not taken in the near future, the number of extinct and extinct in the wild species will increase rapidly, and populations of these species in nature will disappear.

When endangered categories are evaluated on the basis of taxa, amphibians account for the largest number of species in danger at about 2 000. Bird species follow with 1 300 endangered species, while 1 100 mammal species fall into the endangered category. In other taxa, the number of endangered species is less than 500. In this group, reptiles account for the largest number of endangered species, while dragonflies are the taxon with the lowest number of endangered species (GDNCNP-Biodiveristy Monitoring and Assessment Report, 2012).

Monitoring methods and tools. Monitoring methods are subject to change for different species groups and habitats. Moreover, if the biodiversity monitoring encompasses not only species and habitat monitoring, but also process, the status of biodiversity resource usage, threats, the ecosystem services provided by biodiversity, traditional knowledge about biodiversity, access to biodiversity resources and sharing of benefits, the individual method and appropriate tools should be defined for each topic. It important to take a systematic approach to biodiversity monitoring. After the selection of relevant species and habitats for monitoring, the methodology, sampling, sample size, monitoring period and frequency can be determined with the related experts. Direct observation, counting of individuals, point observation and point transects, satellite imagery, drones and photography (photo-traps, etc.) can all be employed as biodiversity monitoring methods.

Monitoring staff. The selection of key species and priority habitats will define the staff needed for the monitoring process, and may include botanists, mammologists, ecologists, ornithologists, herpetologists, entomologists, and database and GIS experts, among others.

Monitoring period. Biodiversity indicators should be monitored monthly/ annually and seasonally.

Data management. The data management system will consist of data gathering, recording, evaluation, analysis, storage, reporting and dissemination. A sample framework for biodiversity monitoring is given in Table 12.

Table 12. Biodiversity monitoring programme

Biodiversity topics	Indicators	Monitoring methods	Monitoring staff	Monitoring period	Data management
1. Key species	Population changes and their causes	- Direct observation - Counting of individuals - Point observation and point transects - Modified time species counting - Photography (photo-traps, etc.) - Templates prepared for species observation (e.g. overlap-abundance scale) - Application of temporary and permanent sample areas, - Field diary method	Botanist, mammologist, ornithologist, amphibian, entomologist, database expert, GIS expert (differs based on the biodiversity values)	Monthly/ annually/ seasonally	Data gathering, recording, evaluation, analysis, storage, reporting and dissemination
2. Priority habitats	- Area coverage of steppe habitats - Area coverage of semi-desert habitats - Land cover change in classes and ha - Land productivity change in t/ha/ year - Naturalness of ecosystems	- Direct observation, taking photographs - Satellite imagery - Aerial photographs	Botanist, mammologist, ornithologist, herpetologist, entomologist, database expert, GIS expert (differs based on the biodiversity values,) etc.	Monthly/ annually/ seasonally	Data gathering, recording, evaluation, analysis, storage, reporting and dissemination

3.3. Socio-economic and grazing monitoring

Socio-economic development and economic activities are key drivers for shaping the landscape in natural ecosystems. In particular, construction activities, agricultural extension, local livelihood strategies and pastoralism affect conservation objectives.

Socio-economic monitoring programmes should examine the area's socio-cultural structures and unique features together with socio-cultural characteristics, all of which can constitute basic resource values.

Ecosystems are potential areas for animal husbandry and, consequently, for grazing. However, in many cases, overgrazing and mis-timed grazing lead to degradation and biodiversity loss, despite functioning as important source of income for local populations. Monitoring of **socio-economic conditions** and **grazing activities** is thus key to any monitoring programme.

Other essential issues may include the inputs and results of tourism and recreation, which affect socio-economic development and changes. In addition, it is important to monitor demographic structures and population estimations and trends, as well as gender distribution and roles. Another central issue for monitoring is the economic benefits drawn from the natural ecosystem by the population that live within it.

Each element incorporated in the monitoring programme is determined in accordance with the overall purpose of monitoring and the objectives to be achieved. For example, as socio-economic and socio-cultural issues are quite extensive, the framework and limits of monitoring should be clearly defined.

Monitoring indicators. The main socio-economic and socio-cultural indicators can be grouped under the headings of demography, socio-economy, tourism and recreation, visitor management, livestock and grazing. The main demography indicators are population size, average household size, age and gender distribution, education level, age groups and migration rates.

Socio-economic indicators consist of the number of people who work in the main economic activities, agricultural production patterns and amounts, per capita income, income generated by agricultural activities, number of livestock per household and so on.

Although socio-cultural monitoring indicators depend on the characteristics of the area's diversity of assets, examples can include change levels and cultural norms and attitudes.

Visitor management indicators comprise the number and distribution of visitors, capacity, visitor satisfaction level and so on. Tourism and recreation visitor management can be evaluated together or separately. Here, tourism-related assets, infrastructure, profits and economic, ecological and social impacts can be recommended as monitoring indicators.

Livestock and grazing indicators include the number, species and distribution of livestock in pastures, duration of grazing period, area grazed by livestock in relation to the total area, density of livestock per hectare within the area, number of reported legal infringements, number and distribution of shepherds using grassland inside the protected areas, herd size and so on.

Monitoring methods and tools. Monitoring methods should be designed around the monitoring needs, objectives and indicators. They might include statistical data, interviews, surveys, questionnaires and field data collection, among others.

Monitoring staff. These include the staff necessary for the monitoring processes, and could include a demographer, socio-economic expert (sociologist, agricultural engineer, etc.), tourism expert, database expert, GIS expert and so on.

Monitoring period. Socio-economic and grazing indicators should be monitored monthly and annually.

Data management. The data management system will be composed of data gathering, recording, evaluation, analysis, storage, reporting and dissemination.

A sample framework for socio-economic and grazing monitoring is given in Table 13.

Table 13. Socio-economic and grazing monitoring programme

Socio-economic and grazing topics	Monitoring indicators	Monitoring methods and tools	Monitoring staff	Monitoring period	Data management
Demography	- Population size - Average household size - Age and gender distribution - Education level - Age groups - Migration rate	Comparison of statistical data over the last 20 years	Demographer	Monthly/ annually/ seasonally	Data gathering, recording, evaluation, analysis, storage, reporting and dissemination
Socio-economy	- Number of people working in main economic activities - Agricultural production patterns and amount - Per capita income - Income generated by agricultural activities - Number of livestock per household	- Comparison of statistical data - Interviews - Surveys - Field data collection	Socio-economic expert (sociologist, agricultural engineer, etc.), database expert, GIS expert	Monthly/ annually/ seasonally	Data gathering, recording, evaluation, analysis, storage, reporting and dissemination
Tourism, recreation, and visitor management	- Number of visitors - Distribution of visitors - Visitor satisfaction level - Profits from tourism - Number of individuals interested in tourism - Ecological, environmental and economic impacts of tourism (positive and negative)	- Statistical data - Interviews - Surveys -Questionnaires	Tourism expert statistician pollster	Monthly/ annually/ seasonally	Data gathering, recording, evaluation, analysis, storage, reporting and dissemination
Livestock and grazing	- Number and species of livestock in pasture - Distribution of livestock in pasture - Duration of grazing period - Area grazed by livestock in relation to total area - Density of livestock per ha within the protected area - Number of reported legal infringements - Number of shepherds using grassland inside the protected areas - Distribution of shepherds using grassland inside the protected areas - Herd size - Number of nomads - Number of animals grazed by nomads	- Statistical data - Interviews - Surveys - Field data collection	Grassland expert/ agricultural engineer (agricultural economist), database expert, GIS expert	Monthly/ annually/ seasonally	Data gathering, recording, evaluation, analysis, storage, reporting and dissemination

3.4. Management effectiveness monitoring

Evaluation and monitoring of management effectiveness is a vital component of adaptive and participatory site management, which requires managers and stakeholders to work together and learn from experience. Nowadays, monitoring and evaluation of the effectiveness of management for areas with landscapes, biodiversity, socio-economic and socio-cultural assets, where protection is a priority, is considered as important as the spatial and numeric growth of these areas. The main reasons are to show that the assets of conservation areas are well protected and to ensure that timely measures are taken to cope with identified problems and difficulties linked to protection. In addition, efforts to define the ecological, economic and social benefits of these areas can highlight the importance of protected areas.

Numerous methods and tools have been developed for the monitoring and evaluation of management efficiency – a field of crucial importance for the success of conservation in these areas. Approximately 72 different protected area management efficiency (PAME) data collection and evaluation methods and tools have been developed to systematically evaluate the efficiency of protected area management, a number that is increasing with new methods being developed in Europe and Latin America (Coad vd., 2015; Leverington vd., 2010; Hockings vd., 2006). The most widely used methods are Rapid Assessment and Prioritization of Protected Area Management (RAPPAM) and the Management Effectiveness Tracking Tool (METT) (Courrau *et al*., 2006).

Together with the above-mentioned evaluation tools, international certification systems provide integral and participatory management approaches for all protected areas and/or areas with sensitive and rare ecosystems. The UNESCO World Heritage List, the IUCN Green List and Green Species List, the EU A Class Certificate under the RAMSAR convention and European Wilderness are just some of these certification systems for protected area management evaluation.

Tools used for the evaluation of protected area management efficiency are classified into three groups:

- evaluation tools at the system level (aimed at main trends and issues)
- tools for monitoring and evaluating progress based on common issues across multiple areas (implementation is fast and easy)
- detailed tools aimed at developing monitoring and evaluation systems at the area level (Leverington *et al.*, 2010).

The methods and tools recommended for each group can be different. For example, RAPPAM was developed to evaluate all protected areas at a system level, while METT is used to evaluate each area individually. The UNESCO Heritage Development Tool was developed to evaluate World Natural Heritage Sites, (Avcıoğlu-Çokçalışkan, Lise and Stanciu, 2010). Information on the evaluation of management efficiency is provided in the **Guidelines for Assessing the Management Effectiveness of Protected Areas** prepared within the framework of the present project.

Monitoring indicators. The following indicators can be used to measure the level of management effectiveness:

- legal status of the area
- protected area boundary demarcation
- existence of a management plan
- existence of a resource inventory
- existence of protection systems
- existence of research
- existence of resource management
- staff numbers
- staff training
- equipment
- administrative structure.

Monitoring methods and tools. Many tools and methods have been developed to measure management effectiveness, but RAPPAM and METT are the most frequently used. METT has been designed to track and monitor progress towards worldwide protected area management effectiveness. The methodology consists of a rapid assessment based on a scorecard questionnaire. The RAPPAM methodology is designed to enable broad-level comparisons among many protected areas, which together make up a protected areas network or system.

RAPPAM is a tool that allows decision-makers to rapidly evaluate progress made by the current management of the protected area. The RAPPAM method takes the form of a file completed by a manager or field worker of a protected area that provides a quick overview of general progress made by the conservation area management. The results of this method are therefore limited (Avcıoğlu-Çokçalışkan, Lise and Stanciu, 2010). Some of the tools used for management efficiency evaluation are summarized in Box 7, Box 8, Box 9 and Box 10.

Box 7. Rapid Assessment and Prioritisation of Protected Area Management Tool (RAPPAM)

RAPPAM is one of the two most widely used and adapted, globally applicable generic systems developed to assess protected area management effectiveness. It is used to report progress towards the Convention on Biological Diversity.

The RAPPAM methodology is designed for broad-level comparisons among many protected areas which together make up a protected areas network or system. RAPPAM provides policy-makers and protected area authorities with a relatively quick and easy method to identify major trends and issues that need to be addressed in order to improve management effectiveness in any given system of protected areas – whether in a country, region or ecoregion. RAPPAM provides protected area agencies with a country-wide overview of the effectiveness of protected area management, threats, vulnerabilities and degradation. It can be used for prioritization and resource allocation, to raise awareness and support, and to improve management (adaptive management) at the system level (Conservation Gateway of Nature Conservancy, 2011; Ervin, 2003).

Box 8. Management Effectiveness Tracking Tool (METT)

The targets and features of METT are similar to those of RAPPAM. It has been designed to track and monitor progress towards worldwide protected area management effectiveness. The methodology consists of a rapid assessment based on a scorecard questionnaire. The scorecard includes all six elements of management identified by the IUCN World Commission on Protected Areas (WCPA). The framework includes context, planning, inputs, process, outputs and outcomes, but emphasizes context, planning, inputs and processes. It is basic and simple to use and provides a mechanism for monitoring progress towards more effective management over time. It is used to enable protected area managers and donors to identify needs, constraints and priority actions in order to improve the effectiveness of protected area management (Courrau *et al.*, 2006).

Box 9. IUCN Green List for Protected Areas

The **IUCN Green List for Protected Areas** is the best, first global practice standard developed for field-based protection. It takes the form of a certification programme for effectively and fairly managed conservation areas such as national parks, World Natural Heritage sites, areas managed by communities and natural reserves.

The aim of the IUCN Green List is to increase the number of conservation areas providing long-term protection for people and nature, by ensuring recognition of well-managed territories.

The **IUCN Green List Standard** is based on the four components of successful nature conservation in protected areas: good governance, effective design and planning, efficient management and successful protection outputs.

Taken together, these four components support the "successful management outputs" component, which determines whether the purpose and objectives of an area have been achieved. Each component has its own set of criteria and indicators to measure achieved results. Evaluations are performed on the basis of these indicators (IUCN, 2019).

Box 10. IUCN Green Species List: A way to measure conservation success

The IUCN Red List of Species in Danger is the most widely used source of information about the conservation status of a species. However, it is likely that it will soon be replaced by another evaluation tool – the IUCN Green Species List.

The IUCN Red List measures decreases in animal and plant species and classifies species according to their extinction status. However, the List leaves questions unanswered. For example, if despite of years of protection a species extinction category does not change, does this indicate that the protection measures are ineffective? This question highlights the need for a different method that will emphasize protecting and reviving species, and provide incentives for positive protection actions and programmes.

The rationale behind the creation of the Green Species List is to change the method of conservation success measurement. The Green Species List concept, published in *Conservation Biology*, aims to help species reach their maximum potential rather than pull them away from the edge of extinction, as is the case with the Red List.

The concept starts by defining what a "fully recovered species" looks like. It then gives a set of four criteria to measure the importance of protection actions for species recovery, taking into account previous actions for protecting species and possible future measures.

Within this framework, the Green List Score calculates the long-term recovery status of a species, and evaluates how conservation actions will contribute to this recovery, what actions are necessary and what else is needed. These calculations also take different counter-scenarios into account.

The Green List is believed to set a global standard for the recovery of species and successful conservation, and metrics from the Green Species List are expected to be included in the Red List in coming year.

The Green List is expected to evaluate the recovery of species based on geographical distribution, existence and functionality. These factors will be measured by Green List Points indicating how far the species is from full recovery on a scale from 0 to 100.

The head of the Red List Unit, Craig Hilton-Taylor, acknowledges that IUCN needs to demonstrate that conservation of biodiversity and setting objectives leads to success. This new concept thus represents an ambitious change in the approach to protection, with a view to ensuring the recovery of species rather than averting their extinction. It is expected that the Green List will be widely used and effective in guiding the priorities of conservation (Akçakaya *et al.*, 2018; IUCN, 2019).

Monitoring staff. Management effectiveness monitoring should be carried out by monitoring and evaluation experts. These experts can be drawn from numerous disciplines with experience in project development, implementation, monitoring and evaluation.

Monitoring period. Indicators of management efficiency should be monitored every three or five years, in accordance with the selected method.

Data management. The data management system will consist of data gathering, recording, evaluation, analysis, storage, reporting and dissemination.

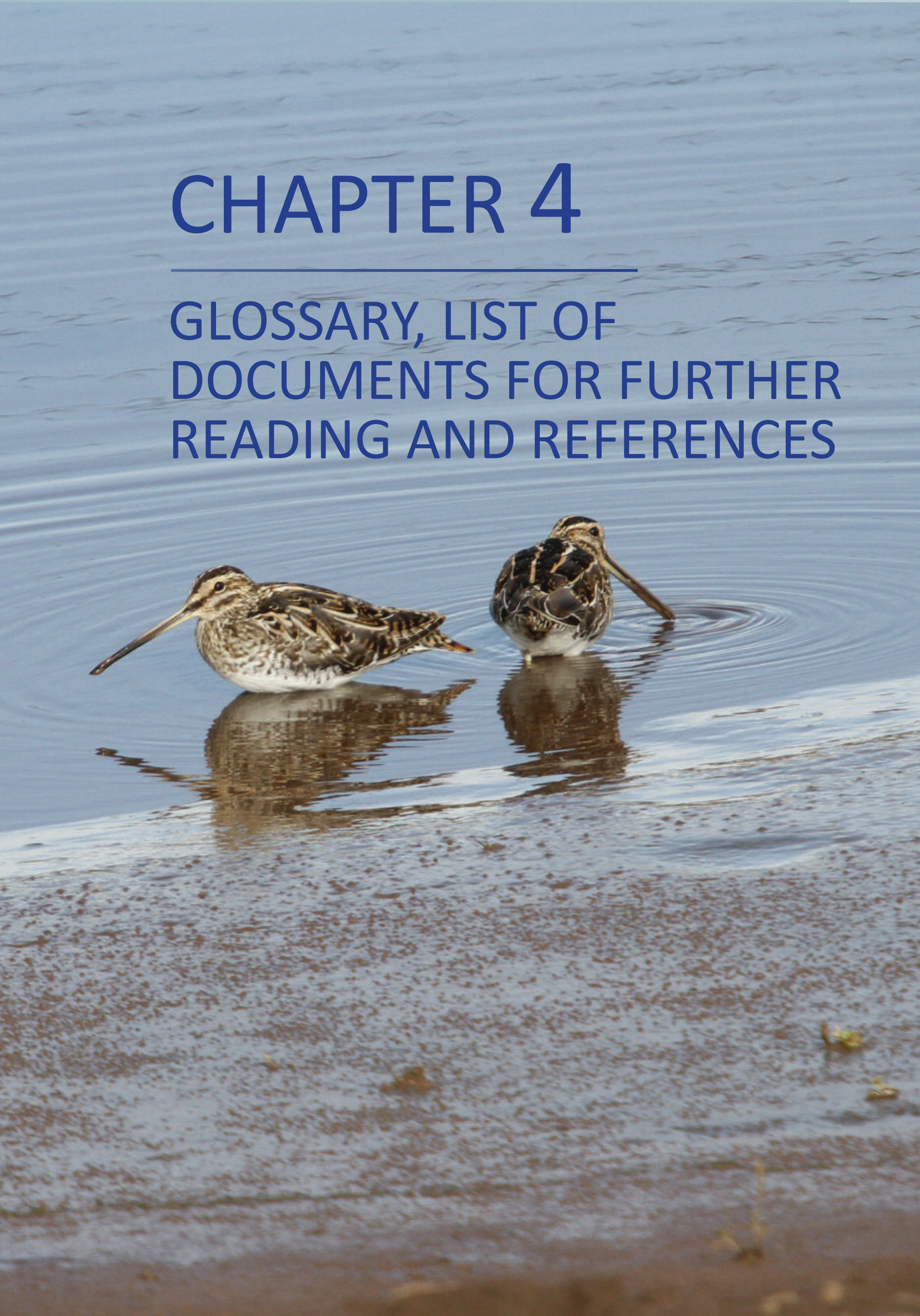
A sample framework for management effectiveness monitoring is given in Table 14.

Table 14. Management effectiveness monitoring programme

Management effectiveness topics	Monitoring indicators	Monitoring methods	Monitoring staff	Monitoring period	Data management
Management effectiveness and measures	- Legal status of the area - Protected area boundary demarcation - Existence of management plan - Existence of resource inventory - Existence of protection systems - Existence of research - Existence of resource management - Staff numbers - Staff training - Equipment	- Regular monitoring and evaluation - METT - RAPPAM	Monitoring and evaluation experts	Three or five annually	Data gathering, recording, evaluation, analysis, storage, reporting and dissemination

CHAPTER 4

GLOSSARY, LIST OF DOCUMENTS FOR FURTHER READING AND REFERENCES



GLOSSARY

Evaluation	Determining the effectiveness of specific measures.
Habitat	A **habitat** is an area that is lived in by a particular species of animal, plant, or other type of organism. It is the natural environment in which an organism lives, or the physical environment that surrounds a population (https://simple.wikipedia.org/wiki/Habitat#)
Indicator	A systematic determination of a subject's merit, worth and significance, using criteria governed by a set of standards.
Indicator species	A plant or animal whose presence is indicative of a specific environment.
Monitoring	Surveillance undertaken to determine the extent of compliance with a predetermined standard or the degree of deviation from an expected norm (Hellawell, 1991).
	The collection and analysis of repeated observations or measurements to evaluate changes in conditions and progress towards meeting a management objective.
Monitoring plan	A guide clearly stating what should be monitored, what information is needed and for whom the monitoring is being done.
Observation	A record (e.g. measurement of height, numerical count) taken from a sample unit.
Population	Any collection of individual items or units which are the subject of investigation. The population is the total number of units, from which subsets or samples are usually taken.
Sample	A subset of the units in a population which represents the population as a whole. If a sample is to be truly representative, the sample must be drawn randomly (i.e. free from bias) from the population.
Sample population	The population or area from which samples may be drawn.
Sample/ sampling unit	A sample unit is an individual population unit from a sample. A sampling unit is a collection of observations with specified dimensions (e.g. a quadrat). A set of these comprises a sample.
Target population	The population of interest for the study (e.g. the population of a species or a habitat area that is being managed and for which there is a set conservation objective).

FURTHER READING

- **Quantifying species recovery and conservation success to develop an IUCN Green List of Species.** H. Resit Akcakaya, Elizabeth L. Bennett, Thomas M. Brooks, Molly K. Grace, Anna Heath, Simon Hedges, Craig Hilton-Taylor , Michael Hoffmann, David A. Keith , Barney Long, David P. Mallon, Erik Meijaard, E.J. Milner-Gulland, Ana S.L. Rodrigues, Jon Paul Rodriguez, P.J. Stephenson,Simon N. Stuart, and Richard P. Young.
- **Conservation Biology**, Volume 32, No. 5, 1128–1138 C 2018 The Authors. Conservation Biology published by Wiley Periodicals, Inc. on behalf of Society for Conservation Biology. DOI: 10.1111/cobi.13112
- **User Manual: IUCN Green List Programme, 2019**. IUCN, World Commission on Protected Areas (WCPA) and Assurance Services International (ASI) (2019). IUCN Green List of Protected and Conserved Areas: User Manual, Version 1.2. Gland, Switzerland: IUCN.
- **Statistical/monitoring tools for the design and analysis of conservation monitoring data**. Doak and Pollock. http://www.biology.ucsc.edu/people/doaklab/natconserv/index.html
- **Tools for measuring, modelling, and valuing ecosystem services Guidance for Key Biodiversity Areas, natural World Heritage sites, and protected areas.** Neugarten, R.A., Langhammer, P.F., Osipova, E., Bagstad, K.J., Bhagabati, N., Butchart, S.H.M., Dudley, N., Elliott, V., Gerber, L.R.,
- **Tools for measuring, modelling, and valuing ecosystem services: Guidance for Key Biodiversity Areas, natural World Heritage Sites, and protected areas** (2018)**.** Gutierrez Arrellano, C., Ivanić, K.-Z., Kettunen, M., Mandle, L., Merriman, J.C., Mulligan, M., Peh, K.S.-H., Raudsepp-Hearne, C., Semmens, D.J., Stolton, S., Willcock, S. Gland, Switzerland: IUCN. x + 70pp.
- **Integrated planning Policy and law tools for biodiversity conservation and climate change** (2019). Lausche, B., Integrated planning. Policy and law tools for biodiversity conservation and climate change. Gland, Switzerland: IUCN. xvi + 120 pp.
- **Guidelines for the application of IUCN Red List of Ecosystems Categories and Criteria.** Bland, L.M., Keith, D.A., Miller, R.M., Murray, N.J. and Rodríguez, J.P. (eds.) (2016). Guidelines for the application of IUCN Red List of Ecosystems Categories and Criteria, Version 1.0. Gland, Switzerland: IUCN. ix + 94pp.
- **An Introduction to the IUCN Red List of Ecosystems: The Categories and Criteria for Assessing Risks to Ecosystems**. IUCN (2016). An Introduction to the IUCN Red List of Ecosystems: The Categories and Criteria for Assessing Risks to Ecosystems. Gland, Switzerland: IUCN. vi + 14pp.
- **A Global Standard for the Identification of Key Biodiversity Areas**. IUCN (2016). A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0. First edition. Gland, Switzerland: IUCN.
- **Freshwater Key Biodiversity Areas in the north-western Mediterranean sub-region**. Máiz-Tomé, L., Darwall, W., Numa, C., Barrios, V. and Smith, K. G. (2017). Freshwater Key Biodiversity Areas in the north-western Mediterranean sub-region. IUCN, Gland, Switzerland, Cambridge, UK and Malaga, Spain: viii + 48pp.

- **Identification and Gap Analysis of Key Biodiversity Areas Targets for Comprehensive Protected Area Systems.** Langhammer, P.F., Bakarr, M.I., Bennun, L.A., Brooks, T.M., Clay, R.P., Darwall, W., De Silva, N., Edgar, G.J., Eken, G., Fishpool, L.D.C.,3 Fonseca, G.A.B. da, Foster, M.N., Knox, D.H., Matiku, P., Radford, E.A., Rodrigues, A.S.L., Salaman, P., Sechrest, W., and Tordoff, A.W. (2007). Identification and Gap Analysis of Key Biodiversity Areas: Targets for Comprehensive Protected Area Systems. Gland, Switzerland: IUCN.
- **Protected planet report 2018: tracking progress towards global targets for protected areas**
- **Monitoring plant and animal populations**. Elzinga *et al.* (2001).
- **Monitoring Natural Resources in our National Parks**, http://www.nature.nps.gov/im/monitor/
- **Designing field studies for biodiversity conservation**. Feinsinger (2001).
- **Monitoring for conservatıon and ecology**. Goldsmith (1991).
- **A species and habitat servey, evaluation and monitoring handbook**. Hill *et al.* (in press).
- **Ecological methodology**. 2nd ed. Krebs (1999).
- **Ecological methods.** Southwood (1978).
- **Monitoring ecological change**. Spellerberg (1991).
- **Ecological census techniques.** Sutherland (1996).
- **Handbook of Biodiversity Methods, Survey, Evaluation and Monitoring,** Hill, D., Fasham, M., Tucker, G., Shewry, M., Shaw, P. 2005.
- **Biodiversity Inventory and Monitoring:** A review of national and international systems and a proposed framework for future biodiversity monitoring by the Department of Conservation. 2005. William Lee, Matt McGlone, Elaine Wright. Landcare Research Contract Report: LC0405/122
- **Monitoring Biodiversity: Quantification and Interpretation**. William L. Gaines, Richy J. Harrod, and John F. Lehmkuhl. 1999. United States Department of Agriculture Forest Service Pacific Northwest Research Station General Technical Report PNW-GTR-443 March 1999
- **Tourism and visitor management in protected areas**, Guidelines for sustainability. Leung, Yu-Fai, Spenceley, Anna, Hvenegaard, Glen, and Buckley, Ralf (eds.) (2018). Tourism and visitor management in protected areas: Guidelines for sustainability. Best Practice Protected Area Guidelines Series No. 27, Gland, Switzerland: IUCN. xii + 120 pp
- **Guidelines for the Establishment and Management of Mediterranean Marine and Coastal Protected Areas**. López Ornat, A. (Editor) 2006 United Nations Environment Programme Mediterranean Action Plan. MedMPA project. Ed: UNEP-MAP RAC\SPA.Tunis

REFERENCES

2010 Biodiversity Indicators Partnership. 2010. Biodiversity indicators and the 2010 Target: Experiences and lessons learnt from the 2010 Biodiversity Indicators Partnership. Secretariat of the Convention on Biological Diversity, Montréal, Canada. Technical Series No. 53, 196 pages

Avcıoğlu-Çokçalışkan, B., Lise, Y. & Stanciu, E. 2010. *Türkiye'de Korunan Alanlar Yönetimi Etkinliği. Kırsal Çevre Yıllığı 2010* [Protected area management effectiveness in Turkey: Rural environment yearbook 2010]. Ankara, Research Association of Rural Environment and Forestry.

Akcakaya, H.R., Bennett, E.L., Brooks, T.M., Grace, M.K., Heath, A., Hedges, S., Hilton-Taylor, C., Hoffmann, M., Keith, D.A., Long, B., Mallon, D.P., Meijaard, E., Milner-Gulland, E.J., Rodrigues, A.S.L., Rodriguez, J.P., Stephenson, P.J., Stuart, S.N. & Young, R.P. 2018. Quantifying species recovery and conservation success to develop an IUCN Green List of Species. *Conservation Biology*, 32(5): 1128–1138. https://doi.org/10.1111/cobi.13112.

Caughlan, L. & Oakley, K.L. 2001. Cost consideration for long-term ecological monitoring. *Ecological Indicators*, 1(2): 123–124.

Coad,L.,Leverington, F.,Kathryn Knights,Jonas Geldmann,April Eassom,Valerie Kapos,Naomi Kingston,Marcelo de Lima,Camilo Zamora,Ivon Cuardros,Christoph Nolte,Neil D. Burgess, arc Hockings. Measuring impact of protected area management interventions: current and future use of the Global Database of Protected Area Management Effectiveness. Published 12 October 2015.DOI: 10.1098/rstb.2014.0281

Conservation Gateway of Nature Conservancy. 2011. *RAPPAM: Rapid Assessment and Prioritisation of Protected Area Management Tool* (available at www.conservationgateway.org/ExternalLinks/Pages/rappam-rapid-assessment-a.aspx).

Courrau, J., Dudley, N., Hockings, M., Leverington, F. & Stolton, S. 2006. *Evaluating effectiveness: A framework for assessing management effectiveness of protected areas*. Best Practice Protected Area Guidelines Series Monographic Series No. 14. Gland, Switzerland, International Union for Conservation of Nature.

DKMPGM-Biyoçeşitliliği İzleme ve Değerlendirme Raporu, 2012. T.C. ORMAN VE SU İŞLERİ BAKANLIĞI DOĞA KORUMA VE MİLLİ PARKLAR GENEL MÜDÜRLÜĞÜ Biyolojik Çeşitlilik Daire Başkanlığı İzleme ve Değerlendirme Şube Müdürlüğü

Elzinga, C.L., Salzer, D.W., Willoughby, J.W. & Gibbs J.P. 2009. *Monitoring plant and animal populations: A handbook for field biologists.* Malden, MA, Blackwell Science.

Ervin, J. 2003. WWF: *Rapid Assessment and Prioritization of Protected Area Management (RAPPAM) methodology*. Gland, Switzerland, World Wide Fund for Nature.

Friberg, R. 2010. *Monitoring, evaluation and adaptive management in the Araucarias Del Alto Malleco model forest of Chile*. Victoria, BC, Royal Roads University.

Gaines, W.L., Harrod, R.J. & Lehmkuhl, J.F. 1999. *Monitoring biodiversity: Quantification and interpretation*. General Technical Report. Portland, WA, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station (available at https://pdfs.semanticscholar.org/16ca/66e9ba9a23fe9fce7358b907d3de32f1306d.pdf).

Goldschmid, E.B. (ed.) 1991. *Monitoring for conservation and ecology*. London, Chapman and Hall.

Hellawell, J.M. 1991. Development of rationale for monitoring. *In* B. Goldsmith, ed. *Monitoring conservation and ecology*, pp. 1–14. London, Chapman and Hall.

Hill, D., Fasham, M., Tucker, G., Shewry, M. & Shaw, P. 2005. *Handbook of biodiversity methods, survey, evaluation and monitoring*. New York, Cambridge University Press.

Hockings, M., Stolton, S., Leverington, F., Dudley, N. and Courrau, J. 2006. Evaluating Effectiveness: A framework for assessing management effectiveness of protected areas. 2nd edition. IUCN, Gland, Switzerland and Cambridge, UK. xiv + 105 pp.

Huber, M., Kirchmeir, H., Berger, V. & Mayrhofer, S. 2018. *Plan and handbook for ecological long-term-monitoring for Kalkalpen National Park*., E.C.O. Institut für Ökologie. Klagenfurt, 91 S

IUCN. 2019 *Protected areas* (available at www.iucn.org/theme/protected-areas/our-work/iucn-green-list-protected-and-conserved-areas/global-standard).

IPBES. 2019. *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem* Services. Bonn, Germany, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service Secretariat (available at https://zenodo.org/record/3553579#.XsUPAJMzY6V).

Jungmeier, M. 2015. Designing research in protected areas – theory and reality. *In* Proceedings of the 5th Symposium for Research in Protected Areas, Mittersill, Austria, pp. 319-323.

Kusek, J.Z. & Rist, R.C. 2004. *Ten steps to a results-based monitoring and evaluation system*. Washington, DC, World Bank.

Lee, W., McGlone, M. & Wright, E. 2005. *Biodiversity inventory and monitoring: A review of national and international systems and a proposed framework for future biodiversity monitoring by the Department of Conservation*. Wellington, Landcare Research Ltd (available at www.landcareresearch.co.nz/publications/researchpubs/biodiv_inventory_system_review_framework.pdf).

Leverington, F., Costa, K.L., Pavese, H. & Hockings, M. 2010. A global analysis of protected area management effectiveness. *Environmental Management*, 46: 685–698. (doi:10.1007/s00267-010-9564-5)

Mercan-Erdoğan, N. 2014. *Biyolojik Çeşitliliğin İzlemesi Ve Uluslararasi Uygulamalar* [Monitoring biological diversity and international applications], Ankara. (Master tezi).

Perez, J.J. 2006. Monitoring in marine protected areas: Managing of monitoring data. *In* A. López Ornat, ed. *Guidelines for the establishment and management of Mediterranean marine and coastal protected areas*, pp. 137–157. Tunis, United Nations Environment Programme.

Sims, N.C., Green, C., Newnham, G.J., England, J.R. Held, A., Wulder, M.A., Herold, M., Cox, S.J.D., Huete, A.R., Viscarra-Rossel, R.A., Roxburgh, S.H. & McKenzie, N.J. 2017. *Good practice guidance. SDG Indicator 15.3.1. Proportion of land that is degraded over total land area. Version 1.0*. CSIRO/UNCCD. Canberra, Commonwealth Scientific and Industrial Research Organisation.

Slocombe, D.S. 1992. Environmental monitoring for protected areas: Review and prospect. *Environmental Monitoring and Assessment*, 21: 49–78.

Stanwell-Smith, D., Bubb, P., Almond, R., Chenery, A., Kapos, V. & Jenkins, M. 2011. *Guidance for national biodiversity indicator development and use.* Cambridge, UK, Biodiversity Indicators Partnership, UNEP World Conservation Monitoring Centre.

Tucker, G., Bubb, P., de Heer, M., Miles, L., Lawrence, A., Bajracharya, S.B., Nepal, R.C., Sherchan, R. & Chapagain, N.R. 2005. *Guidelines for biodiversity assessment and monitoring for protected areas*. Kathmandu, King Mahendra Trust for Nature Conservation.

Uppenbrink, M. 1998. Pressekonferenz “Ökologische Flächenstichprobe” – Statement von Präsident Martin Uppenbrink, Bundesamt für Naturschutz [Press conference “Ecological sample of land” – Statement by President Martin Uppenbrink, Federal Agency for Nature Conservation]. *In* Federal Statistical Office, ed. *Ökologische Flächenstichprobe* [Ecological area sample]. Results of the joint press conference, 3 February. Bonn, Presseclub.

WWF Turkey. 2014. *Ekolojik Ayak İzi* [Ecological footprint]. Istanbul, World Wide Fund for Nature (available at www.wwf.org.tr/basin_bultenleri/raporlar/yaayan_gezegen_raporu/yasayangezegenraporu2014/ekolojikayakizi).

WWF Turkey. 2018. *Yaşayan Gezegen Raporu 2018* [Living planet report 2018]. Istanbul, World Wide Fund for Nature (available at www.wwf.org.tr/basin_bultenleri/raporlar/?8160/Yasayan-gezegen-raporu-2018-).

Zielińska, A. 2010. Management system of protected areas and its monitoring in Poland. *Economics & Sociology*, 3(2): 121–127.

“Conservation and Sustainable Management of
Turkey’s Steppe Ecosystems Project”

GCP/TUR/061/GFF

Sets of guidelines developed to provide standards and recommendations for the sustainable management and conservation of the country’s natural assets within the framework of the project: