Food and Agriculture Organization of the United Nations

GUIDELINES ON FOREST BIODIVERSITY MONITORING METHODOLOGIES FOR CENTRAL ASIAN COUNTRIES

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Abbreviations

BIP	The Biodiversity Indicators Partnership
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CSIRO	The Commonwealth Scientific and Industrial Research Organization
EDO	European Drought Observatory
FAO	Food and Agriculture Organization of the United Nations
FAO SEC	FAO Subregional Office for Central Asia Countries
EUFORGEN	European Forest Genetic Resources Programme
GBIF	Global Biodiversity Information Facility
GIS	Geographic Information System
GEO BON	The Group on Earth Observations Biodiversity Observation Network
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IPBES	The Intergovernmental Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
MEA	Millennium Ecosystem Assessment
NCC	Nature Conservation Centre
NFIs	National Forest Inventories
OECD	Organisation for Economic Cooperation and Development
SDGs	The UN Sustainable Development Goals
UNECE	United Nations Economic Commission for Europe
UNEP	The United Nations Environment Programme
UNODCS	United Nations Office on Drugs and Crime
UNSTAT	United Nations Statistics Division
WWF	World Wide Fund for Nature

Executive summary

For effective forest biodiversity monitoring in FAO Subregional Office for Central Asia (SEC) countries (Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan and Türkiye), it is important to develop cost-effective and efficient monitoring methods. The main purpose of the guidelines on forest biodiversity monitoring methodologies is to support FAO SEC countries in their efforts to detect changes in forest biodiversity and to ensure that appropriate measures are taken for sustainable forest management.

The monitoring process begins with the assessment of monitoring requirements and the establishment of specific goals for the subsequent development of the monitoring approach. Subsequently, essential factors such as indicators, methods and tools for monitoring, team composition, frequency of monitoring, and data management are identified to shape the monitoring initiative, integrating aspects related to the state, impact, and response. The monitoring process is then concluded through the practical implementation of the programme via field investigations, analysis and interpretation of the gathered information, and dissemination of resultant reports to pertinent stakeholders. The guidelines for forest biodiversity monitoring methodologies employ this comprehensive five-step monitoring cycle as a foundation for crafting an efficient forest biodiversity monitoring programme.

The guidelines on forest biodiversity monitoring methodologies are designed to take into account the changes in pressure, state and response indicators especially for biodiversity monitoring with the contributions of subject-matter experts. This study uses the "Pressure–State–Response" framework that has been frequently used in different global, regional, and national monitoring programmes.

In the guidelines, monitoring targets for species, habitats, ecosystem services, and forestry practices are defined for each monitoring component by using relevant indicators. Using Türkiye's national biodiversity database (Noah's Ark Database) and its monitoring tables as samples, the indicators are tabulated with detailed information on the following topics:

- Monitoring Level
- Monitoring Period and Frequency
- Monitoring Area
- Monitoring Method
- Monitoring Team/Expertize
- Target / Success Criteria

For effective implementation of the guidelines, a governance mechanism is also proposed for the participation of regional and national stakeholders.

The guidelines serve as a comprehensive framework for monitoring forest biodiversity in FAO SEC countries with the aim of providing practical guidance and recommendations for establishing effective forest biodiversity monitoring systems in those countries. The guidelines also emphasize the importance of harmonization and standardization of biodiversity indicators and methods across countries, enhancing comparability and facilitating regional and global reporting.

Overview

Background and scope

Forests stand as vital ecosystems, offering invaluable ecological, economic, and societal advantages. They serve as bastions of biodiversity, actively sequester carbon, regulate water systems, and provide essential livelihood support (FAO, 2018). However, the world's forests are under siege, facing alarming threats like rampant deforestation, pervasive degradation, detrimental fragmentation, and the relentless impacts of climate change. These perilous circumstances have triggered a distressing decline in both forest biodiversity and the crucial ecosystem services they deliver. Consequently, it becomes an utmost necessity to diligently monitor and comprehensively assess the state and dynamics of forest biodiversity (FAO and UNEP, 2020). This imperative task serves as a compass, guiding decision-makers, shaping effective policies, and enabling the sustainable management of these precious forested landscapes.

These guidelines provide practical recommendations for monitoring forest biodiversity in the FAO Subregional Office for Central Asia (SEC) countries (Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan and Türkiye). They aim to establish effective monitoring systems to generate reliable and comparable data on forest biodiversity, identify priority areas and threats, and track management and conservation impacts. The guidelines promote harmonization and standardization of biodiversity indicators and methods to enhance data comparability and transparency for regional and global reporting.

The guidelines target government agencies, researchers, Nongovernmental Organizations (NGOs), the private sector, local communities, and international organizations involved in forest biodiversity monitoring and management. They are also useful for those interested in understanding biodiversity monitoring concepts and their application in forest conservation.

Forest biodiversity in FAO subregional office for Central Asia (FAO SEC) countries

Among the FAO Subregional Office for Central Asia (FAO SEC) countries, forests play a crucial role, providing crucial support to highly diverse but vulnerable ecosystems. This region serves as a unique convergence point for diverse biogeographic regions, resulting in a rich tapestry of landscapes and ecosystems that harbour a wide array of biodiversity. It is also characterized by its exceptional endemism, species richness, taxonomic uniqueness, and the rare presence of major habitat types (FAO, 2022).

However, environmental changes have posed significant challenges to forest ecosystems in the region since the dissolution of the Soviet Union. Intense anthropogenic pressures, such as excessive or illegal logging for fuelwood, overgrazing, and infrastructure projects, have resulted in deforestation, soil erosion, and loss of forest cover. The process of land privatization has further exacerbated these issues (FAO, 2020).

To gain a comprehensive understanding of forest biodiversity in the FAO SEC countries, a stocktaking assessment was conducted, examining each country under different headings: general information on biodiversity, nature conservation (protected area network), general information on forest ecosystems, forest biodiversity, forest biodiversity monitoring, and multilateral projects on forest ecosystems.

Azerbaijan, located within the Caucasus Biodiversity Hotspot, boasts a diverse range of habitats, including forests, alpine meadows, and mountain steppes. It showcases high levels of endemism for vascular plants within the temperate zone. Currently, Azerbaijan has a forest cover of 1 137 700 hectares (13.7 percent) dominated by deciduous species. However, systematic forest biodiversity monitoring is lacking in the country (FAO, 2022).

Kazakhstan, the largest country in Central Asia, has forests covering 3 309 000 hectares (1.3 percent) of its land, with saxaul vegetation accounting for nearly half of the forest ecosystems. The country has terrestrial protected areas covering 10.03 percent of its total land area, but systematic forest biodiversity monitoring is yet to be established (FAO, 2020).

The Kyrgyz Republic, despite being smaller in size, exhibits a high biodiversity due to its geological diversity and varied habitats. Forests cover 6.9 percent of the country, primarily situated between 700 and 3500 meters above sea level. The Special Protected Area network covers 7.4 percent of the total area. Kyrgyzstan is currently implementing a national monitoring programme for several mammal species listed in the Red Data Book, as well as game birds and mammals (FAO, 2020).

Turkmenistan, primarily a desert country, showcases a range of ecosystems such as deserts, marshes, lakes, mountain forests, the Caspian Sea, and coastlines. The current forest cover of Turkmenistan is 4.26 million hectares (8.8 percent), with 2.4 percent of these forests under protection. While Special Protected Areas cover 3.25 percent of the country's land area, systematic biodiversity monitoring is still absent (FAO, 2020).

Tajikistan, with a current forest cover of 3.1 percent (which was 16–18 percent in 1920), possesses a protected areas system that encompasses approximately 31 690 km^2 (22.28 percent) of the total country area. The region harbours numerous rare and endangered species; however, the lack of an adequate monitoring system hinders the assessment of biodiversity and ecosystem status (FAO, 2020).

Türkiye, situated at the crossroads of three continents, boasts diverse ecosystems and forests that cover 29.40 percent of its land area (FAO, 2020). The country has implemented an ecosystem based multi-functional forest management approach and has successfully integrated biodiversity into over 1.15 million hectares of forest ecosystems. Additionally, Türkiye has established the Noah's Ark National Biodiversity Database, which serves as a foundation for national biodiversity monitoring.

Uzbekistan, with its diverse biogeographical zones, has forests covering 8.4 percent of its land area, representing different forest types such as desert zone forests, mountain deciduous forests, juniper forests and tugai forests. The national protected area system covers a substantial portion of the country, and efforts are being made to implement an improved national monitoring system as part of biodiversity and ecosystem services management (FAO, 2020).

Monitoring of forest biodiversity

Forests are vital for human life, providing various benefits such as maintaining air quality, supporting biodiversity, offering habitats for plants and animals, sustaining livelihoods, protecting watersheds, moderating climate change, and supplying renewable resources like lumber (UNECE and FAO, 2021). To ensure the continued provision of these benefits, it is crucial to monitor and assess forest biodiversity in the FAO Subregional Office for Central Asia (FAO SEC) countries (Azerbaijan, Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan, Tajikistan, and Türkiye).

Monitoring is an integral part of biodiversity conservation and conservation biology, involving the systematic collection and analysis of repeated observations or measurements (Elzinga *et al*., 2009; Ülgen and Lise, 2020). Its significance extends globally, as it is considered one of the essential tools for nature conservation (Schmeller, 2008). By relying on reliable observations, monitoring studies aim to identify, measure, evaluate, and draw conclusions about the natural changes in species, ecosystems, and social issues over time, whether they result from intentional or unintentional human intervention (Marsh and Trenham, 2008).

In order to ensure the efficacy of monitoring forest biodiversity, it is imperative to discern the appropriate indicators that can effectively gauge and evaluate transformations in forest conditions. These indicators need to be pertinent to the objectives of forest management, easily measurable and interpretable and possess a keen sensitivity to alterations in forest biodiversity. Furthermore, the frequency of monitoring should be established based on the pace at which these indicators change and the available resources. Indicators that exhibit swift fluctuations necessitate more frequent monitoring, while indicators with gradual variations may be adequately assessed through less frequent monitoring. By employing such a comprehensive approach, it can be enhanced the accuracy and reliability of forest biodiversity monitoring (MEA, 2005).

Efficient data management plays a vital role in ensuring the effectiveness of monitoring forest biodiversity. It is essential to securely store all collected data in a manner that allows easy access and regularly analyze it to identify any changes and advancements towards meeting management objectives. To enable stakeholders to make well informed decisions, monitoring data should adhere to standardized protocols, be transparent, and be readily accessible. Additionally, employing suitable statistical techniques during data analysis aids in identifying patterns and deviations, and communicating the results in a timely and comprehensible manner to all relevant stakeholders further enhances the process. By prioritizing robust data management practices, it can be optimized forest biodiversity monitoring efforts (IPBES, 2019).

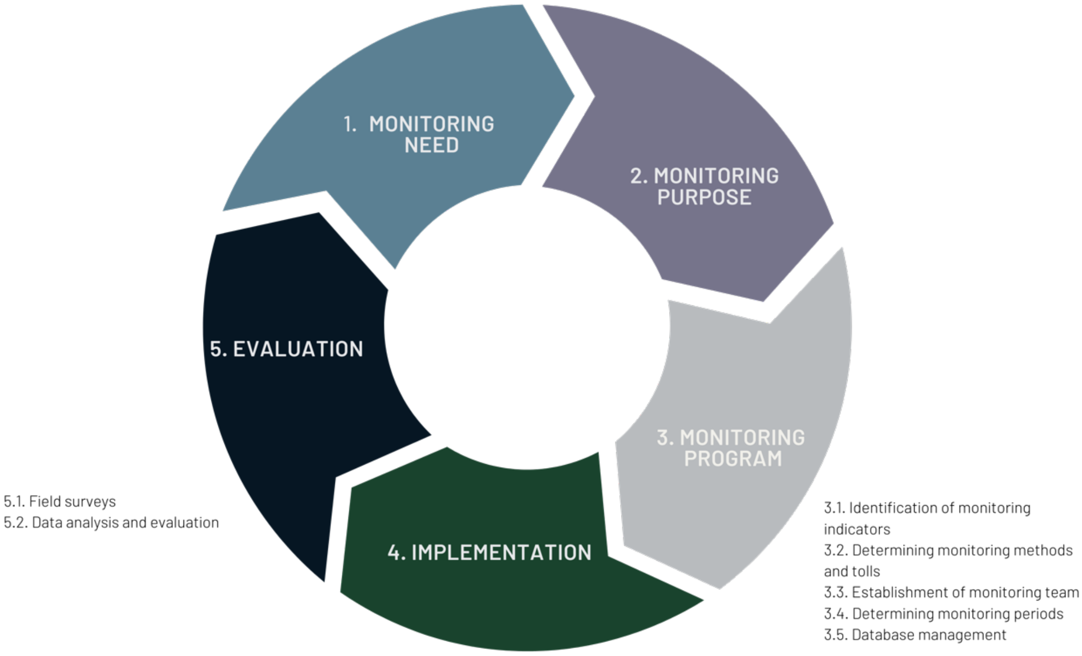
The effectiveness of monitoring forest biodiversity is fundamentally shaped by the active engagement and participation of local communities and stakeholders. By actively involving local communities, it can be enhanced the precision and reliability of the data collected, while simultaneously raising stakeholder awareness and garnering their invaluable support. This inclusive approach fosters a deep sense of ownership and responsibility for the conservation and management of forest biodiversity. Moreover, the active involvement of stakeholders throughout the entire monitoring process facilitates the timely identification of emerging issues and the generation of innovative solutions. It also promotes transparency and accountability, ensuring that management decisions align with the diverse interests and needs of all stakeholders. Therefore, it is imperative to thoughtfully design monitoring programmes that deliberately include and engage local communities and stakeholders at each stage of the process, thereby maximizing the effectiveness and success of forest biodiversity monitoring endeavours (FAO and UNEP, 2020).

For an effective monitoring concept, sufficient financial resources should be allocated, teams should be formed, appropriate equipment should be used in place, institutional capacity should be managed in a sufficient way and expert support should be sought when necessary. Due to the high cost of long term monitoring, sufficient technical and financial resources may not be secured, and this system may not be established. For this reason, it is important to develop low cost and effective monitoring methods by determining the points that will form the basis of the monitoring plan such as monitoring level, subject, indicators, time, frequency, methodology and success criteria with the involvement of practitioners and interest groups.

Monitoring cycle and components

Monitoring begins by identifying the need and objectives of the monitoring programme. This involves determining indicators, methods, team composition, frequency, and data management. These aspects are integrated to form a comprehensive monitoring concept, incorporating state, pressure, and response components. The programme is then implemented through field studies, followed by data analysis and interpretation. The findings are documented in detailed reports, which are shared with relevant stakeholders to ensure effective communication. This iterative monitoring cycle, involving planning, implementation, analysis, and reporting, ensures a systematic and comprehensive approach to monitoring (Tucker *et al.*, 2005; Ülgen and Lise, 2020).

Figure 1. Monitoring cycle and workflow diagram



Source: Adapted from Tucker, Bubb, de Heer, Miles, Lawrence, Bajracharya, Nepal, Sherchan, Chapagain. 2005. *Guidelines for Biodiversity Assessment and Monitoring for Protected Areas.* KMTNC, Kathmandu, Nepal. & Jungmeier and Yenilmez Arpa. 2022. *Guidelines for Monitoring Conservation and Sustainable Management of Turkiye's Steppe Ecosystems Project*. Ankara, FAO Ministry of Agriculture and Forestry (MAF).

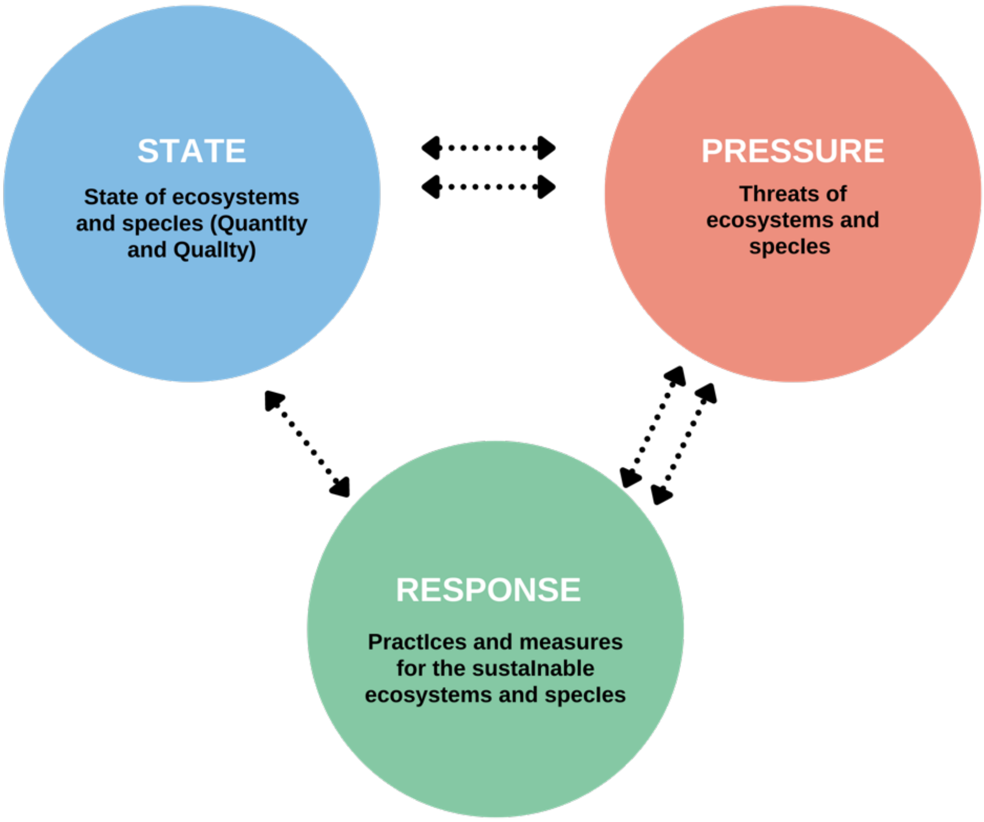
To ensure effective forest biodiversity monitoring, the guidelines provide a five step monitoring cycle process. This process involves the identification of the need for monitoring, the definition of the purpose, the development and implementation of monitoring concepts, and the interpretation of the results. Figure 1 illustrates this cycle.

The guidelines on forest biodiversity monitoring methodologies propose a monitoring programme, which is developed within the framework of the Pressure–State–Response (OECD, 2003).

Pressure–State–Response framework

The purpose of these guidelines is to provide a framework for forest biodiversity monitoring methodologies that take into account changes in pressure, state, and response indicators.

Figure 2. A schematic of the Pressure–State–Response framework



Source: Adapted from Organization for Economic Cooperation and Development (OECD). 2013. "*Framework of OECD work on environmental data and indicators", in Environment at a Glance 2013: OECD Indicators*, OECD Publishing, Paris.

As shown in Figure 2, the framework is based on the "**Pressure–State–Response** " model, which has been widely used in global, regional, and national monitoring programmes, and is included in the Post–2020 Global Biodiversity Framework document. The model consists of three types of indicators (OECD, 2019):

- **Pressure**: Indicators that identify and monitor main threats to ecosystems and species, such as agricultural expansion and harvesting pressure, pollution, hunting, and impacts of forest management.

- **State**: Indicators that show the state of the ecosystem (state of the environment and natural resources) and species (rare and threatened species).

- **Response**: Indicators that define and monitor conservation efforts (efficient management practices, implementation of conservation projects, etc.).

Chapter 1

State component

The state component of forest biodiversity monitoring aims to understand the current status of biodiversity and how it is changing over time. This is achieved through monitoring species, ecosystems, genetics, and ecosystem services. The monitoring approach used is compatible with existing national biodiversity monitoring programmes, such as the Noah's Ark Biodiversity Database in Türkiye.

1.1. Species level

Species level monitoring component, which is basically an approach through which living species of an area can be monitored to see the changes in other systems and processes associated with this group. It is one of the most commonly used methods for monitoring biodiversity at different scales. This monitoring component is an important approach used to track changes in various systems and processes associated with living organisms in a given area. Monitoring forest biodiversity at the level of species involves tracking variations in the quantity of threatened forest species at risk and changes in the population patterns of those species that are in danger in the forest.

1.1.1. Indicator 1: Changes in the number of threatened forest species

The indicator is designed to assess the threat to forest species by comparing the number of endangered species listed in the International Union for Conservation of Nature (IUCN) Red List to the total number of forest species at the national level. The methodology involves analysing the categories present in the IUCN National Red List to keep track of variations in the number of threatened forest species. Data will be collected by national forest agencies in the FAO Subregional Office for Central Asia (FAO SEC) countries every five years to track changes in this indicator. A decrease in the ratio of threatened forest species to the total number of forest species will indicate an improvement in the protection of forest species. However, in many FAO SEC countries, there is a lack of national red lists, which makes it necessary to develop and implement them as a means of monitoring and safeguarding forest biodiversity.

Table 1. Monitoring state components, basic issues, indicators, and frequencies in species level

STATE COMPONENT							
Monitoring Indicator		**Monitoring Level**	**Period and Frequency**	**Monitoring Area**	**Monitoring Method**	**Team/Expertize**	**Success Criteria**
Changes in number of threatened forest species		National	5 years	Forest ecosystems	Analysing the IUCN National Red List categories	National Forestry Agency / Species Experts	Decrease in the number of threatened forest species
Changes in population trends of threatened forest species	Forest Specialists Index	National	5 years	Forest ecosystems	Calculating Forest Specialists Index	National Forestry Agency / Species Experts	No decrease in Forest Specialists Index
	Red List Index	National	5 years	Forest ecosystems	Calculating Red List Index (forest specialist species)	National Forestry Agency / Species Experts	No decrease in Red List Index (forest specialist species)
	Forest Bird Index	National	5 years	Forest ecosystems	Calculating the Forest Bird Index (Wild Bird Index – forest specialist birds)	National Forestry Agency / Forest Bird Experts	No decrease in the trends of threatened forest species.
	Wildlife Picture Index	National	Annual	Forest ecosystems	Calculating the Wildlife Picture Index	National Forestry Agency / Large Mammal Experts	No decrease in Wildlife Picture Index

Source: Nature Conservation Centre (NCC). 2023. (©NCC)

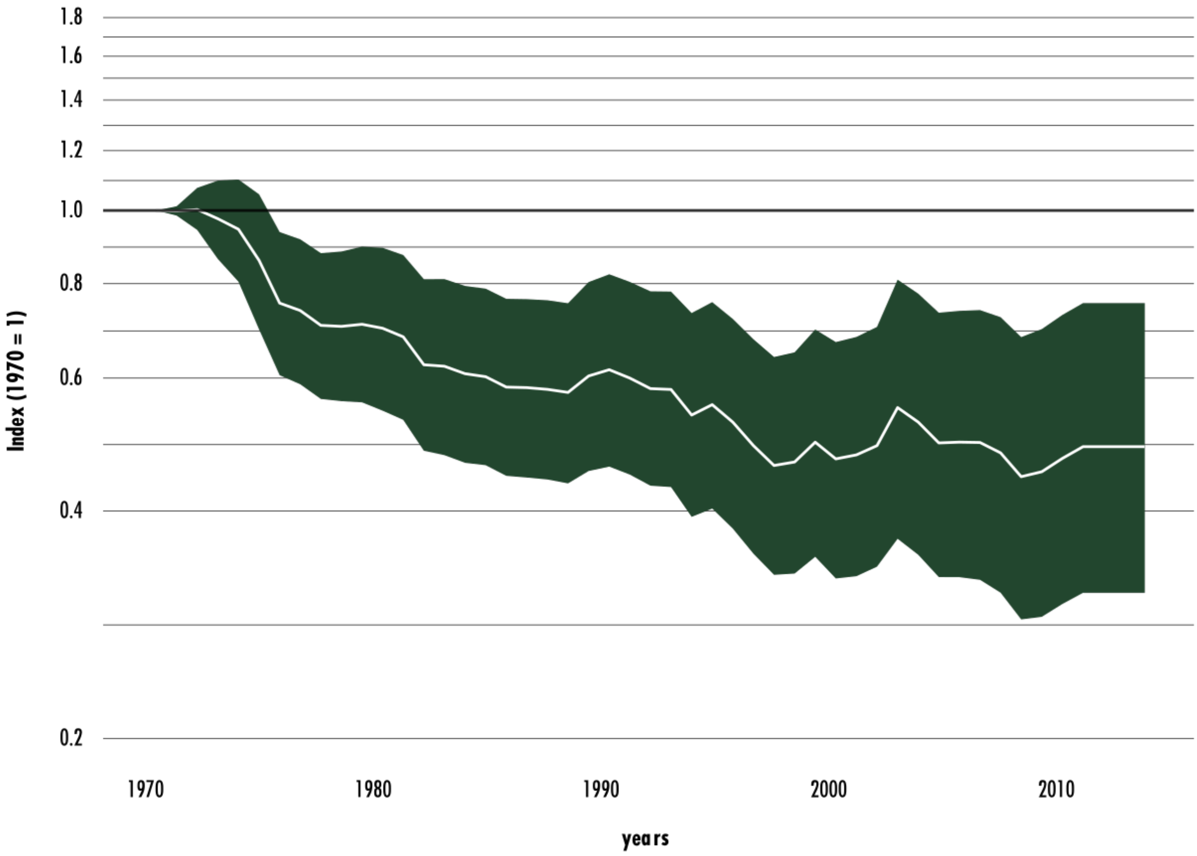
1.1.2. Indicator 2: Changes in population trends of threatened forest species

Given the limited availability of species specific population data in the forest ecosystems of the FAO Subregional Office for Central Asia (FAO SEC) countries, it is recommended to use global and regional indices to assess population trends among threatened forest species. These indices will provide a useful tool for monitoring and evaluating changes in population levels over time. At the species level, monitoring changes in the number of threatened forest species encompasses four distinct indicators, namely, living planet index – forest specialist index, red list index – forest specialist index, wild bird index – forest bird index, and wildlife picture index.

1.1.2.3. Living planet index (LPI) – Forest specialist index

The living planet index (LPI) is a metric developed by the World Wildlife Fund (WWF) in 1998 that tracks population trends in a wide range of species, including mammals, birds, and reptiles. By comparing the average size of a species' population within its range to a reference population size in 1970, the LPI provides valuable insights into the impacts of human activity on the environment and helps guide conservation efforts. The LPI forest specialist index is a vital instrument that enables us to comprehend population trends among vertebrate species that are exclusive to forest habitats. The LPI Forest Specialists Index is particularly useful for assessing forest species as they rely solely on forest habitats for gauging overall ecosystem health. As shown in figure 3, this index takes into account the fluctuations in the populations of threatened and non threatened species, providing valuable insights into the overall stability and health of forest ecosystems (BIP, 2022a).

Figure 3. The overall decline in an LPI forest specialist index for 268 forest vertebrate species between 1970–2014 on the global scale

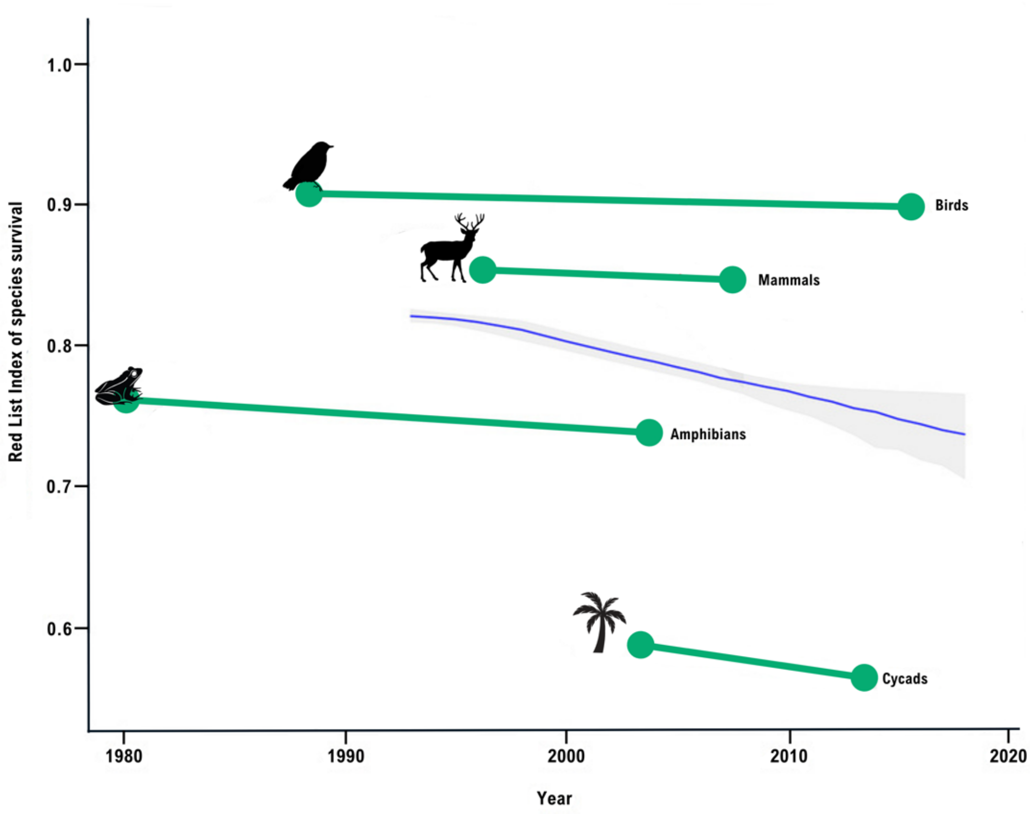


Source: Adapted from Green, E. J., McRae, L., Freeman, R., Harfoot, M. B. J., Hill, S. L. L., Baldwin Cantello, W., and Simonson, W. D. 2020. *Below the canopy: global trends in forest vertebrate populations and their drivers.* Proceedings of the Royal Society B, 287(1928). http://dx.doi.org/10.1098/rspb.2020.0533, The LPI forest specialist index provides insight into the population trends of forest dwelling species and helps to understand the overall health of forest ecosystems. The calculation of the LPI forest specialist index involves two different methodologies. First, the Weighted LPI Methodology (LPI–D), which is commonly known as the "diversity weighted" variant of the Living Planet Index, employs a unique weighted approach that places greater emphasis on species that are considered more threatened or endangered (Green *et al*., 2020). Secondly, the Unweighted LPI Methodology (LPI–U) is an unweighted version of the LPI, which means that all species are given equal weight in the calculation of the index. This contrasts with the weighted LPI, which gives more weight to species that are considered more ecologically important or threatened (WWF, 2018).

1.1.2.2. The red list index (RLI) – Forest specialist index

The red list index (RLI) is a valuable tool for tracking changes in the extinction risk of species and monitoring the overall health of forest ecosystems. The RLI requires data from repeated assessments of species using the Red List categories and criteria (IUCN, 2022). The RLI forest specialist index provides a valuable metric for tracking the conservation status of forest specialist species and managing forest ecosystems and biodiversity sustainably. As indicated in figure 4, this index is a useful tool for guiding conservation efforts and ensuring the long term viability of forest habitats (BIP, 2022b).

Figure 4. The red list index (RLI) measures the conservation status based on survival rates



Source: Adapted from International Union for Conservation of Nature (IUCN). 2022. *The Red List Index (RLI).* https://www.iucnredlist.org/assessment/red-list-index.

The RLI forest specialist index provides a valuable metric for tracking the conservation status of forest specialist species and managing forest ecosystems and biodiversity sustainably. This index is a useful tool for guiding conservation efforts and ensuring the long term viability of forest habitats. Specifically, monitoring the RLI values of forest specialist species over time can reveal patterns that indicate the need for conservation action to maintain the health of these ecosystems. Moreover, a declining RLI value of a species may indicate the presence of stressors impacting the overall wellbeing of its forest habitat. In summary, the RLI forest specialist index is a crucial tool for identifying conservation needs and maintaining the resilience of forest ecosystems (BIP, 2022b).

1.1.2.3. Wild bird index (WBI) – Forest bird index

The wild bird index (WBI) is a valuable tool for tracking population trends of bird species during their breeding season, with a specific focus on groups of birds dependent on particular habitats. This index is particularly useful for monitoring the health of the environment and the status of specialist species. As a subunit, the forest bird index (FBI) is an important tool for monitoring the population trends of bird species during their breeding season. The FBI focuses on forest dependent bird species, while the WBI covers a broader range of bird species and habitats (BIP, 2022c). By tracking changes in these indices over time, conservationists can identify patterns and trends that may signal the need for conservation action to maintain the resilience of ecosystems and protect the wellbeing of wild bird species. The methodology for calculating these indices involves surveying a representative sample of bird species in the forest ecosystems and comparing the results to a baseline period or reference area. After collecting the data, analyses are done to calculate the index, and trends are tracked for a period of five or ten years (BirdLife International, 2021).

The forest bird index is a metric used to assess the health of forest ecosystems by measuring the average population trends of representative groups of wild birds. It is a dependable indicator that supports the formal measurement and interpretation of national, regional, and global targets for monitoring forest biodiversity loss (Nagy *et al*., 2005). The index provides equal weight to every species, which makes it a reliable tool for monitoring changes in the population of each species over time. The species selection for the index is based on their typical variability and behaviour. With the help of the FBI, conservationists can keep an eye on the population trends of forest bird species and take the necessary conservation measures to protect the diversity of wild forest birds (Sheehan, 2010)

1.1.2.4. Wildlife picture index (WPI)

The wildlife picture index (WPI) is a tool that measures changes in the diversity of large mammal species over time using camera trap data. It helps assess the effectiveness of conservation efforts and define the conservation status of a species if it is deteriorating or improving (BIP, 2022d; O'Brien *et al*., 2010).

Figure 5. The photographs acquired through the use of camera traps

Source: Nature Conservation Centre (NCC). 2023. *Images from the photo archive obtained from camera traps within the scope of forest biodiversity monitoring studies*. (© NCC).

As pointed out figure 5, the methodology involves using digital camera traps in forest ecosystems, with each camera recording the daily occurrence history for each species. The data is then processed and analysed to create annual occupancy rates and geographical occurrence patterns (Conservation International and Hewlett Packard Enterprize (HPE), 2013). The protocol employs 60–90 camera traps at a density of one camera per 2 km. The occupancy rate can be estimated by accumulating similar detection histories from all cameras placed in the area. To determine the trend of the WPI, the trend can be modelled as a smooth nonlinear function of time using the General Algebraic Modelling Systems (GAMs). The slope of the smoothed trend measures the pace of change in diversity. A negative value indicates that the rate of decline is accelerating, and a positive value indicates that the rate of decline is slowing (O'Brien, 2010; GEOBON, 2023).

1.2. Ecosystem level

Ecosystems and habitats, where living organisms exist, are among the most important natural elements, along with the organisms in a natural area. Habitats are extremely important because they provide for the species living in the area and play a fundamental role in the formation of ecosystems and, ultimately, the natural area as a whole. When defining a monitoring plan, it is important to ensure that monitoring of specific forest habitats has the potential to show the changes in the area and is recommended according to the classification systems rather than the entire forest ecosystem in the country. Both achieve the expected outcomes of the monitoring activity and use materials and human resources as efficiently as possible.

1.2.1. Indicator 1: Changes in forest ecosystem area

The extent of forests is a baseline variable providing an indication of the relative extent of forests in a country. The indicator is expressed as a percent of forest area in terms of a proportion of the land area.

Table 2. Monitoring state components, basic issues, indicators, and frequencies in ecosystem level

STATE COMPONENT						
Monitoring Indicator	**Monitoring Level**	**Period and Frequency**	**Monitoring Area**	**Monitoring Method**	**Monitoring Team/Expertise**	**Success Criteria**
Changes in forest ecosystem area (Forest area as a proportion of total land area)	National	Annual	Forest ecosystems	GIS analysis	National forestry agency	No decrease in the forest ecosystem area
Changes in naturalness of forest ecosystems (Forest Naturalness Index)	National	5 years	Forest ecosystems	Calculating Forest Naturalness Index	National forestry agency	No decrease in the naturalness of forest ecosystems (Forest Naturalness Index)
Changes in percentage of mixed forest	National	5 years	Forest ecosystems	GIS analysis	National forestry agency	Increase in the percentage of mixed forest
Changes in area of old-growth forests	National	5 years	Forest ecosystems	GIS analysis	National forestry agency	Increase in the area of old-growth forests
Changes in biodiversity intactness and resilience of forest ecosystems (Biodiversity Intactness Index)	National	5 years	Forest ecosystems	Calculating Biodiversity Intactness Index	National forestry agency	No decrease in Biodiversity Intactness Index
Changes in biodiversity intactness and resilience of forest ecosystems (Bioclimatic Ecosystem Resilience Index)	National	5 years	Forest ecosystems	Calculating Bioclimatic Ecosystem Resilience Index	National forestry agency	No decrease in Bioclimatic Ecosystem Resilience Index
Improvement in comprehensiveness of conservation (ex situ and in situ) of socioeconomically as well as culturally valuable species (wild fruit trees)	National	5 years	Forest ecosystems	Calculating the trend of comprehensiveness of conservation of wild fruit trees	National forestry agency & related government institutes	Increase in the trend of comprehensiveness of conservation of wild fruit trees (0-100)
Changes in protective forests (managed primarily for the protection of soil and water) area	National	5 years	Forest ecosystems	GIS analysis	National forestry agency	Increase in the protective forests (managed primarily for the protection of soil and water) area

Source: Nature Conservation Centre (NCC). 2023. (©NCC)

1.2.1.1. Forest area as a proportion of the total land area index

The measurement known as the forest area as a proportion of the total land area index is of paramount importance for evaluating the extent and distribution of forest cover in a specific geographic area, as well as for assessing the overall health and sustainability of forest ecosystems. This indicator is derived by taking the total forest area of a region and dividing it by the total land area, after which the result is expressed as a percentage. In order to effectively monitor changes in this index over time, the use of Geographic Information System (GIS) analysis and land use change detection tools is crucial, as it allows researchers to identify areas where deforestation or other human activities may be having a negative impact on the forest ecosystem. National forest inventories provided by the forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries will serve as the primary source of data for this indicator, and comparisons of forest area as a proportion of the total land area will be made on an annual basis (FAO, 2020).

Table 3. Forest area as proportion of total land area

Years	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Türkiye	Uzbekistan
2000	11.94	1.17	6.16	2.95	8.78	26.18	6.96
2010	12.49	1.14	6.41	2.95	8.78	27.39	7.87
2015	13.04	1.23	6.53	3.04	8.78	28.10	8.34
2016	13.16	1.24	6.55	3.04	8.78	28.10	8.43
2017	13.27	1.25	6.57	3.04	8.78	28.26	8.49
2018	13.41	1.26	6.67	3.04	8.78	28.47	8.55
2019	13.55	1.27	6.76	3.05	8.78	28.67	8.61
2020	13.69	1.28	6.86	3.05	8.78	28.87	8.67

Source: Adapted from FAO. 2020. Global Forest Resources Assessment 2020: Main report. Rome. https://doi.org/10.4060/ca9825en

To improve the accuracy of this indicator, it is essential to use a consistent methodology and data sources over time. The indicator may be calculated at different scales, such as national, regional, or global levels, and it is considered a key measure of the overall state and trends of forest ecosystems. Additionally, performing land use change detection is an important tool to understand the extent of land cover loss and gain over time in forest areas. By analysing changes in forest area as a proportion of the total land area index over time, researchers can identify potential areas of concern or improvement and take steps to address these issues. Ultimately, the forest area as a proportion of the total land area index is crucial for monitoring and safeguarding forest biodiversity and ensuring the long term sustainability of forests (UNSTATS, 2023a).

1.2.2. Indicator 2: Changes in the naturalness of forest ecosystems

The term "forest naturalness" refers to the extent to which a forest's characteristics and behaviours are determined solely by natural, inhuman factors. Naturalness indicators are being developed for various forest biomes to measure the ecological health of a location, and mapping efforts are underway to identify areas with high naturalness for conservation purposes (Winter, 2012; Muys *et al.*, 2022).

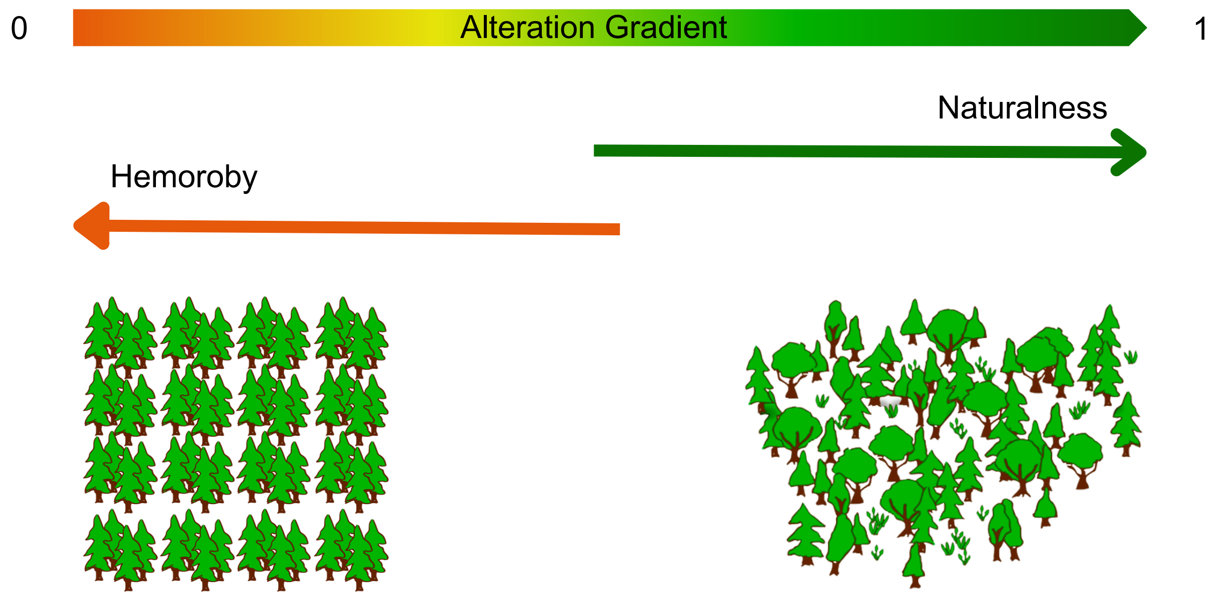
1.2.2.1. Forest naturalness index (FNI)

The forest naturalness index (FNI) is a widely used metric for evaluating the degree to which a forest represents a natural and undisturbed ecosystem. It assesses the resemblance of the current forest state to its natural state, considering factors such as tree species diversity, natural forest structures and processes, and the level of human disturbance. Forest naturalness refers to the extent to which a forest's characteristics and dynamics are solely influenced by natural, forces excluding anthropogenic. The term "forest naturalness" is commonly reported as "undisturbed by man" in Forest Europe, UNECE, and FAO reports, and as "primary forest" in FAO Global Forest Resources Assessment (FRA) Reports (Winter, 2012).

The evaluation of the naturalness of forests depends on data acquired through National Forest Inventories (NFIs). These inventories offer extensive and detailed information essential for assessing naturalness (McRoberts *et al*., 2012). Vital indicators utilized in identifying naturalness in seminatural forests consist of the percentage of native species, the quantity of standing trees and dead branches, the density of large trees, and the proportion of the forest area occupied by tree species surpassing economic maturity. Criteria like silvicultural practices, species composition, age of trees or stands, and the presence/quantity of deadwood are commonly employed in NFIs based evaluations of forest naturalness (Chirici *et al*., 2011).

Once the indicators for evaluating forest naturalness have been chosen for each specific forest type and biogeographical region, it is necessary to establish benchmark values for these indicators. This can be accomplished by measuring indicator values in old growth forests or referencing theoretical ecology studies. By comparing the current indicator value with the benchmark potential value, it becomes possible to assess the relative naturalness of the specific indicator. To obtain a comprehensive quantification of forest naturalness, the indicators can be combined using multicriteria analysis, resulting in a final assessment ranging from 0 to 1 on a scale (Figure 6). A value of 0 represents 100 percent human disturbance and 0 percent naturalness, while a value of 1 signifies 0 percent human disturbance and 100 percent naturalness (Winter *et al*., 2012).

Figure 6. The theoretical focus of forest naturalness and hemeroby



Source: Adapted from Winter, S. 2012. *Forest naturalness assessment as a component of biodiversity monitoring and conservation management*. Forestry: An International Journal of Forest Research, 85(2): 293–304.

1.2.3. Indicator 3: Changes in the percentage of mixed forest

1.2.3.1. Mixed forest index (MFI)

The mixed forest index (MFI) monitors the changes in the percentage of mixed forest within the total forest area, which is important in assessing the diversity and resilience of a forest ecosystem. Mixed forests, characterized by a diverse range of tree species, play a vital role in enhancing both the structural and genetic diversity of the ecosystem. In contrast, monoculture forests are more vulnerable to fluctuations in environmental conditions, particularly in the face of climate change. The data sources for this indicator rely on national forest inventories provided by the national forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries (Federal Ministry of Food and Agriculture [Germany], 2020).

To determine the mixed forest index, Geographic Information System (GIS) analyses are utilized as the preferred methodology. This approach allows for the integration of various geospatial data sources, including topographical maps and satellite imagery. A higher value of the mixed forest index indicates a larger proportion of different tree species within the forest, highlighting a more diverse and resilient ecosystem (GEO BON, 2023). Conversely, a lower index value suggests a lower proportion of diverse tree species, indicating a less diverse and potentially more fragile ecosystem. A higher mixed forest index value signifies a more valuable and sustainable forest, less susceptible to pests, diseases, and the impacts of climate change in the context of forestry and forest management. Conversely, a lower mixed forest index value may indicate a less valuable or sustainable forest (Bravo Oviedo *et al*. 2014).

1.2.4. Indicator 4: Changes in area of old growth forests

1.2.4.1. Old growth forest index

The old growth forests Index focuses on measuring the extent of mature/old growth forest habitats that are protected within forest management plans. These forests are highly valuable but also face significant threats. National forest inventories conducted by the national forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries provide the primary data source for assessing the indicator. These inventories offer comprehensive and reliable information on the forest area, including the coverage of mature/old growth forest habitats.

Geographic Information System (GIS) analyses serve as the methodology for determining the old growth forest index. This approach involves integrating various geospatial data sources to evaluate the structural complexity and biodiversity of old growth forests. GIS techniques enable the analysis of spatial patterns and distribution of forest characteristics such as tree size, age, and species composition. The indicator values are derived from the national data obtained through national forest inventories. GIS analysis is then applied to compare the surface area polygons of old growth forests over a specific time interval (typically five years). This analysis allows for the assessment and interpretation of changes in the area of old growth forests, providing insights into their conservation status and guiding management decisions (McGarigal and Cushman, 2002).

1.2.5. Indicator 5: Changes in biodiversity intactness and resilience of forest ecosystems

Assessing and preserving the health and sustainability of forest ecosystems is paramount, in the FAO Subregional Office for Central Asia (FAO SEC) countries. To achieve this, two key indices are utilized: The biodiversity intactness index (BII) and the bioclimatic ecosystem resilience index (BERI). The BII focuses on quantifying the level of biological diversity within a specific forest ecosystem, providing valuable insights into its overall biodiversity status. On the other hand, the BERI assesses the ecosystem's resilience and ability to withstand and recover from various disturbances, including climate change, pest outbreaks, and environmental stressors. These indices serve as essential tools for evaluating and managing forest ecosystems, ensuring their health for the long term, functionality, and conservation.

1.2.5.1. The biodiversity intactness index (BII)

The biodiversity intactness index (BII) is an essential instrument used to evaluate and safeguard biodiversity in particular geographical locations. It measures the degree to which biodiversity remains intact by analysing the average abundance of diverse species within terrestrial areas. Through a comparison with a baseline that represents minimal human impact, the BII provides a relative assessment of the biodiversity wellbeing in the given region. This indicator is extensively utilized by researchers, conservationists, and policymakers to assess the impact of human activities on biodiversity and prioritize conservation efforts in areas requiring protection (Purvis *et al*., 2018; BIP, 2022e).

The calculation of the BII follows internationally recognized principles of biodiversity assessment, employing a standardized methodology. It combines data from field observations and remote sensing to evaluate biodiversity conditions at local and global scales. Statistical models are utilized to estimate how local biodiversity responds to land use and related pressures, allowing for projections of past and future biodiversity states based on available pressure estimates (Scholes and Biggs, 2005). The BII calculations often utilize the PREDICTS package in the R platform, and relevant data can be obtained from the Natural History Museum data portal (Hudson *et al*., 2015).

The BII scale ranges from 100 percent for pristine assemblages to 0 percent for completely destroyed or replaced assemblages. It takes into account functional diversity by weighting taxa proportionally to their species richness, thus providing a diversity weighted index of abundance. A BII value below 90 percent is considered a threshold for potential degradation of ecosystem services on a large scale according to Steffen *et al*. (2015). Negative trends in the BII indicate increasing degradation of species assemblages, while positive trends signify the recovery of species assemblages due to reduced human impact or other factors.

1.2.5.2. Bioclimatic ecosystem resilience index (BERI)

The bioclimatic ecosystem resilience index (BERI) is a valuable tool that plays a significant role in assessing the capacity of ecosystems to maintain biodiversity in the face of ongoing and uncertain climate change. It employs advanced data and modelling techniques at a fine spatial resolution, typically around 1km, enabling reliable evaluations at the national level. The methodology underlying BERI involves analysing the spatial turnover of species composition within plants, invertebrates, and vertebrates, and projecting these changes under different climate scenarios. By examining the configuration and connectivity of habitats that support similar species compositions under changing climates, the index is computed for each grid cell, providing insights into the resilience of the ecosystem. By utilizing BERI, researchers, conservationists, and policymakers can gain a comprehensive understanding of how ecosystems respond and adapt to climate change, facilitating informed decision making and targeted conservation efforts (BIP, 2022f; Ferrier *et al*., 2019).

National assessment of BERI for the FAO Subregional Office for Central Asia (FAO SEC) countries can be obtained using global data and models at a 1km grid resolution, enabling comparisons in five year intervals. Occurrence data for sensitive species in forest ecosystems and terrestrial species are essential for modelling changes in species distribution due to climate induced impacts. Opensource databases like the Global Biodiversity Information Facility (GBIF) and Map of Life are commonly used as sources for species occurrence data. The BERI provides insights into the future favourability or inhibition of species distributions under climate change. Higher BERI values indicate greater resilience of ecosystems to climate change, implying the ability to maintain biodiversity even in changing climatic conditions. Conversely, lower BERI values suggest reduced suitability for certain species, indicating vulnerability to climate change impacts and the need for management interventions to preserve biodiversity and ecosystem services. National level BERI results for 2005, 2010, and 2015 have been generated by the Commonwealth Scientific and Industrial Research Organization (CSIRO) and are presented in Table 3 for FAO SEC countries.

Table 4. The bioclimatic ecosystem resilience index (BERI) values for FAO SEC countries

Year	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Türkiye	Uzbekistan
2005	0.318	0.405	0.477	0.453	0.407	0.321	0.380
2010	0.313	0.417	0.483	0.455	0.413	0.315	0.386
2015	0.309	0.413	0.486	0.455	0.415	0.310	0.386
Annual rate of change	0.312%	0.199%	0.194%	0.042%	0.185%	0.366%	0.139%

Source: Adapted from Commonwealth Scientific and Industrial Research Organisation (CSIRO). 2023. *Data Portal: BERI v2: Bioclimatic Ecosystem Resilience Index: 30s global time series.* https://data.csiro.au/collection/csiro:54238

1.3. Genetic level monitoring

The genetic diversity of forest ecosystems is critical for their resilience to environmental change. Allelic diversity measures can provide information about the genetic makeup of forest ecosystems. The Food and Agriculture Organization of United Nations (FAO) has been monitoring forest genetic diversity since 1970, resulting in the production of guidelines for forest genetic monitoring. These guidelines provide definitions, descriptions, and summaries of the scientific theories behind forest genetic monitoring. They also offer step by step instructions for implementing and conducting forest genetic monitoring, as well as calculating associated costs. The guidelines were developed in response to European Forest Genetic Resources Programme (EUFORGEN) recommendations and include various levels of genetic monitoring intensity (Bajc *et al*. 2020).

1.3.1. Indicator 1: Improvement in comprehensiveness of conservation (*ex situ* and *in situ*) of socioeconomically as well as culturally valuable species (wild fruit trees)

The indicator measures the comprehensiveness of the conservation of socioeconomically and culturally valuable wild fruit tree species in the FAO Subregional Office for Central Asia (FAO SEC) countries. Due to the lack of sufficient genetic data for most relevant species, the indicator uses ecogeographic methods as a proxy for genetic diversity. To measure the indicator, it is necessary to identify important fruit species and assess the extent to which they are protected within conservation areas. This can be done using databases, surveys, and monitoring efforts. The indicator is measured on a scale of 0 to 100 and calculated as ex situ and in situ scores, averaged for each species to produce a merged final conservation score. Species are categorized for conservation priority as high, medium, low, or sufficiently conserved based on their scores. The proportion of species that are categorized as low priority or sufficiently conserved out of all assessed species is then derived, and this percentage is used to calculate the indicator (BIP, 2022g).

The trend of comprehensiveness of conservation of wild fruit trees is measured every five years for FAO SEC countries' fruit tree species. The indicator is calculated as the proportion of relatively well conserved species out of all assessed species, producing a percentage on a scale of 0 to 100. Both ex situ and in situ scores are calculated for each species and then averaged to produce a merged final conservation score. The indicator aims to provide a sense of the overall health and resilience of an ecosystem and identify potential threats to biodiversity. By tracking the extent to which valuable species are protected over time, it is possible to understand the effectiveness of conservation efforts and plan for further conservation action if necessary.

Table 5. Monitoring state components, basic issues, indicators, and frequencies

STATE COMPONENT							
State Component Indicator Level	**Monitoring Indicator**	**Monitoring Level**	**Period and Frequency**	**Monitoring Area**	**Monitoring Method**	**Monitoring Team/Expertize**	**Success Criteria**
Genetic level	Improvement in comprehensiveness of conservation (ex situ and in situ) of socioeconomically as well as culturally valuable species (wild fruit trees)	National	5 years	Forest ecosystems	Calculating the trend of comprehensiveness of conservation of wild fruit trees	National forestry agency and related government institutes	Increase in the trend of comprehensiveness of conservation of wild fruit trees (0─100)
Ecosystem services level	Changes in protective forests (managed primarily for the protection of soil and water) area	National	5 years	Forest ecosystems	GIS analysis	National forestry agency	Increase in the protective forests (managed primarily for the protection of soil and water) area

Source: Nature Conservation Centre (NCC). 2023. (©NCC)

1.4. Ecosystem services level monitoring

Ecosystems and habitats, along with the organisms in a natural area, are essential components of the environment. Habitats play a crucial role in sustaining the species that inhabit the area and contribute to the formation of ecosystems in the natural area. When designing a monitoring plan, it is important to select specific forest habitats that can accurately represent the changes occurring in the area and are recommended based on classification systems to achieve expected outcomes efficiently. Ecosystem functions are ecological processes that regulate the movement of energy, nutrients, and organic matter across the environment. Ecosystem services, on the other hand, refer to the benefits derived by humans directly or indirectly from ecological functions. Forests play a significant role in managing natural resources, such as water regulation and erosion control, to provide protective functions. However, other forest functions, such as pollination of crops, recreational opportunities, and mitigating natural disasters, should also be considered when provisioning ecosystem services at different scales. Efforts have been made over the past decade to manage and restore forests sustainably to maximize their contribution to ecosystem services (Pettorelli *et al.*, 2018).

1.4.1. Indicator 1: Changes in protective forests (managed primarily for the protection of soil and water) area

Protective forests (managed primarily for the protection of soil and water) are the main ecosystem service providers in the forest ecosystems. The indicator measures the percentage change in the area of protective forests that are primarily managed for soil and water protection in forest management plans. These forests play a crucial role in providing ecosystem services (FAO, 2020).

The Geographic Information System (GIS) analysis is an effective method for assessing changes in protective forests. It allows for a detailed understanding of these forests and facilitates informed management decisions to ensure soil and water protection for the long term. The indicator relies on national data provided by the FAO Subregional Office for Central Asia (FAO SEC) countries' national forestry agencies, specifically from national forest inventories. Changes in protective forest area are compared over a specified time interval of five years.

Table 6. Primary designated management objective: Protection of soil and water. Forest area (1000 ha)

Years	Kazakhstan	Kyrgyzstan	Türkiye	Uzbekistan
1990	2,736.30	1,134.47	7,794.17	2,040.00
2000	2,449.50	1,129.60	7,945.60	2,205.00
2010	2,015.30	1,151.43	8,441.59	2,269.50
2015	2,113.80	1,156.96	8,560.68	2,214.00
2020	2,160.30	1,211.58	8,805.60	2,532.00

Source: Adapted from FAO. 2020. Global Forest Resources Assessment 2020: Main report. Rome. https://doi.org/10.4060/ca9825e

Chapter 2

Pressure component

The pressure component in forest biodiversity monitoring is human activities and factors that negatively impact forest ecosystems and biodiversity. These pressures include deforestation, land use changes, forest loss, habitat fragmentation, biotic agents like invasive species, abiotic agents like drought, poaching and trafficking of protected species and illegal logging. Monitoring the pressure component involves assessing the extent, intensity, and trends of these activities to understand their consequences for forest biodiversity. It provides crucial information for policy decisions, conservation strategies, and sustainable forest management.

2.1. Monitoring forest loss

Forest loss monitoring, which is a crucial component of forest biodiversity monitoring, entails systematic monitoring of changes in forest cover, encompassing deforestation and degradation, within a designated area of observation. The data collected through this process offers significant insights to policymakers and conservationists, empowering them to devise focused strategies and interventions to combat deforestation and foster sustainable forest management practices.

2.1.1. Indicator 1: Annual forest area changes rate (percentage)

The indicator annual forest area changes rate (percentage) plays a vital role in monitoring forest ecosystems and sustainable forest management. It assesses the direction and variability of changes in forest areas over time. The indicator examines the forest area change rate for the most recent period and compares it to a baseline period to determine the direction of change. The annual forest area change rate is calculated by comparing the extent of forest cover over a specified period. It is typically expressed as a percentage, where a positive rate indicates an increase in forest area, while a negative rate signifies a decrease. This indicator is essential for tracking forest cover changes, evaluating the impacts of deforestation, afforestation, and land use transformations on forest ecosystems. It also contributes to measuring progress towards achieving the United Nations Sustainable Development Goals (SDGs), particularly Goal 15 (Life on Land) and Goal 2 (Zero Hunger) (UNSD, 2021).

Various methods, such as satellite remote sensing and ground based measurements, can be employed to measure the annual forest area change rate. The values of this indicator rely on national data provided by the FAO Subregional Office for Central Asia (FAO SEC) countries' national forestry agencies, obtained from national forest inventories. The annual forest area change rate (percentage) is determined by comparing the most recent period (e.g., 2010–2020) to a baseline period (e.g., 2000–2010).

2.1.2. Indicator 2: The biodiversity habitat index (BHI)

The biodiversity habitat index (BHI) serves as a measure to assess the rate of natural habitat loss, degradation, and fragmentation, including forests, and predicts their impact on the preservation of terrestrial biodiversity. The indicator value represents the proportion of environments supporting distinct species assemblages, with a corresponding portion of their distribution existing within relatively natural habitats. The BHI offers flexibility in terms of spatial aggregation, allowing calculations and reporting at various scales, ranging from 1 km grid cells to extensive areas such as ecoregions, nations, biomes, realms, or even the entire planet. Its significance lies not only in monitoring and evaluating habitat quality in Mediterranean forests but also in its potential applicability to other regions and ecosystems (Friedl *et al*., 2010; BIP, 2022h).

The BHI evaluation utilizes a finely detailed grid encompassing the terrestrial surface of the entire planet. For each cell within this grid, an estimation is made regarding the fraction of habitat that remains intact in ecologically comparable cells to the one of interest. Drawing from the most reliable occurrence data available for global plants, vertebrates, and invertebrates, the ecological resemblance between cells is projected based on abiotic environmental factors. The method employs comprehensive data covering the land area of all countries worldwide at a grid resolution of 1 km. When calculating the BHI score for a specific "focal unit" the average condition of ecologically similar units is taken into account, with other units contributing to the calculation weighted according to their predicted similarity to the focal unit. The BHI is derived through the integration of ecological similarity models and a suitable habitat state surface specific to the year under consideration (GEO BON, 2023b).

Table 7. Pressure component monitoring details

PRESSURE COMPONENT						
Monitoring Indicator	**Monitoring Level**	**Period and Frequency**	**Monitoring Area**	**Monitoring Method**	**Monitoring Team/Expertize**	**Success Criteria**
Forest loss: Annual Forest area change rate (percentage)	National	Annual	Forest ecosystems	GIS analyses and comparison	National forestry agency	No decrease in annual forest area
Forest loss: The Biodiversity Habitat Index	National	5 years	All country area	Biodiversity Habitat Index (0–1)	National forestry agency / GIS expert	No decrease in Biodiversity Habitat Index
Forest damage: Changes in forest area and percent of forests affected by biotic processes and agents (e.g., disease, pests, invasive alien species)	National	Annual	Forest ecosystems	Data gathering and GIS analyses	National forestry agency	No increase in forest area and percent of forests affected by biotic processes and agents
Forest damage: Changes in forest area and percent of forests affected by abiotic agents (e.g., fire, storm, drought, land clearance)	National	Annual	Forest ecosystems	Data gathering and GIS analyses	National forestry agency	No increase in forest area and percent of forests affected by abiotic agents
Forest fragmentation: Changes in area of continuous forest and of patches of forest separated by non forest lands	National	5 years	Forest ecosystems	GIS analyses	National forestry agency / GIS expert	No change in area of continuous forest and of patches of forest separated by non forest lands
Drought impact on forest ecosystems: Changes in annual area of drought impact on vegetation productivity in forest ecosystems	National	Annual	Forest ecosystems	GIS analyses	National forestry agency / GIS expert	No increase in annual area of drought impact on vegetation productivity in forest ecosystems
Poaching and trafficking of protected species: Changes in proportion of traded wildlife that was poached or illicitly trafficked (national CITES authority)	National	Annual	All country area	Data gathering and comparison	National forestry agency and National CITES authority	No increase in proportion of traded wildlife that was poached or illicitly trafficked
Illegal cutting: Changes in the forest area under illegal cutting pressure	National	Annual	Forest ecosystems	Data gathering and comparison	National forestry agency	No increase in the forest area under illegal cutting pressure

Source: Nature Conservation Centre (NCC). 2023. (©NCC)

Table 8. Biodiversity habitat index (BHI) results for Azerbaijan and Türkiye

Year	Azerbaijan	Türkiye
2005	0.452	0.450
2010	0.445	0.448
2015	0.444	0.443
BHI between 2005-2015 (annual rate Change)	-0.176%.	-0.15%.

Source: Adapted from Yale University Environmental Performance Index (EPI). 2020. Biodiversity Habitat Index [Cited 8 September 2023] https://epi.yale.edu/epi-results/2020/component/bhv

2.2. Monitoring of forest damage

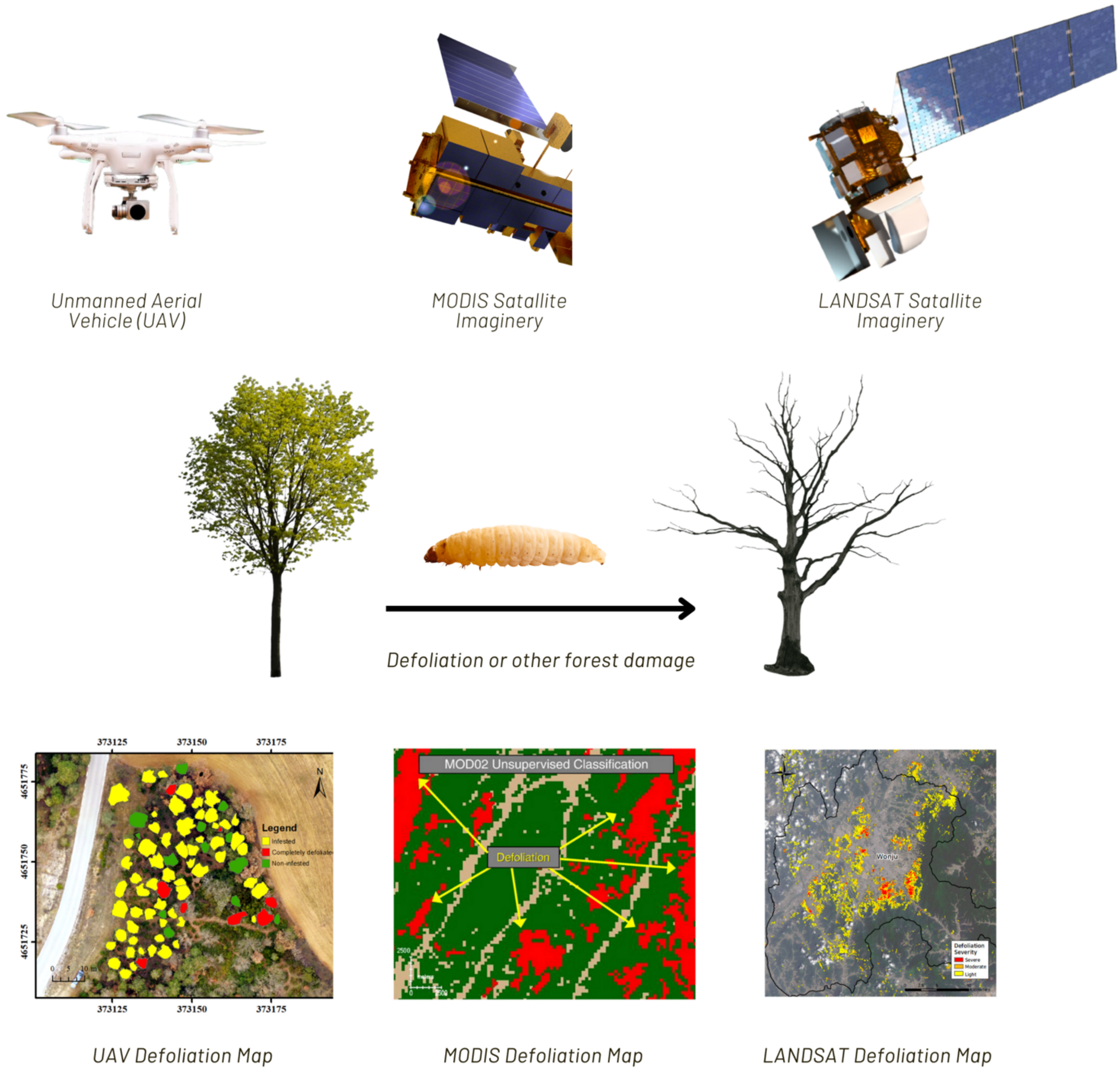
Monitoring of forest damage involves the systematic observation and assessment of detrimental changes occurring within forest ecosystems. It entails the ongoing surveillance and analysis of factors such as deforestation, degradation, and disturbances impacting the health and integrity of forests. By employing various data collection methods and analytical tools, monitoring efforts aim to track and quantify the extent of forest damage, providing valuable insights for conservationists and policymakers in devising targeted strategies for sustainable forest management.

2.2.1. Indicator 1: Changes in forest area and percent of forests affected by biotic processes and agents (e.g., disease, pests, invasive alien species) beyond reference conditions.

The indicator assesses the extent of forest impact caused by biotic processes, including diseases, pests, and invasive species. The indicator values are determined based on national data provided by the forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries. National forestry services will report annual measurements of affected forest areas using Geographic Information System (GIS) analysis. The indicator values will rely on data provided by national forestry agencies, enabling the determination of changes in forest area and the percentage of forests affected by biotic processes compared to reference conditions. To detect these changes, Aerial Detection Survey (ADS) data and digital aerial mapping technology will be employed.

ADS data, including Digital Aerial Mapping Technology (DASM), is utilized to detect changes in forest areas and the impact of biotic processes and agents. The aerial survey protocol involves mapping new defoliation, mortality, and other damage since the last observation (Figure 7). The mapping of forest damage through aerial surveys involves identifying and characterizing different types of damage, such as defoliation and mortality. It is important to note that some significant biological agents, like root diseases and dwarf mistletoe, may not be easily detected in aerial surveys (Housman *et al*., 2018).

Figure 7. Aerial survey and remote sensing methods for detection of forest damage



Source: Adapted from Housman, I. W., Chastain, R. A., & Finco, M. V. 2018. *An Evaluation of Forest Health Insect and Disease Survey Data and Satellite Based Remote Sensing Forest Change Detection Methods: Case Studies in the United States*. Remote Sensing, 10(8), 1184.

The allocation of aerial survey areas will primarily follow the annual work plan, but adjustments can be made based on pest reports, areas of specific concern, and logistical considerations. It is important to note that some highly destructive biological agents may not be detectable through aerial surveys, and accurate mapping requires a clear characterization of the damage. The year 2020 can serve as the reference year for this indicator, allowing for annual comparisons of indicator values.

2.2.2. Indicator 2: Changes in forest area and percent of forests affected by abiotic agents (e.g., fire, storm, drought, land clearance)

The forest abiotic processes and agents indicator measures the extent and proportion of forest areas affected by abiotic processes and agents such as fire, storm, drought, land clearance, disease, pests, and invasive alien species. The methodology involves using the Geographic Information System (GIS) analysis to report the annual measurement of forest areas and percentages impacted by abiotic agents, with data provided by national forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries. The changes in forest area and percent of forests affected beyond reference conditions will be determined, and the indicator values can be compared annually with 2020 as the reference year.

2.2.3. Indicator 3: Forest fragmentation – changes in the area of continuous forest and of patches of forest separated by non forest lands

The assessment of forest fragmentation is the primary focus of this indicator, which involves evaluating changes in the density of forested areas and the distribution of forest patches across various size categories. By utilizing the Geographic Information System (GIS) analysis, the indicator examines the patterns of density and distribution in forested regions to gain insights into the effects of habitat isolation on species connectivity and viability. This indicator is in line with Forest Europe’s recommendation to monitor forest fragmentation trends based on forest area density and patch distribution. The analysis of spatial forest distribution relies on readily available satellite data and analytical tools. In Europe, including Türkiye, the Corine Land Cover (CLC) dataset, which provides nationally produced land cover maps over time, serves as the primary data source for assessing forest fragmentation. For the FAO Subregional Office for Central Asia (FAO SEC) countries, national datasets on forest distribution can be used as the primary data source for this indicator (Forest Europe, 2019).

Forest fragmentation is evaluated by utilizing the Forest Area Density at Fixed Observation Scale (FAD–FOS) within the designated assessment unit. To differentiate between continuous forests and patches that are separated by non forest lands, various forest patch size classes ranging from 100 to >100.000 hectares are considered. A FAD threshold of 40 percent is proposed to distinguish these different fragmentation classes. Each forest patch is assigned a single fragmentation class, and the average FAD value at the pixel level is calculated for each patch. The indicator values are derived from comprehensive analyses conducted by the national forestry agencies of FAO SEC countries. Reporting takes place at the country level, featuring tabular statistics on forest fragmentation classes, along with spatially explicit trend maps that are based on carefully selected datasets. The provided table presents valuable insights into forest patch size classes and enables a comparison of changes in the area of continuous forest and patches separated by non forest lands over five year periods (Soille and Vogt, 2022).

2.2.4. Indicator 4: Indicator for drought impact on forest ecosystems – changes in the annual area of drought impact on vegetation productivity in forest ecosystems

The indicator assesses the impact of drought on forest ecosystems by analysing changes in the annual area of vegetation productivity affected by drought. Severe and frequent droughts lead to habitat loss, species migration, and biodiversity decline. The indicator uses remote sensing data to track anomalies and trends in vegetation productivity affected by drought forest ecosystems of the FAO Subregional Office for Central Asia (FAO SEC) countries for the long term. It relies on the Soil Moisture Anomaly (SMA) time series from the European Drought Observatory to calculate drought pressure. National forestry agencies provide the necessary data, and comparisons are made annually (European Drought Observatory, 2021).

The quantification of drought pressure occurs at a detailed level, specifically at the pixel level, utilizing annual soil moisture anomalies for the long term observed during the vegetation growing season. The presence of negative soil moisture anomalies indicates a reduction in moisture availability, leading to persistent changes in the ecosystems conditions. To identify severe drought pressure, a threshold of –1 standard deviation is employed to detect significant negative soil moisture anomalies. Furthermore, the evaluation of annual drought impact takes into account large integral anomalies and the assessment of growing season productivity using remote sensing data.

The Plant Phenology Index (PPI) derived from Moderate Resolution Imaging Spectroradiometer (MODIS) data serves as the vegetation index for assessing productivity, with a focus on complete ground surface coverage. The indicator relies on the utilization of PPI, obtained through a radiative transfer model that incorporates reflectance measurements in the visible red (RED) and Near Infrared (NIR) spectral ranges. The article further discusses the specific methodology employed for calculating the indicator values and the data analysis techniques applied. Additionally, it highlights the selection of a threshold to identify minor deviations from average for the long term, thus capturing moderate productivity levels under drought pressure (Jin and Eklundh, 2014).

2.2.5. Indicator 5: Indicator for poaching and trafficking of protected species – changes in the proportion of traded wildlife that was poached or illicitly trafficked (national CITES authority)

This indicator focuses on evaluating the extent of poaching and illicit trafficking of protected species by quantifying the proportion of wildlife trade that is identified as illegal. The national Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) authority possesses the necessary information pertaining to this indicator. The calculation of the indicator involves determining the ratio of illegal trade to the total trade, which encompasses both legal and illegal transactions. The value of legal trade is derived by aggregating the documented species product units found in CITES export permits, as reported in the CITES annual reports of the FAO Subregional Office for Central Asia (FAO SEC) countries. These quantities are then multiplied by the respective prices of the species product units, which are obtained through a weighted average of prices declared for legally imported analogous species product units. On the other hand, the value of illegal trade is obtained by summing the species product units recorded in the World Wildlife Seizure (World WISE) database and multiplying them by the previously mentioned species product unit prices (UNODC, 2019).

The CITES Trade Database, overseen by the United Nations Environment Programme (UNEP) World Conservation Monitoring Centre, serves as a repository for legal trade statistics reported annually by CITES Parties. Starting in 2017, the UNODC database known as the World WISE has been integrated with illicit trade data obtained from various sources as part of the obligatory annual reporting on CITES Illegal Trade (UNODC, 2020). The value assigned to a species product unit can be determined by calculating the weighted average of prices declared for legally imported analogous species product units, which are sourced from national authorities in FAO SEC countries. The indicator values will be established using national data provided by the respective national CITES authority to the forestry agencies of FAO SEC countries. The assessment will focus on monitoring changes in the proportion of wildlife traded that has been subjected to poaching or illicit trafficking on an annual basis.

2.2.6. Indicator 6: Indicator for illegal cutting – changes in the forest area under illegal cutting pressure

The indicator focuses on evaluating the magnitude of illegal logging in forests by quantifying the forest area (measured in hectares) subjected to illegal cutting pressure. Each countries forestry service will provide annual reports on this information. The indicator values will be derived from national data provided by the forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries, enabling an annual comparison of changes in the forest area affected by illegal logging (WCS Lao PDR Programme and GIZ, 2015).

In addition, remote sensing techniques can be utilized to detect alterations in forest cover. Satellite imagery equipped with red edge and shortwave infrared bands has demonstrated effectiveness in identifying vegetation. For example, the WorldView–3 satellite incorporates a red edge band that, in conjunction with random forests, plays a pivotal role in the object oriented forest classification. Similarly, Sentinel–2 offers four distinct red edge bands and two shortwave infrared bands that are widely employed for forest detection. Moreover, the health decline of forests can be monitored by calculating the chlorophyll index using red edge reflectance. By employing the Differentiated Normalized Burning Rate (dNBR) calculated from shortwave infrared bands and combining it with the maximum interclass variance algorithm, it becomes possible to determine the location and extent of forest fire areas with varying degrees of burning (Hu *et al*., 2022)

Chapter 3

Response component

3.1. Monitoring of forest gain

3.1.1. Indicator 1: Annual forest gain rate (afforestation)

The annual forest gain rate (afforestation) indicator monitors the total land area that has transitioned from an unforested to a forested state in a given period via afforestation activities. As a methodology, the use of Geographic Information System (GIS) analysis allows for monitoring of the annual forest gain rate (afforestation) indicator, which tracks the amount of land that has changed from a non forested to a forested state during a specified period through afforestation activities (FAO, 2020).

3.2. Monitoring of forest recovery

3.2.1. Indicator 1: Annual forest recovery rate (rehabilitation, reforestation, restoration)

The annual forest recovery rate indicator monitors the areas of forest that have been previously degraded (but not completely deforested) and is now regrowing, recovering, and regaining ecological and economic functions, biodiversity, and/or carbon levels. It measures the total land area that has been recovered in a given period via rehabilitation, reforestation, and restoration activities. As a methodology, through the application of Geographic Information System (GIS) analyses, it is possible to track the annual forest recovery rate (through rehabilitation, reforestation, and restoration) indicator. This measures the amount of forested land that has been restored, replanted, or rehabilitated during a given period. The indicator values will base on the results of national data provided by the national forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries (from national forest inventories) and the annual forest recovery rate (rehabilitation, reforestation, restoration) will be reported annually (Ritchie and Roser, 2021).

Table 9. Response component monitoring details

RESPONSE COMPONENT						
Monitoring Indicator	**Level**	**Frequency**	**Area**	**Method**	**Team/Expertise**	**Success Criteria**
Forest Gain: Annual Forest gain rate (afforestation)	National	Annual	Forest ecosystems	GIS analysis	National forestry agency	No decrease in annual forest gain rate
Forest Recovery: Annual Forest recovery rate (rehabilitation, reforestation, restoration)	National	Annual	Forest ecosystems	GIS analysis	National forestry agency	No decrease in annual forest gain rate
Change in area of forest and other wooded land protected to conserve biodiversity, landscapes, and specific natural elements	National	5 years	Forest protected areas	Assessing change in the area	National forestry agency & National Nature Conservation Agency	Increase in the area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements
Protected Forests: Change in area managed for conservation and utilization of forest tree genetic resources (in situ and ex situ genetic conservation) and area managed for seed production	National	5 years	Selected areas	Assessing change in the area	National forestry agency & related government institutes	Increase in the area managed for conservation and utilizations of forest tree genetic resources (in situ and ex-situ genetic conservation) and area managed for seed production
Protected Forests: Change in area managed as protective forests (managed primarily for the protection of soil and water)	National	5 years	Forest ecosystems	Assessing change in the area	National forestry agency	Increase in the area managed as protective forests (managed primarily for the protection of soil and water)
Forest Biodiversity Data Assessment: Growth in species occurrence records accessible through GBIF	National	Annual	Forest ecosystems	Reviewing records on GBIF website	National forestry agency	Increase in species occurrence records accessible through GBIF
Forest Biodiversity Data Assessment: Proportion of known forest species assessed through the IUCN Red List	National	5 years	Forest ecosystems	IUCN National Red List analyses	National forestry agency & related government institutions	Increase in the proportion known forest species assessed through the IUCN Red List
Sustainable Forest Management: Proportion of forest area with a long-term management plan	National	Annual	Forest ecosystems	Measuring changes in proportion	National forestry agency	Increase in the proportion of forest area with a long-term management plan
Sustainable Forest Management: Changes in area of forest under certified management	National	Annual	Forest ecosystems	Measuring changes in area	National forestry agency	Increase in the area of forest under certified management.
Sustainable Forest Management: The availability of national criteria and indicators set for sustainable forest management, the success of implementing these criteria and indicators	National	Annual, 5 years	Forest ecosystems	Checking the availability of SFM criteria an indicators & assessing the implementation success	National forestry agency	Increase in the number of countries having national criteria and indicators set for sustainable forest management. Increase in the success of implementing national criteria and indicators set for sustainable forest management.
Biodiversity integration into forest management plans: Number of forest management plans with biodiversity integration and size	National	Annual	Forest ecosystems	Assessing the change in the number of plans and the area	National forestry agency	Increase in the number of forest management plans with biodiversity integration and increase in size

Source: Nature Conservation Centre (NCC). 2023. (©NCC)

3.3. Monitoring for protected forests

3.3.1. Indicator 1: Change in area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements

The change in area of forest and other wooded land protected to conserve biodiversity, landscapes, and specific natural element indicator measures the forest area located within legally established protected areas. The methodology involves evaluating changes in the amount of protected forest and wooded land over time to determine the effectiveness of conservation efforts aimed at preserving biodiversity, landscapes, and natural elements. The indicator values will be based on national data provided by the national forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries and compared for five year periods (FAO, 1997; FAO, 2020).

3.3.2. Indicator 2: Change in area managed for conservation and utilisation of forest tree genetic resources (in situ and ex situ genetic conservation) and area managed for seed production

The indicator measures the area managed for conservation and utilisation of forest tree genetic resources and the area managed for seed production, including seed orchards, clone parks, seed stands, and gene conservation forests. The changes in these areas provide insight into the efforts made to conserve and utilize forest tree genetic resources over time. The indicator values are based on national data provided by the FAO Subregional Office for Central Asia (FAO SEC) countries' national forestry agencies, and the change in the area managed for these purposes will be compared for five year periods.

3.3.3. Indicator 3: Change in area managed as protective forests (managed primarily for the protection of soil and water)

The change in area managed as protective forest indicator measures the amount of forest and wooded land used for preserving water resources, preventing soil erosion, and maintaining other protective functions. The assessment is made by tracking changes in the amount of land used for this purpose, providing insights into the effectiveness of efforts to protect and preserve these natural resources. The indicator values are based on national data provided by the FAO Subregional Office for Central Asia (FAO SEC) countries' national forestry agencies and are compared every five years. The data from the Global Forest Resources Assessment 2020 report is also used for comparison (FAO, 2020).

3.4. Monitoring for protected forests

3.4.1. Indicator 1: Change in area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements

This indicator aims to evaluate the degree of protection granted to forest areas within legally designated protected areas, specifically targeting the conservation of biodiversity, landscapes, and specific natural elements. The assessment focuses on monitoring changes in the extent of protected forest and wooded land over time. By closely monitoring these changes, it becomes possible to assess the effectiveness of conservation initiatives in safeguarding and preserving biodiversity, landscapes, and natural elements. The indicator values are obtained by analysing national data supplied by the forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries, utilizing information sourced from national forest inventories. Comparisons are made between changes in the area of protected forest and other wooded land, specifically designated for the conservation of biodiversity, landscapes, and specific natural elements, over five year intervals. These assessments enable the evaluation of trends and the effectiveness of conservation initiatives (FAO, 2020).

3.4.2. Indicator 2: Change in area managed for conservation and utilisation of forest tree genetic resources (in situ and ex situ genetic conservation) and area managed for seed production

This indicator focuses on quantifying the extent of land designated for the conservation and utilization of forest tree genetic resources, including in situ and ex situ genetic conservation, as well as seed production. Such areas encompass seed orchards, clone parks, seed stands, and gene conservation forests. By assessing changes in the managed land for these purposes, valuable insights can be gained regarding the conservation and utilization efforts for forest tree genetic resources over time (Lefèvre, 2020). The indicator values will rely on national data provided by the forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries, obtained from national forest inventories, enabling comparisons of changes in the managed land for the conservation and utilization of forest tree genetic resources (including in situ and ex situ genetic conservation) and seed production over five year periods (FAO, 2003).

3.4.3. Indicator 3: Change in area managed as protective forests (managed primarily for the protection of soil and water)

This indicator evaluates the extent of forest and other wooded land designated for the preservation of soil and water resources and other protective functions. Changes in the area of land allocated for the protection of soil erosion, water resources, and other protective purposes are used as an assessment method. It quantifies the land dedicated to conserving water resources, preventing soil erosion, and maintaining protective functions. By monitoring changes in this land area, the indicator provides valuable insights into the effectiveness of conservation efforts for these crucial natural resources (Dudley, 2008). The indicator values are derived from national data provided by the national forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries, obtained from national forest inventories. The comparison of changes in the area managed as protective forests, primarily focused on soil and water protection, is conducted over five year periods. The Global Forest Resources Assessment 2020 report includes data on the area of protective forests (managed primarily for soil and water protection) for FAO SEC countries (FAO, 2020).

3.5. Monitoring of forest biodiversity data assessment

3.5.1. Indicator 1: Growth in species occurrence records accessible through GBIF

This indicator monitors the availability of digitally accessible records published through the Global Biodiversity Information Facility (GBIF). It measures the quantity of species occurrence records documenting the spatial and temporal distribution of species, which can be freely accessed by researchers and policymakers online. A higher indicator value indicates a larger volume of records shared by various data providers, including researchers, Nongovernmental Organizations (NGOs), government agencies, and citizen science initiatives, in an open format. Conversely, a lower value suggests a decreased availability of such data for research and policy purposes (BIP, 2022i).

To assess forest biodiversity, the monitoring process involves analysing records on the GBIF website. The growth in the number of species occurrence records accessible through GBIF serves as the basis for evaluation. GBIF acts as a comprehensive repository of species data from all countries, and the number of occurrence records in the GBIF data index reflects the cumulative sum of records shared by institutions holding data. The indicator values are derived from the analysis of total GBIF records at the end of each year for the FAO Subregional Office for Central Asia (FAO SEC) countries. The annual report includes information on the growth in species occurrence records accessible through GBIF datasets. The baseline value for this indicator can be obtained from the species occurrence data for 2022, provided in Table 5.

Table 10. GBIF database species occurrences data for 2022 for each FAO SEC countries

Year	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Türkiye	Uzbekistan
Occurrences	230,938	342,493	171,818	76,929	47,719	2,680,642	104,143
Datasets	521	780	483	444	501	1,516	532
Publishers	200	254	183	174	194	386	209

Source: Adapted from Global Biodiversity Information Facility (GBIF). 2023. *Biodiversity Data*. [Cited 29 December 2022]. https://www.gbif.org/

3.5.2. Indicator 2: Proportion of known forest species assessed through the IUCN red list

The indicator focuses on evaluating the proportion of forest species that have undergone extinction risk assessment according to the global or national International Union for Conservation of Nature (IUCN) Red List of Threatened Species. While national red list books are not commonly available in the most FAO Subregional Office for Central Asia (FAO SEC) countries, there is a need to develop them. The IUCN Red List has a long standing history of over fifty years, and its robust methodology has been extensively documented in scientific literature. Monitoring the indicator proportion of known species assessed through the IUCN Red List has been an ongoing practice, with regular updates provided on the IUCN Red List website. In the context of this report, the indicator has been revised as the proportion of known forest species assessed through the IUCN Red List for each FAO SEC country. However, the number of forest species with IUCN Red List status is limited in FAO SEC countries, and monitoring efforts are carried out through various projects and platforms. The species list provided in Annex 7 can serve as a baseline for this indicator (IUCN, 2022).

The assessment of the proportion forest species evaluated through the IUCN Red List plays a crucial role in identifying knowledge gaps regarding forest biodiversity and prioritizing conservation actions for species facing significant risks. Although the number of forest species with IUCN Red List status is limited in FAO SEC countries, monitoring efforts are undertaken through various projects and platforms. The species list provided in Annex 1 can serve as a fundamental reference point for this indicator. To evaluate changes in the proportion of known forest species assessed through the IUCN Red List, reliable data from national red list analyses conducted by the national forestry agencies of FAO SEC countries will be utilized. The indicator values will be derived from these assessments and will facilitate the monitoring of conservation progress and the effectiveness of species protection measures over five year periods. By analysing these changes, it becomes possible to enhance our understanding of forest biodiversity and implement targeted conservation strategies (UNSTATS, 2022).

3.6. Monitoring of sustainable forest management

3.6.1. Indicator 1: Proportion of forest area with a long term management plan

This indicator measures the proportion of forest area in a country that has a long term management plan in place to meet sustainable goals, with periodic reviews. The management of forests typically involves the implementation of long term plans spanning over ten years or more, aiming to achieve sustainable objectives, with periodic reviews. This indicator focuses on assessing the percentage of forest area covered by long term management plans in a country. Monitoring changes in this proportion over time provides insights into the progress of sustainable forest management practices.

The indicator aims to assess the level of sustainable forest management in a country. Changes in this proportion are measured over time to monitor progress towards sustainable forest management. The data for this indicator is provided by national forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries, and the proportion of forest area with a long term management plan is reported annually (UNSTATS, 2023c).

Table 11. In FAO SEC countries, the proportion of forest area with a long term management plan

Country	Proportion of Forest Area with a Long Term Management Plan
Azerbaijan	0%
Kazakhstan	100%
Kyrgyzstan	89.0%
Tajikistan	0%
Turkmenistan	0%
Türkiye	100%
Uzbekistan	95.80%

Source: Adapted from United Nations Economic Commission for Europe (UNECE). 2023*. Indicator 15.2.1: Proportion of forest area with a long term management plan, %.* [Cited 8 September 2023]. https://w3.unece.org/SDG/en/Indicator?id=179

3.6.2. Indicator 2: Changes in area of forest under certified management

This indicator measures the area of responsibly managed forests, including natural or semi natural forests used for timber and nontimber forest products and forest plantations. An increase in the area of Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC) certified forests represent progress towards sustainable forest management, including biodiversity conservation and promotion of social, economic, cultural, and ethical dimensions. The indicator is measured by tracking changes in the certified forest area over time. National data provided by forestry agencies in the FAO Subregional Office for Central Asia (FAO SEC) countries is used to report annually, and data can be verified through the official websites of the FSC and PEFC (UNSTATS, 2023d).

3.6.3. Indicator 3: National criteria and indicators set for sustainable forest management

The indicator measures the availability and success of implementing a national set of criteria and indicators for sustainable forest management in the FAO Subregional Office for Central Asia (FAO SEC) countries. The monitoring method involves checking for the availability and assessing the implementation success of these criteria and indicators. The data for this indicator will be based on national data provided by the national forestry agencies of FAO SEC countries, with an independent expert assessing the success of implementation. The increase in the number of countries having national criteria and indicators set for sustainable forest management and the increase in the success of implementation will be reported annually and over five years. The indicator values rely on national data provided by the national forestry agencies of FAO SEC countries, including information on the:

- Existence of a national set of criteria and indicators for sustainable forest management (Note: Türkiye, Kazakhstan, Kyrgyzstan, and Uzbekistan have their own national sets)

- The success of implementing the national criteria and indicators set for sustainable forest management, if applicable.

3.4. Monitoring of biodiversity integration into forest management plans

3.4.1. Indicator 1: Number of forest management plans with biodiversity integration and size (ha)

The indicator measures the number of forest management plans with biodiversity integration and their size (in hectares), indicating progress in the sustainable management of natural forests. In the context of sustainable management of natural forests, the inclusion of biodiversity conservation measures within production forests is crucial. Türkiye serves as an example with its current practices of integrating biodiversity values into forest management plans. The indicator focuses on quantifying the number of forest management plans that incorporate biodiversity integration and their corresponding size in hectares. Monitoring involves assessing changes in both the quantity of plans and the total area covered by these plans over time. The number of forest management plans with biodiversity integration and size serves as the designated indicator to track progress in this domain. The indicator values will be derived from national data provided by the forestry agencies of the FAO Subregional Office for Central Asia (FAO SEC) countries, utilizing information from national forest inventories. Changes in the number of forest management plan with biodiversity integration and their respective sizes will be reported annually, enabling the evaluation of progress and performance.

Chapter 4

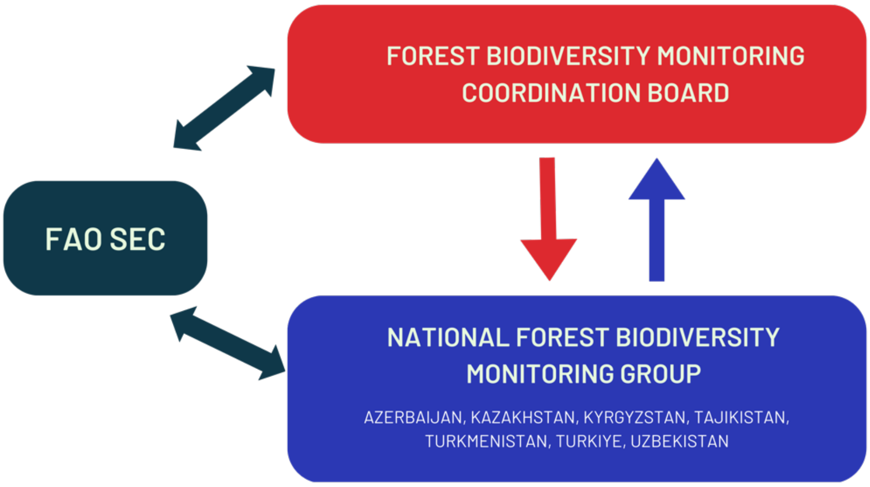
Governance mechanism

Governance can be defined as processes and structures that enable society to share its power and transform it into individual and social actions (Young, 1992). Governance does not imply the sole authority of the government but rather includes laws, regulations, negotiation, conflict resolution, public consultations, and other decision making processes. In other words, governance is collective management by interactions of many actors including academics and Nongovernmental Organizations (NGOs). It can be formally institutionalized or expressed through subtle norms of interaction or even more indirectly by influencing the agendas and shaping the contexts in which actors contest decisions and determine access to resources.

It is shortly defined as “the process of decision making and the process by which decisions are implemented or not implemented.” The principle of good environmental governance is important for governance in forest biodiversity monitoring. This involves creating processes to build trust, integrity, inclusivity, transparency, accountability, flexibility, reciprocity, and communication as foundations of good governance and collaboration (Lockwood *et al*., 2010). Governance is defined as “good” when there is stakeholder participation, transparency of decision making, accountability of actors and decision makers, rule of law and predictability. It is mainly associated with efficient and effective management of natural, human and financial resources and fair and equitable allocation of resources and benefits (FAO, 2011).

For the effective implementation of the guidelines on forest biodiversity monitoring methodologies, a governance mechanism is proposed for the participation of regional and national stakeholders. The governance mechanism will include a forest biodiversity monitoring coordination board and national forest biodiversity monitoring groups in each the FAO Subregional Office for Central Asia (FAO SEC) country (Figure 8).

Figure 8. Governance mechanism scheme



Source: Authors' own elaboration, Nature Conservation Centre (NCC). 2023. (©NCC).

4.1. Forest Biodiversity monitoring coordination board

It will be set up with the support of the FAO Subregional Office for Central Asia (FAO SEC) with the participation of the representatives of the following national institutions:

- **Azerbaijan**: The Ministry of Ecology and Natural Resources of the Republic of Azerbaijan – Forest Development Department – Department of Forest Development
- **Kazakhstan**: Ministry of Ecology, Geology and Natural Resources – The Forestry and Wildlife Committee
- **Kyrgyzstan**: State Agency of Environment Protection and Forestry – Department of Forest Ecosystems and Protected Areas
- **Tajikistan**: Forestry Agency of the Republic of Tajikistan
- **Turkmenistan**: The Ministry of Agriculture and Environment Protection of Turkmenistan – Department of Forestry

- **Türkiye**: The Ministry of Agriculture and Forestry – General Directorate of Forestry
- **Uzbekistan**: The Ministry of Nature Resources of The Republic of Uzbekistan – The Forestry Agency
- FAO SEC representative

The board may invite relevant institutions and organizations to the meetings when necessary. It is envisaged that the board will meet annually to share the monitoring data and assess the progress.

4.1.1. Tasks of the coordination board

1. The tasks of the coordination board are proposed for effective implementation and evaluation of the guidelines on forest biodiversity monitoring methodologies:
2. To ensure coordination and cooperation among the FAO Subregional Office for Central Asia (FAO SEC) country representatives for implementation and evaluation of the guidelines on forest biodiversity monitoring methodologies
3. To ensure the implementation of the monitoring work plan and to evaluate its progress.
4. To facilitate the timely and effective provision of financial resources and expert support required for monitoring activities.
5. To ensure the establishment of national forest biodiversity monitoring groups and to supervise their work.
6. To organize training on monitoring methods.
7. To ensure that the annual monitoring data are collected and reported.
8. To ensure that the Forest Biodiversity Status Report is prepared every five years.
9. To ensure that the reports are shared with the relevant institutions and organizations at international and national levels.
10. To select the secretariat in two years intervals.

4.1.2. The secretariat

The secretarial tasks of the board can be undertaken by a country representative (to be selected in the first meeting for two years and then given to another country in turn) with the support of the FAO Subregional Office for Central Asia (FAO SEC).

4.2. National forest biodiversity monitoring group

For effective implementation and evaluation of the guidelines on forest biodiversity monitoring methodologies, a national forest biodiversity monitoring group can be established under the coordination of the national forestry agency in each the FAO Subregional Office for Central Asia (FAO SEC) country. This group may take the responsibility of collecting and analysing monitoring data and reporting. It may have members from government organizations (including authorities on protected areas and the Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES) authorities), academia (institutes, universities) and Nongovernmental Organizations (NGOs) working on forest biodiversity.

This group can carry out monitoring activities at the country level, putting the expertize of the members to practice. The group may collect data and process the collected data into the databases and support the coordination board in the preparation and analysis of the monitoring reports. The group members may be assigned and gathered annually or when necessary, depending on the specialty required during the specific monitoring activity.

4.3. Reporting cycle

For some of the indicators, data will be collected annually. To strengthen the coordination and cooperation between national public institutions and stakeholders, and regional organizations for effective implementation and evaluation of the guidelines on forest biodiversity monitoring methodologies, information about the progress will be received and evaluated by the coordination board at the end of each year. The work related to reporting will be carried out by the secretariat. The progress reports will be used in the preparation of brief annual monitoring reports at the end of each year. The annual reports will be compiled into a 'Forest Biodiversity Status Report' (in English and Russian) every five years. These reports will be shared with the relevant regional and national institutions and organizations.

4.4. Work plan

The work plan of the forest biodiversity monitoring coordination board, which will be established for the effective implementation of the monitoring concept, is presented below.

Table 12. Work plan

Activity	***Years***					
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**	**Second 5 year period**
Establishing Forest Biodiversity Monitoring Coordination Board	X					
Establishing National Forest Biodiversity Monitoring Group	X					
Onset of the monitoring activities	X	X	X	X	X	X
Preparation of the Annual Monitoring Reports	X	X	X	X	X	X
Preparation of the Forest Biodiversity Status Report					X	

Source : Nature Conservation Centre (NCC). 2023. (©NCC)

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Annexes

Annex I. Red list analyses in FAO SEC countries

Given that biodiversity is not evenly dispersed in space, the processes driving its loss, and the resources available for its conservation are not equal, biodiversity trends should exhibit significant geographical disparities. This is supported using the International Union for Conservation of Nature (IUCN) red list index at the national scale, which is produced based on changes in the threat status of species according to national red lists. These country-level indicators are valuable for tracking national biodiversity targets, but they need more utility for illuminating progress toward global biodiversity targets. Different countries indeed bear varying degrees of worldwide responsibility for conserving the species they harbour (Rodrigues *et al*., 2014).

The red list index is a metric utilized to assess the overall changes in the risk of extinction for various species groups. This index takes into account the genuine fluctuations in the number of species within each category of extinction risk as identified on The IUCN Red List of Threatened Species (www.iucnredlist.org). The red list index is represented as a numerical value between 0 and 1, signifying the extent of change observed. A value of 1 indicates that all species are classified as 'Least Concern,' while a value of 0 signifies that all species are classified as 'Extinct.' Thus, the Red List Index provides valuable insights into the collective trajectory of species towards the threat of extinction (OECD, 2021).

The red list index is a valuable tool that allows for the assessment of the overall extinction risk faced by species within a particular country or region. It measures the relative contribution of that area to the global species extinction risk, considering the taxonomic groups included. The index is represented on a scale of 0 to 1, where a score of 1 indicates the highest potential contribution that the country or region can make to global species survival. In such cases, all species within the area are classified as "Least Concern" on the IUCN Red List, implying a minimal risk of extinction. On the other hand, a score of 0 reflects the lowest potential contribution to global species survival, signifying that all species within the country or region have unfortunately gone extinct. By utilizing the red list index, it becomes possible to evaluate the unique role and impact of a specific country or region in global conservation efforts aimed at protecting species diversity (IUCN, 2023).

Table 1. Red list index for FAO SEC countries

Years	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Türkiye	Uzbekistan
2000	0.91515	0.87845	0.98809	0.98817	0.98124	0.88847	0.98013
2001	0.91475	0.8776	0.98775	0.98783	0.98079	0.88798	0.9793
2002	0.91459	0.87696	0.98727	0.98752	0.98026	0.88749	0.97865
2003	0.91398	0.87616	0.98685	0.98753	0.97973	0.88698	0.97771
2004	0.91349	0.87557	0.98662	0.98714	0.97938	0.88661	0.97713
2005	0.91294	0.87507	0.98632	0.98721	0.97919	0.88625	0.9767
2006	0.91253	0.87475	0.98604	0.987	0.97905	0.88577	0.97633
2007	0.91195	0.87437	0.98582	0.98714	0.97889	0.88533	0.97613
2008	0.91171	0.87395	0.98574	0.98765	0.97882	0.88505	0.97591
2009	0.91117	0.87336	0.98548	0.98775	0.9787	0.88471	0.97556
2010	0.91144	0.87277	0.98528	0.98775	0.97862	0.88436	0.97509
2011	0.91136	0.87244	0.98509	0.98773	0.97847	0.88409	0.97472
2012	0.91145	0.87189	0.98486	0.98771	0.97837	0.88367	0.97424
2013	0.91136	0.87141	0.98463	0.98767	0.97828	0.8834	0.97409
2014	0.9116	0.8709	0.98443	0.98766	0.97814	0.88299	0.97353
2015	0.91144	0.87065	0.98424	0.98762	0.97808	0.88278	0.97319
2016	0.91138	0.87012	0.98401	0.98761	0.97802	0.88219	0.97263
2017	0.91115	0.86958	0.98391	0.9876	0.97791	0.88202	0.97215
2018	0.9114	0.86919	0.98365	0.98756	0.97784	0.88179	0.97194
2019	0.91135	0.86877	0.98344	0.98756	0.97775	0.88152	0.97154
2020	0.91151	0.86834	0.9832	0.98755	0.97764	0.88098	0.97103
2021	0.91169	0.86788	0.98298	0.98755	0.97754	0.8804	0.97084
2022	0.91179	0.86754	0.98277	0.98754	0.97744	0.88	0.97045

Source: United Nations Economic Commission for Europe (UNECE). 2023. *Indicator 15.5.1 Red List Index. [Cited 8 September 2023].*
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Annex II. Details of bird field survey methods

Bird species can display different behaviours of feeding, resting and so on, and space uses characteristics during mating, summering, wintering, and migration periods. In order to monitor the population size for the species, monitoring studies covering these different periods are important for more accurate population size estimates and for determining the true size of the population. In this context, monitoring activities are designed to represent these different periods and behaviours. Therefore, the methodologies carried out for feeding, wintering or breeding are important monitoring periods that also allow the population size of the species to be monitored. While examining these different periods and behaviour patterns, at the same time existence-absence, gender, age, etc. information should also be collected. For example, many bird groups reach reproductive maturity after three years, and in studies aimed at determining only the active nest, these immature individuals may not be visible.

Representing these individuals in population estimates may become probable with monitoring studies to be carried out during the summer and/or overwintering periods. Hence breeding, wintering, summering, etc. Performing monitoring studies using appropriate methods in different periods is important in order to reach true population estimates. The main methods for bird field surveys are line transect and point counts. Both methods can be used in the field surveys.

- **Transect Count**: For forest species, the transect count method can be preferred. Line transect is more suitable if the field conditions or forest structure is allowed the surveyor to walk, and at least 30 minutes' walk is generally required.
- **Point Count:** The point count technique is a frequently used method to monitor the population variables of wild animals. It is based on the principle of counting the individuals entering the field of vision from a dominant point in the working area within a certain period of time. It is the best method for the breeding period point count studies. Binoculars or telescopes are essential for observation.

It is preferred when walking on the site is difficult. Observation points are selected from the areas having a clear view. At each observation point, the area was surveyed for at least 10 minutes.

Annex III. Details of field survey methods for camera trapping

Direct observation of large mammals is difficult in the field. Large mammals have better senses than humans, and they notice the surveyors before the surveyors detect them. The other factor that makes direct observation difficult is the low population size of the large mammals compared to the other species groups. One other factor is their nocturnal lifestyle. Therefore, the general approach used in large mammal field surveys is indirect detection methods, and camera traps are the main methods used in these studies. Camera traps are heat and motion-sensitive devices that take photos of animals passing in front of it. It is set on a tree trunk on the animal paths.

The primary goal of the monitoring study is to safeguard and enhance suitable habitats to ensure the sustained presence of species in these specific areas. During the initial phase of the monitoring study, it is crucial to determine the number of individuals utilizing the area and assess the population size. The most efficient approach to achieve this involves deploying camera traps in the appropriate locations frequented by large mammal species. Employing camera traps across all suitable habitats in the area will provide essential data on the population size of the target large mammal species, thereby guiding conservation and monitoring initiatives. By closely monitoring changes in the current population size, valuable insights can be gained regarding potential threats exerting pressure on the species. This information will contribute to the development and implementation of targeted conservation measures that account for these factors.

Camera traps are placed approximately 50 cm above the ground on the trails that target large mammal species may use. Camera traps should not be placed perpendicular to the trail. Placing the camera traps shooting up or down the trail minimizes the possibility of missing the animals using the trail, that is, triggering empty. Also, the camera trap's viewing angle sensors should be in a north-south direction with the least exposure to the sun. Weeds and branches that may interfere with the view in front of the tree on which the trap is established should be cleaned. In order to prevent the camera traps from being stolen or damaged, it is recommended to install on more secluded trails that are difficult to notice from outside, instead of roads where human activity is intense (Figure 1). After each camera trap is installed, it should be tested by putting it into a test state.

The indicator can be produced for each the FAO Subregional Office for Central Asia (FAO SEC) country, if there are at least five forest monitoring sites concurrently monitored with camera trap data using a comparable methodology. These forest monitoring sites can be distributed along major environmental gradients present in the country (rainfall, temperature, soil type, soil moisture) (Ahumada *et al*., 2016).

For this indicator, at each forest monitoring site, a camera trap sample shall consist of 60 camera trap points, distributed among two to three camera trap arrays. Each point is sampled over a 30-day period, once a year, during summer and no bait is used to attract animals to the points. Ideally, all 60 points should be sampled simultaneously; however, this is precluded by cost and logistical constraints. Therefore, the sampling points may be divided into two or three (depending on the particular site) camera trap arrays. Each camera trap array contains 20 camera traps at a density of one trap per 2 km^2. Each array is sampled sequentially, not simultaneously; however, all arrays must be sampled within the same summer season. This means that the first array of camera traps is deployed and remains in the field for 30 days. Immediately thereafter, the camera traps are picked up, the batteries and memory cards are replaced, and the replenished camera traps are immediately moved to the second array and remain there for 30 days. Increasing the number of camera traps to 30 is a factor that will increase the effectiveness of monitoring studies.

After the installation of the camera traps and receiving data, the Wild Picture Index (WPI) is derived from primary annual camera trap monitoring data using Tropical Ecology, Assessment and Monitoring (TEAM) network standardized monitoring methods (TEAM, 2021). After images are classified by species, a hierarchical model is run to estimate occupancy of all species by year, by monitoring site with no covariates. This model corrects for detection probability which is estimated as a single parameter with a random effect per species. The posterior distribution of occupancy per species per year is then used to calculate the WPI as the geometric mean of occupancy relative to the initial occupancy of the species (year 1). The confidence intervals of the WPI are naturally propagated from these posteriors.

Figure 1. Setting up a camera trap and an installed camera

Source : Nature Conservation Centre (NCC). 2023. *Images of the installation of camera traps within the scope of forest biodiversity monitoring studies.* (© NCC).

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Annex IV. The bioclimatic ecosystem resilience index (BERI) values for FAO SEC countries

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) generate national level results for BERI values in 2005, 2010 and 2015.

Table 1. Bioclimatic ecosystem resilience index (BERI) Values for FAO SEC countries

Year	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Türkiye	Uzbekistan
2005	0.318	0.405	0.477	0.453	0.407	0.321	0.380
2010	0.313	0.417	0.483	0.455	0.413	0.315	0.386
2015	0.309	0.413	0.486	0.455	0.415	0.310	0.386
Annual rate of change 2005-2015	0.312%.	0.199%.	0.194%.	0.042%.	0.185%.	0.366%.	0.139%.

Source: Adapted from Commonwealth Scientific and Industrial Research Organisation (CSIRO). 2023. *Data Portal: BERI v2: Bioclimatic Ecosystem Resilience Index: 30s global time series.* https://data.csiro.au/collection/csiro:54238

Annex V. Biodiversity habitat index (BHI) results for Azerbaijan and Türkiye

Table 2. Biodiversity habitat index (BHI) values for Azerbaijan and Türkiye.

Year	Azerbaijan	Türkiye
2005	0.452	0.450
2010	0.445	0.448
2015	0.444	0.443
Annual rate of change 2005-2015	-0.176%.	-0.15%.

Source: Adapted from Yale University Environmental Performance Index (EPI). 2020. *Biodiversity Habitat Index* [Cited 8 September 2023] https://epi.yale.edu/epi-results/2020/component/bhv

Annex VI. GBIF database species occurrences data for 2022 for each FAO SEC countries

Table 3 Species occurrence data in FAO SEC countries

Year	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Türkiye	Uzbekistan
Occurrences	230,938	342,493	171,818	76,929	47,719	2,680,642	104,143
Datasets	521	780	483	444	501	1,516	532
Publishers	200	254	183	174	194	386	209

Source: Adapted from Global Biodiversity Information Facility (GBIF). 2023. *Biodiversity Data*. [Cited 8 September 2023]. https://www.gbif.org/

Annex VII. Forest species list

Forest species listed in the IUCN Red List database are retrieved and a list of forest species is developed for further monitoring activities (IUCN, 2022).

Table 1. The IUCN threat categories for forest mammal species in FAO SEC countries

COMMON NAME	SPECIES NAME	IUCN CATEGORY	COUNTRY
European Roe Deer	*Capreolus capreolus*	Least Concern	Türkiye, Azerbaijan
Red deer	*Cervus elaphus*	Least Concern	Türkiye, Azerbaijan
Tarim Red Deer	*Cervus hanglu*	Least Concern	Tajikistan, Turkmenistan, Uzbekistan
Brown bear	*Ursus arctos*	Least Concern	Türkiye, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
European lynx	*Lynx lynx*	Least Concern	Türkiye, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
Grey Wolf	Canis lupus	Least Concern	Türkiye, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
Striped Hyaena	*Hyaena hyaena*	Near Threatened	Türkiye, Tajikistan, Azerbaijan, Uzbekistan
Kashmir muskdeer	*Moschus cupreus*	Endangered	Tajikistan
Siberian Musk Deer	*Moschus moschiferus*	Vulnerable	Kazakhstan
Urial	*Ovis vignei*	Vulnerable	Turkmenistan
Snow Leopard	*Panthera uncia*	Vulnerable	Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan
Siberian Tiger	*Panthera tigris altaica*	Endangered	Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan
Markhor	*Capra falconeri*	Near Threatened	Tajikistan, Turkmenistan, Uzbekistan
Eastern Tur	*Capra cylindricornis*	Near Threatened	Azerbaijan
Hyrcanian Field Mouse	*Apodemus hyrcanicus*	Near Threatened	Azerbaijan
Mouflon	*Ovis gmelini*	Near Threatened	Türkiye, Azerbaijan

Source: The International Union for Conservation of Nature (IUCN). 2002. IUCN Red List of Threatened Species. [Cited 8 September 2023] https://www.iucnredlist.org/

Table 2. The IUCN threat categories for forest bird species in FAO SEC countries

COMMON NAME	SPECIES NAME	IUCN CATEGORY	COUNTRY
Eurasian Curlew	*Numenius arquata*	Near Threatened	Breeding in Kazakhstan, Azerbaijan, Türkiye, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
Pallid Harrier	*Circus macrourus*	Near Threatened	Caucasus, Central Asia
Caucasian Grouse	*Lyrurus mlokosiewiczi*	Near Threatened	Türkiye, Azerbaijan
Cinereous Vulture	*Aegypius monachus*	Near Threatened	Breeding in Türkiye, Azerbaijan
Saker falcon	*Falco cherrug*	Endangered	Caucasus, Central Asia
Woodchat Shrike	*Lanius senator*	Near Threatened	Türkiye, Azerbaijan
Rustic Bunting	*Emberiza rustica*	Vulnerable	Breeding in Kazakhstan
Redwing	*Turdus iliacus*	Near Threatened	Breeding in Kazakhstan, Azerbaijan, Türkiye
Red-footed Falcon	*Falco vespertinus*	Vulnerable	Türkiye, Azerbaijan, Kazakhstan
Bistrita Warbler	*Locustella acrocephala*	Vulnerable	Breeding in Kazakhstan, Azerbaijan, Türkiye, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
Greater Spotted Eagle	*Aquila clanga*	Vulnerable	Azerbaijan, Kazakhstan, Turkmenistan, Kyrgyzstan, Uzbekistan, Tajikistan, Türkiye
Eastern Imperial Eagle	*Aquila heliaca*	Vulnerable	Türkiye, Azerbaijan, Uzbekistan
White-tailed Sea-eagle	*Haliaeetus albicilla*	Least Concern	Resident in Azerbaijan and Türkiye; breeding in Kazakhstan and Turkmenistan; non-breeding in Kyrgyzstan, Uzbekistan.
White-backed Woodpecker	*Dendrocopos leucotos*	Least Concern	Azerbaijan, Kazakhstan, Türkiye
Great Spotted Woodpecker	*Dendrocopos major*	Least Concern	Resident in Azerbaijan and Türkiye; breeding in Kazakhstan; non-breeding in Kyrgyzstan
Black Woodpecker	Dryocopus martius	Least Concern	Resident in Azerbaijan and Türkiye; breeding in Kazakhstan
Northern Goshawk	Accipiter gentilis	Least Concern	Resident in Azerbaijan, Kazakhstan, Türkiye and Uzbekistan; breeding in Kyrgyzstan.

Source: The International Union for Conservation of Nature (IUCN). 2002. IUCN Red List of Threatened Species. [Cited 8 September 2023] https://www.iucnredlist.org/

Table 3. The IUCN threat categories for forest reptile species in FAO SEC countries

COMMON NAME	SPECIES NAME	IUCN CATEGORY	COUNTRY
Caucasian salamander	*Mertensiella caucasica*	Vulnerable	Türkiye
	Darevskia kopetdaghica	Endangered	Turkmenistan
	Pelodytes caucasicus	Near Threatened	Türkiye
Caucasian Toad	*Bufo verrucosissimus*	Near Threatened	Türkiye
Transcaucasian Long-nosed Viper	*Vipera transcaucasiana*	Near Threatened	Türkiye
Armenian Viper	*Montivipera raddei*	Near Threatened	Azerbaijan, Türkiye
Vipera	*Vipera barani*	Near Threatened	Türkiye, Azerbaijan
Central Asian Viper	*Vipera kaznakovi*	Endangered	Türkiye

Source: The International Union for Conservation of Nature (IUCN). 2002. IUCN Red List of Threatened Species. [Cited 8 September 2023] https://www.iucnredlist.org/

Table 4. The IUCN threat categories for forest tree species in FAO SEC countries

COMMON NAME	SPECIES NAME	IUCN CATEGORY	COUNTRY
Oriental sweetgum	*Liquidambar orientalis*	Endangered	Türkiye
Atlantic Pistachio	*Pistacia atlantica*	Near Threatened	Türkiye, Azerbaijan
Drooping Pear	*Pyrus nutans*	Endangered	Azerbaijan
Zangezurian Pear	*Pyrus zangezura*	Near Threatened	Azerbaijan
Caspian Poplar	*Populus caspica*	Endangered	Azerbaijan
Anti Lebanon Wild Cherry	*Prunus microcarpa*	Near Threatened	Azerbaijan, Türkiye
	Prunus arabica	Near Threatened	Türkiye
	Amygdalus bucharica	Vulnerable	Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
	Amygdalus ledebouriana	Endangered	Kazakhstan
	Berberis karkaralensis	Critically Endangered	Kazakhstan
	Quercus pontica	Endangered	Türkiye
	Quercus castaneifolia	Near Threatened	Azerbaijan, Türkiye
Common Ash	*Fraxinus excelsior*	Near Threatened	Azerbaijan, Türkiye
Cedar of Lebanon	*Cedrus libani*	Vulnerable	Türkiye
Oriental Arbor-vitae	*Platycladus orientalis*	Near Threatened	Tajikistan, Uzbekistan
Caucasian zelkova	*Zelkova carpinifolia*	Vulnerable	Türkiye, Azerbaijan
Caucasian wingnut	*Pterocarya fraxinifolia*	Vulnerable	Türkiye, Azerbaijan
Cilician fir	*Abies cilicica*	Near Threatened	Türkiye
English yew	*Taxus baccata*	Least Concern	Azerbaijan, Türkiye
Scots pine	*Pinus sylvestris*	Least Concern	Azerbaijan, Türkiye, Kazakhstan
Caucasian fir	*Abies nordmanniana*	Least Concern	Azerbaijan, Türkiye
	Abies nordmanniana subsp. equi-trojani	Endangered	Türkiye
Asian beech	*Fagus orientalis*	Least Concern	Azerbaijan, Türkiye
Black oak	*Quercus macranthera*	Least Concern	Azerbaijan, Türkiye
Common hornbeam	*Carpinus betulus*	Least Concern	Azerbaijan, Türkiye
Oriental Spruce	*Picea orientalis*	Least Concern	Türkiye

Source: The International Union for Conservation of Nature (IUCN). 2002. IUCN Red List of Threatened Species. [Cited 8 September 2023] https://www.iucnredlist.org

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