# Technical Assistance to the Development of two Standardized Target PA-specific Management Effectiveness Assessment Plans (Biodiversity Monitoring Indicators) for two Protected Areas in Georgia (Machakhela and Mtirala PAs)

## *Indicator protocols*

***18 June 2020***

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## Table of Contents

## Executive Summary

Within the GEF/UNDP project "Enhancing financial sustainability of the Protected Areas system in Georgia", the Caucasus Nature Fund (CNF) is assisting the Agency of Protected Areas (APA) with the development of two standardized target PA-specific management effectiveness assessment plans (including biodiversity monitoring indicators) for the protected areas of Machakhela National Park (MaNP) and Mtirala National Park (MtNP).

These are not meant to be separate plans, but rather resources offered to APA to support the strengthening of the implementation as well as the future updating of the existing management plans of these national parks. They focus on the strengthening of the adaptive management of MaNP and MtNP through more systematic, indicator-based monitoring of the state of key biodiversity features, threats and management responses.

In Phase 2 of the assignment, draft Management Effectiveness Assessment (MEA) Plans for Machakhela National Park and Mtirala National Park including a long-list of items to monitor and a shortlist of priority indicators on the state of biodiversity including ecosystems, habitats and species, threats and management efforts were prepared by the Consultant. This was based on input of stakeholder workshops and individual expert consultations. The conclusions of this phase were discussed with APA, CNF and UNDP during a half-day workshop on 14 February 2020.

Building on these discussions, the Consultant elaborated protocols for five priority indicators:

- **State of Colchic Deciduous and Mixed Forest (S1)**, as the main and globally significant ecosystem of MaNP and MtNP and at the same time the ecosystems within which all other biodiversity there is nested;
- **State of Sweet Chestnut and Incidence of Chestnut Blight (S2)**, as one important aspect of ecological forest state of the Colchic deciduous forests, and at the same time focusing on a main pressure on these forests;
- **Site Occupancy of Caucasian Salamander (S3),** as a key biodiversity feature in its own right with high relevance to communication in both parks, and at the same time a species responsive to water pollution, damaging forestry activities and climate change;
- **Infringement Records and Signs (P1)**, as a combined indicator of numerous potential threats that were identified as potentially critical by stakeholders; and
- **Patrolling Capacity/Intensity (M1)**, as an indicator of the main management response to the threats monitored as per Indicator P1 above and at the same time a key parameter to interpret its findings.

This report, which should be read in conjunction with the Phase 2 reports including the long-lists and indicator shortlists, presents detailed justifications, protocols and estimates of resource as well as capacity needs for these indicators. Some of the proposed indicators shall be used by APA and the administrations of MaNP and MtNP independently, while others would most practically be implemented by specialist contractors.

# 1 Detailed protocol for Indicator S1: State of Colchic Deciduous and Mixed Forest

The assignment has identified the ecological state of Colchic forest as a key monitoring object for both Machakhela NP and also Mtirala NP.

## 1.1 Justification

Colchic deciduous and mixed forest is by far the most critical biodiversity value of MaNP and MtNP, and therefore of the highest priority for ecological state monitoring, because:

- It is the ecosystem that occupies by far the largest part of the area of both parks, comprising a wide range of sub-systems and types;
- Most of the other biodiversity depend on the status of the Colchic forest. Their local conservation status will follow that of the forest ecosystem;
- It is a key ecosystem of one of the Worlds 25 Biodiversity Hotspots (Mittermeier et al. 2004) and one of WWF's globally important 200 Ecosystems (Olson & Dinerstein 2002). MaNP and MtNP were established to maintain the integrity of these ecosystems;
- The Colchic forests are subject to climate change (Anon. 2016), in as yet poorly understood ways; broad explorative forest monitoring will be a suitable way to detect and understand its impacts in a timely manner;
- Potentially related to the above, some key species and types of Colchic forest are affected by pathogens (e.g. Sweet Chestnut by Chestnut Blight), which have the potential to seriously reduce the viability of the overall ecosystem and hence need to be monitored and managed, to the extent possible.
- MaNP could become and MtNP already is part of the "Colchic Rainforests and Wetlands", which have been nominated for inscription on the World Heritage List in 2019 (APA 2019). This requires monitoring of the proposed attributes of Outstanding Universal Value of the nominated series, i.e., first and foremost the Colchic Forest. In the nomination dossier Georgia commits to four indicators related to Colchic forest extent and composition, for which it currently does not consistently apply monitoring protocols[1].
- Depending on the fine-tuning of a monitoring plan and indicator(s), Colchic forest monitoring could also provide information about the state of several Emerald habitats overlapping with MaNP (and MtNP), for which there is currently high political interest in Georgia.

Beyond the specific relevance of this indicator set to the two focal parks of this assignment, the indicator set is also potentially relevant to many other forest PAs in Georgia.

[1] There should be a forest inventory in each forest PA every 10 years, but such an inventory has only been conducted for MaNP (in 2016), not for MtNP and most other Georgian forest Pas. The classical forest inventory methods are also more geared towards exploitative forest management, which is only necessary - to a limited extent – in the traditional use zones of MaNP/MtNP.

## 1.2 Monitoring protocol

The ecological state of natural or regenerating forest cannot be measured using one indicator alone. Several key ecological attributes need to be considered to understand it sufficiently to inform management (see Section 1.3 for specific management questions to be addressed). Therefore, we propose a simple set of indicators building on an ecological baseline assessment that was conducted in MaNP in 2015 (Ilia University 2016) for the time being. The 2015 assessment compiled data on the state of forest and other vegetation for 104 sampling plots of 500 $m^2$ each. These plots covered the entire Machakhela Valley, and most of them were within the current MaNP. This offers the unique opportunity to build a forest indicator for this key park on not only a tried and tested methodology for which the Georgian PA community has know-how, but also an established, sufficiently dense grid of sampling stations with 2015 baseline data. A possible outline of an adapted grid for future sampling is shown in Figure 1.

While the Ilia University protocol is broadly in line with the standard Georgian forest inventory methodology as described in Resolution of the Government of Georgia No. 179, 2013, , a new field manual for the National Forest Inventory (NFI) has since been drafted (Anonymous 2020; cf. Annex 1), an inventory including some stations within MtNP and MaNP has been conducted in 2019 (Figure 2), and a fully complementary method for local forest management inventories (FMI) with a denser grid and slightly different variables, but building on the same base methodology and using the same concepts and terminology is currently in preparation The Consultant recommends that forest state monitoring inside Georgian protected areas use relevant elements of the FMI methodology once this is fully available, and also use information from the few stations of the NFI overlapping with PAs for their monitoring. This will maximize consistency and synergies between site-level and national forest monitoring and make the detailed guidance and strong monitoring capacity developed for the NFI available to APA and its PA administrations.

For MaNP, this means that there two similar, but still different methods need to be considered to ensure consistency and comparability of past (Ilia University 2016) and future monitoring efforts. The Consultant proposes achieving this through a systematic comparison of both protocols and one monitoring campaign in 2020/21, which would apply both methodologies – or a common denominator of both that would result from the comparison – and thereby function as a bridge between the protocols and the data produced therewith. This shall be conducted by a specialist familiar with both methodologies. The Consultant proposes to conduct this comparison and monitoring campaign once the final FMI methodology is agreed and fully available, as an adapted version of the FMI rather than the NFI methodology appears most suitable for forest state monitoring in individual Georgian PAs.

Forest State Monitoring is also a priority for MtNP. The Consultant recommends introducing this based on an adapted version of the FMI method as described above once available.

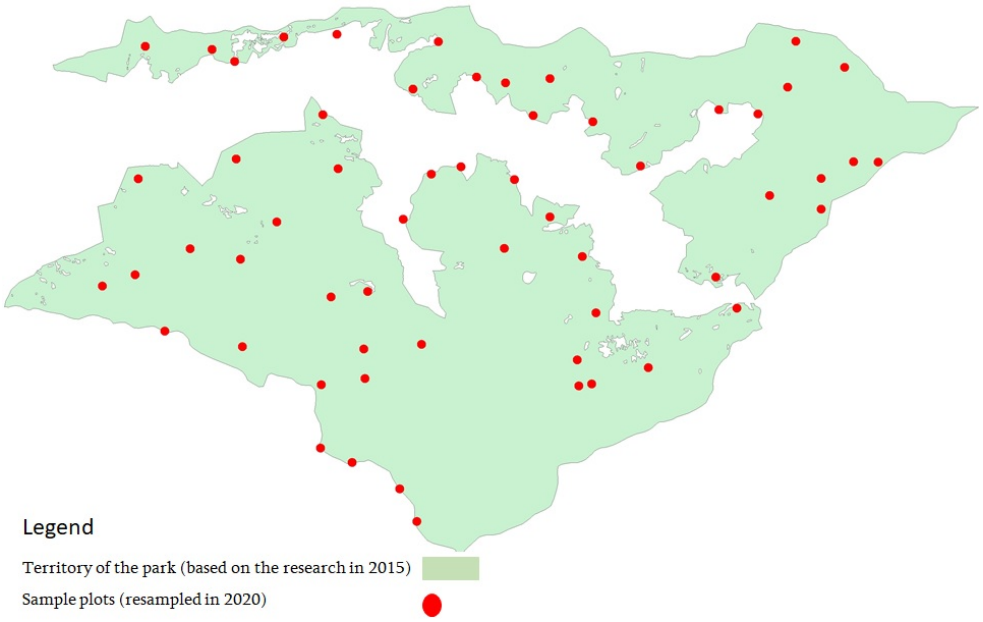


**Figure 1.** Proposed sampling grid for indicator S1, based on a re-sampling of the stations surveyed in 2015. (Source: Metreveli, pers. comm.)

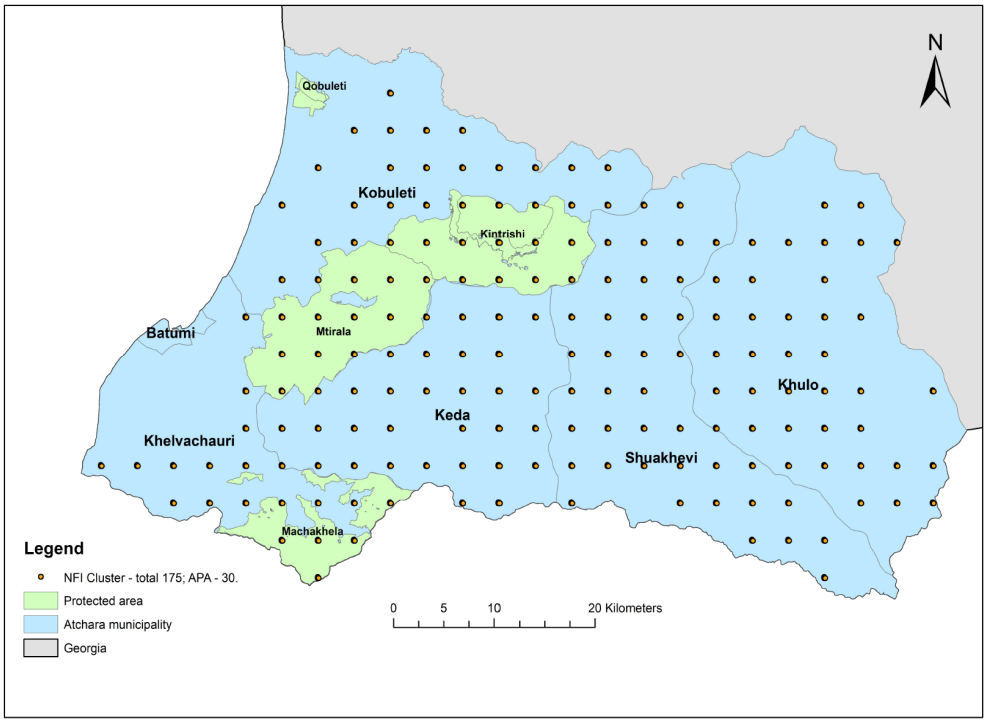


**Figure 2.** Sampling grid of the National Forest Inventory for the area including MaNP and MtNP. (Source: C. Gönner, pers. comm.)

### 1.2.1 *Identification of monitoring sites*

The sampling grid adapted from the 2015 Ilia University survey meets the key requirements for forest state monitoring in PAs (Figure 1): Sampling stations are distributed broadly across the various forest types of MaNP, and sufficiently numerous to provide a solid data base for the statistical analysis of long-term trends. The Consultant proposes 40-50 sampling plots distributed among the main forest types. These have been derived from the existing 104 plots of the 2015 assessment as follows:

- Considering that only part of the 104 of the sampling stations of the 2015/16 survey overlap with what is now MaNP, and that some of these are in non-forested areas, the first step in establishing a suite of monitoring sites has been to focus only on forest sites inside the current MaNP. A few stations outside are proposed as general reference and because of their relevance to the neighbouring Machakhela Protected Landscape, but these are not strictly part of the forest state monitoring grid of MaNP.
- Sampling have been stratified according to dominant species and only a sample of stations for each type will be monitored[2]. A number (ca. 10) of plots with stands of species of a high conservation interest shall also be monitored in addition.

### 1.2.2 *Sampling frequency*

The current lifespan of the MaNP management plan is 9 years, with three three-year operational plans.. This is based on current APA practice, not any specific legal requirements. Sampling shall happen at such a frequency that results will be available to inform the main decision-making occasions within the MaNP management cycle, i.e. mainly the updating of management plans.. APA may set additional monitoring occasions at closer intervals, e.g. coinciding with the three-year operational planning cycle if operational planning requires recent information, or responding to other information needs such as those defined by projects supporting MaNP. However, a forest state monitoring frequency of more than once in five years is generally considered very high for temperate forests.

### 1.2.3 *Field sampling*

Field data collection shall follow the protocol of Ilia University (2016)[3]. In short, two-person teams with support of local rangers will approach sampling stations with the aid of hand-held GPS units. Once a sampling plot is reached and positively identified, the following variables are measured within a 12.6 m radius from its centre:

- Characteristics of terrain including slopes (only needed at baseline stage);
- Presence of species of particular conservation interest;
- No. of trees by species and status category (see Ilia University 2016); this includes standing and lying dead trees.

[2] A proposal for a specific set of sampling plots in accordance with this methodology has been developed by Mr. Vasil Metreveli, Ilia State University, the lead author of the 2015 assessment.
[3] As discussed above, it may be modified based on the FMI field manual once this becomes available.

- Basal area, diameter at breast height, height of trees (the latter measured for some sample trees only) and wood volume, again by species and status category;
- Number and diameter of seedlings and saplings by species (in three smaller sub-plots per plot);
- Dead wood – impact on forest regeneration
- Signs of human impact, e.g. stumps of felled trees.
- Integrity of the crown canopy (photographic images using fish eye lense – interpretation in conjunction with remote imagery);
- Incidence of forest pathogens including Chestnut Blight, Boxtree Twig and Leaf Blight, unknown pathogens;
- Other observations.

Data are entered into a hand-held data recorder. Photos are taken to document the sampling plot with the main observations, and durable ground markers at the centre of the plot are attached or replaced[4].

### *1.2.4 Data recording, compilation and analysis*

Field data will be entered into handheld computers or mobile phones using CyberTracker or MS Excel. Upon return to the PA administration, they will be transferred to Excel Spreadsheets as used in Ilia University (2016), secured and stored on desktop computers or servers at each administration.

## 1.3 Interpretation of indicator in the context of adaptive PA management

Indicator S1 with its sub-indicators has been designed to answer the following management related questions:

- What is the ecological integrity of the Colchic forest in the park(s)? (***Source:*** *trends in integrity of crown canopy, rejuvenation, species dominance and composition*)
- How well is the regeneration of the Colchic forest after the uncontrolled logging crisis of the 1990 continuing? Is the secondary forest succession (where relevant) proceeding towards a natural state of forest? (***Source:*** *Trends in age and wood volume of forest, comparison of species dominance and composition to historical or inferred natural forest vegetation*)
- Which signs of stresses that might be related to management-relevant pressures (e.g. illegal grazing, logging) does the forest display? (***Source:*** *trends in number and diameter of seedlings and saplings, occurrence of use signs such as tracks and tree stumps*)
- What is the incidence of invasive alien species (IAS) among the dendroflora of the parks? (***Source:*** *incidence of identified IAS among the flora on forest plots*);
- Which signs of emerging threats (e.g. diseases, potentially other climate change impacts) does the forest display? (***Source:*** *trends in proportion of tree status categories, incidence of*

[4] No ground markers were established during the 2015 assessment, which means this would need to happen at the next sampling occasion.

*visible signs of known parasites and pests, complex vertical shifts of tree species dominance/composition across the entire dataset, other unexpected phenomena*)

- What is the status of species of particular conservation interest within the forest of the park(s)? (***Source:*** *number and health of individuals of species of particular conservation interest*[5])

### 1.4 Equipment needs and costs

Table 1 summarizes the equipment needs necessary to conduct the monitoring using this indicator. This assumes that standard field ranger equipment such as warm outdoor clothing/uniforms and boots as well as other personal outdoor equipment, transport and field infrastructure as necessary, a personal computer for entering data etc. are already available to monitoring staff, and that none of the equipment items is available to the administration already. Since monitoring is foreseen every nine years only, it is likely that this equipment needs to be purchased anew for each monitoring occasion. Theoretical annual equipment costs for this indicator are estimated at ca. $ 260.

The equipment listed in the table shall at the same time also be used for the monitoring of the incidence and damage from Chestnut Blight to forests (Indicator S2 in this report). Therefore, equipment costs will be shared between the two indicators if APA choses to use both of them in a given PA, reducing the annual equipment costs per PA and indicator to $ 130. The equipment could also be shared with other PAs, as it will only be needed every few years in one PA.

[5] In some cases, more specific metrics will need to be used to monitor species of particular conservation concern.

**Table 1.** Equipment needs and costs. Two of each are needed.

| Item | Purpose | Overall cost ($) |
|---|---|---|
| Handheld GPS | Finding sampling sites | 800 |
| Mobile phone or handheld computer with CyberTracker or Excel installed | Entering data in the field | 500 |
| Measuring tape | Defining radius of sampling plots | 50 |
| Forestry caliper | Measuring diameter of trees | 300 |
| Clinometer | Measuring height of trees | 400 |
| Digital camera | Documenting sampling sites | 300 |
| **Total ($)** | | 2,350 |

### 1.5 Staff and consultancy time requirements

Following the example of the 2015 survey, Indicator S1 should be measured in cooperation between the rangers of MaNP/MtNP (transport, finding sites, help with specific measurements and protocolling) and a specialized forest monitoring team (sampling design, oversight of the sampling, species identification, classification of state of trees, data management and quality control).

It is expected that about three site surveys can be conducted per day (cf. Ilia University 2016). Assuming 40 sampling stations, and a sampling team that consists of one ranger and two external monitoring experts, the estimated (field) staff time requirement in the field would be 13 ranger days and 26 external expert days per sampling campaign, plus perhaps 3 person days for preparation, data entry/management and the maintenance of equipment***. We therefore estimate that the theoretical annual staff time requirement for this indicator in MaNP or MtNP will be 1.5 ranger days plus 3.5 external expert days.*** Additional time will be needed for further analysis and interpretation of the data. This will usually be part of the situation analysis preceding each new management planning process or other decision making processes for which this information is needed, and is therefore not listed separately.

This also means that some additional funds will need to be mobilized to pay for external forest monitoring teams, during the monitoring years of this indicator. The exact amount depends on the contractors engaged for this assessment[6].

[6] An alternative option is for APA to develop the capacity for ecological forest monitoring centrally and to use it in a rotating manner in all Georgian PAs.

## 1.6 Training needs and costs

Training needs of MaNP/MTNP staff for the use of this indicator will be negligible because this monitoring will mainly be led by external experts on forest monitoring. The limited amount of training/guidance to the participating rangers will be provided by the experts directly during the field assessments.

Considering the staff turnover of rangers in PAs such as MaNP and MtNP, the low sampling frequency of this indicator and the fact that there are several well-trained forest monitoring service providers in the country, it would in any case not appear efficient to develop on-site capacity on forest monitoring.

## 2 Detailed protocol for Indicator S2: State of Sweet Chestnut and Chestnut Blight

As an important sub-aspect of the ecological state of Colchic forest in both MaNP and MtNP, the assessment so far has identified the status of Sweet Chestnut (*Castanea sativa*) trees and stands and – closely connected to it – the incidence of the Chestnut Blight (caused by the ascomycete *Cryphonectria parasitica*). This indicator can be considered a measure of both the status of chestnut forests in these areas (as Chestnut Blight is the main negative impact on them), and the parasite as a pressure itself.

### 2.1 Justification

The Chestnut Blight has strongly decimated Sweet Chestnut forests in Northern America and – to a lesser extent – in pan- Europe including Georgia. About 8% of the chestnut wood of non-PA forests in Ajara is currently dead, with an unknown additional percentage infected but still alive (J. Stritih, pers. comm.). The percentage inside PAs may be similar[7]. At the same time, these chestnut forests and poly-dominant forests with chestnut represent one important sub-type of Colchic rainforests. This and additional factors contribute to the justification for this indicator:

- As Colchic deciduous and mixed forest is the most critical biodiversity value of MaNP and MtNP, the affectedness of one of its component species and sub-types by its major pressure and overall status warrants monitoring.
- A considerable range of other specialized biodiversity (including various invertebrates, bats, birds like woodpeckers, etc.) depends on chestnut trees and stands. Their local conservation status in MaNP and MtNP will follow that of the species;
- There is more than one management option for chestnut stands affected by the disease, at least in the long term, and decisions on which option to choose will have to be informed by monitoring (see below).
- Many parasites including *C. parasitica* interact with climate change (Anon. 2016), in currently poorly understood ways. The same is potentially true for other environmental factors. This suggests that parasite impacts on chestnut may be amplified or attenuated by climate change or other impacts in the future, and that new intervention points for management may be identified through monitoring.
- Since Colchic forests with chestnut are an Emerald habitat, the monitoring of the status of chestnut forests could also contribute to Emerald monitoring.
- APA is very interested in monitoring the incidence of Chestnut Blight. Beyond the specific relevance of this indicator set to the two focal parks of this assignment, the indicator set is also potentially relevant to many other forest PAs with some chestnut trees in Georgia.

Considering the available and affordable monitoring technology and management options, the only variable that currently warrants monitoring is the ***distribution and trend of infected and dead trees of Sweet Chestnut***. This is because:

[7] Among 37 monitoring plots with at least 10% wood volume contribution of Sweet Chestnut within Machakhela Valley including MaNP, 17 consisted of >95% fully intact trees, whereas seven had more than 25% of chestnut wood volume in dead or dying trees in 2015 (calculated from Ilia University 2016).

- While several management options exist in theory, most of them will only become practicable in the future: **(1)** No-intervention management in National Parks (NP), i. e. leaving dead trees in the forest and relying on spread of natural hypovirulence in parasites on living trees (cf. Celiker et al. 2017, Rigling et al. 2018) and subsequent re-growth is the only management option currently available. A slight spontaneous recovery and regrowth has been observed in some affected stands in western Georgia. This may be connected to the significant incidence of natural hypovirulence (caused by the CHV-1 virus): Up to 29% incidence has been detected in isolates of the parasite from this part of the country (Rigling et al. 2018). This means that some affected stands (those infected by haplotypes of the parasite that are susceptible to the virus and thus less virulent) may be undergoing – or have strong potential for – recovery without intervention[8]. **(2)** Treating at least some affected trees to induce hypovirulence (Nuss 1992, Perelou & Diamandis 2010) has been practiced in chestnut forests of several European countries (Heiniger & Rigling 1994), but may be impracticable in natural poly-dominant forests where trees are spread over large mixed stands in inaccessible terrain and is considered unappropriate for NPs. Work on induced hypovirulence at the Forest Protection Laboratory of the Ajaran Forestry Agency in Shuakhevi is at the stage of experimental trials, with large scale application unavailable for the foreseeable future. If this changes in the future, there would still be enough time to survey affected stands and identify which lack the CHV-1 virus and hence would respond to hypovirulence treatment. **(3)** Removal and destruction of infected (particularly dead) trees from the forest may eliminate sources of re-infection and has been recommended for smaller infection hotspots, but is impracticable in most mixed natural forests. In addition, the damage done to these forests inside PAs by such an intervention would most likely outweigh the potential benefit in terms of disease control and therefore should be excluded from NPs.
- There are currently no affordable protocols available to monitor other variables of interest, such as the distribution and trend of CHV-1 infection of *C. parasitica*. In any case, while this information could be used to guide hypovirulence treatment, it will only be relevant once large-scale induced hypovirulence programmes are available in Georgia.
- To ensure relevance to management, any more in-depth monitoring of variables related to Chestnut Blight would only make sense as part of a broader management strategy. Since *C. parasitica* does not respect PA boundaries, any such strategy would need to be coordinated between APA (with its management mandate for forest PAs) and the management of adjacent forests. It is recommended that APA liaise with the abovementioned Forest Protection Laboratory of the Ajaran Forest Agency, the Working Group of Pest and Diseases of the National Forest Programme, and any relevant donor funded projects to coordinate its efforts on more in-depth Chestnut Blight monitoring and management.

[8] The incidence and degree of natural hypovirulence of *C. parasitica* differs on a small geographical scale and depending on the haplotype of the parasite (cf. Prospero et al. 2013).

## 2.2 Monitoring protocol

Field monitoring will be conducted in known stands of Sweet Chestnut (*Castanea sativa*) within each PA where this indicator is used. The sampling plots will be identified within the colline-submontane and lower montane vegetation belts in areas of poly-dominant forest with Sweet Chestnut as described under 1.2.1 below. The same areas will be monitored at each sampling occasion. For each sampling plot, the proportion of dead and otherwise affected trees will be monitored, along with the incidence of visible signs of Chestnut Blight.

### *2.2.1 Identification of monitoring sites*

Monitoring will focus on identified forests with a high proportion of Sweet Chestnut. For MaNP, chestnut monitoring plots can be selected from the plots of the general baseline forest inventory that was conducted in 2015 (Ilia University 2016). Sweet Chestnut contributes at least 25% to the volume of wood of 24 of the 104 sampling plots of this baseline assessment[9]. These shall be chosen for monitoring Sweet Chestnut status.

For MtNP (if the same indicator shall be used there), it will be necessary to consult forestry maps or other similar sources to identify a similar number of monitoring plots with Sweet Chestnut dominance or at least a high proportion of this species. Candidate sites then shall be visited and the presence of chestnut be confirmed.

### *2.2.2 Thee-year sampling frequency and sampling season*

The proposed frequency of the forest state monitoring is every 3 years, following the operational planning cycle of Georgian national parks such as MaNP and MtNP.

Sampling should happen in the year before each operational planning process but maintaining the three-year rhythm. Thereby, the monitoring cycle would be in line with the period of practical decision making for MaNP and comparable PAs, which happens during management planning (every nine years) and operational planning.

Sampling should happen during late spring to early summer as affected trees can be best recognized during this season (V. Metreveli, pers. comm.).

### *2.2.3 Field sampling*

Field data collection shall follow the protocol of Ilia University (2016). In short, two-person teams with support of local rangers will approach relevant sampling stations with the aid of hand-held GPS units. Once a sampling plot is reached and positively identified, the following variables are measured within a 12.6 m radius from its centre:

- No. of chestnut trees by status category;

[9] Sample plots with ID numbers starting with "900", followed by 30, 29, 115, 92, 16, 13, 54, 88, 64, 109, 23, 37, 17, 56, 87, 76, 66, 86, 83, 85, 74, 110, 98 and 106, respectively. Some of these points may fall outside of what is now MaNP and would have to be excluded from future monitoring.

- Basal area, diameter at breast height and height of chestnut trees (the latter measured for some sample trees only), by status category;
- Number of seedlings and saplings of Sweet Chestnut;
- No. of trees with visible signs of Chestnut Blight (bark cancers, water shoots, conidia, thinning crown with dry branches carrying dried leaves), including a description and photographic documentation;
- Other relevant observations.

Data are entered into a hand-held data recorder or smartphone. Photos are taken to document the sampling plot with the main observations, and the ground markers at the centre of the plot are established/checked.

#### *2.2.4 Prevention of cross-infection between sampling sites during monitoring*

To prevent cross-infection of sampling sites with Sweet Chestnut Blight during sampling, all equipment as well as the boots of the monitoring team shall be carefully disinfected with 70% ethanol after the visit to each station. Outer layer clothing of the sampling team including hats shall be changed between sampling stations, and hands shall be disinfected using standard hand disinfectant.

#### *2.2.5 Data recording, compilation and analysis*

Data will be entered using a hand-held computer or smartphone and summarized/stored on excel sheet as used in Ilia University (2016), or following generic APA protocols for data storage. The following metrics will be calculated from the raw data:

- Contribution (absolute and %) of status categories to the number and overall wood volume of Sweet Chestnut for each sampling plot, and across all sampling plots;
- Contribution (absolute and %) of trees with visible signs of Sweet Chestnut Blight (other than mortality – i.e. cankers, water shoots etc.) to the number and overall wood volume for each sampling plot and across all sampling plots;
- Qualitative description of the severity of affectedness of stands;
- Number of sampling plots without any mortality from, or other signs of Chestnut Blight;

In addition to these quantitative statistics, these data will also be mapped visually, to offer an intuitive insight into hotspots of the disease.

### 2.3 Interpretation of indicator in the context of adaptive PA management

A comparison of the above statistics data between sampling occasions for individual plots and across each PA will provide an overview over the trend of forest damage from Sweet Chestnut Blight under non-intervention management. In the ideal case, a receding overall trend of the disease across the parks will indicate that no intervention will be necessary to control the virus.

The monitoring data will also allow identifying hotspots of the disease. These data can then be used to define areas for:

- denser (both spatially and temporally) surveys of the incidence of Sweet Chestnut Blight;
- applied scientific studies on more specific aspects, such as the genetic variability and vegetative compatibility of *C. parasitica* or the types of the CHV-1 virus present, by external scientific cooperation partners of APA;
- potential management responses based on induced hypovirulence or other appropriate techniques, should these become available and deemed both feasible and sufficiently safe in the future;
- Coordination of any such efforts with those of the Forest Agency of Ajara in adjacent forests under their jurisdiction.

### 2.4 Equipment needs and costs

The same equipment as for indicator S1 will be used for indicator S2 (Table 1).

### 2.5 Staff time requirements

It is expected that about four site surveys can be conducted per day. Considering a two-person sampling team and 24 sampling stations, the estimated (field) staff time requirement would be 12 person days per sampling campaign, plus perhaps 3 person days for preparation, data entry/management and the maintenance of equipment***. We therefore estimate that the average annual staff time requirement for this indicator will be 5 ranger days for MaNP, and a similar amount of time for MtNP.***

Combination of Sweet Chestnut monitoring with general forest monitoring would be possible during those sampling years when the latter is also conducted (once every nine years).

### 2.6 Training needs and costs

***The indicator on status of Sweet Chestnut and incidence of Chestnut Blight within Colchic forest of MaNP/MtNP can be used independently by local natural resource specialists,*** after training input from national experts such as those working at Forest Protection Laboratory of the Ajaran Forestry Agency or Ilia State University Tbilisi (e. g. Mr. Vasil Metreveli, who currently implements a PhD thesis on the subject of *C. sativa* and *C. parasitica* in Georgia).

In the interest of data quality, time and cost efficiency and the consistency of monitoring data, the Consultant recommends that up to four local PA staff (including the natural resources specialists of each local PA Administration) are trained on the following skills:

- Justification and purpose of monitoring of Sweet Chestnut Blight;
- Use of GPS and measuring tape to find and delineate sampling sites;
- Technical skills for general tree measurements and observation of visible signs of Chestnut Blight;
- Data entry using smartphone or handheld computer;
- Photographic documentation;
- Data storage and analysis;

- Behaviour during field sampling to prevent cross-contamination of sampling stations by monitoring team and/or equipment.

The consultant estimates that a training on the above subjects could be conducted in about three days. The expert input related to this training/setup phase would be five days including preparation and documentation. The required consultancy, travel, accommodation and subsistence costs are estimated at up to $ 2,500.

# 3 Detailed protocol for Indicator S3: Site Occupancy of Caucasian Salamander

Phase 2 of the assignment has identified the population status of Caucasian salamander (*Mertensiella caucasica*) as one of the state indicators for Mtirala National Park (MtNP) to be further developed. This indicator would also be relevant to Machakhela NP (MaNP).

The recommended indicator for the population status of Caucasian salamander is the presence of its larvae across a number (10-15) identified breeding sites.

## 3.1 Justification

Monitoring of Caucasian Salamander would be justified because it is:

- A key species of Mtirala National Park and Machakhela National Park;
- Globally and nationally vulnerable (Georgian Biodiversity Database 2019a, IUCN 2019);
- Concentrated in only a few Georgian PAs, and possibly represented by several cryptic species there (Tarkhnishvili et al. 2000); this would make MtNP and MaNP key areas for conservation of this species;
- An indicator species of forest state (e.g. Tarkhnishvili & Gokhelashvili 1999, Williams et al. 2006) and water quality (Sayım et al. 2009), complementing other forest-related indicators;
- A likely indicator species of climate change, in line with other amphibian species (Li et al. 2013);
- A relatively observable flagship species of the Colchic rainforests with high communication and education potential;
- An official indicator species of the Colchic Rainforests and Wetlands nominated World Heritage site (APA 2019).

This means that the status of Caucasian Salamander is not only worth monitoring as a key species of MaNP and MtNP in its own right[10], but can also help answer the important general management question if narrow, moist forest gorges and their streams are conserved well, and if management of MaNP & MtNP enables it to meet one of its ecoregional conservation responsibilities (conservation of Caucasian salamander). This is in spite of the fact that the areas for which this indicator can provide conclusive information represent only a small part of the area of MaNP and MtNP.

## 3.2 Monitoring protocol

A monitoring methodology for the Caucasian Salamander has been compiled in 2019 (Yankoshvili et al. 2019) . The following has been adapted from this protocol, taking into account a widely used monitoring protocol for the Fire Salamander *Salamandra salamandra* (Karch 2018) and the specific ecology and life history traits of the Caucasian Salamander in western Georgia (Tarkhnishvili & Kaya 2009, Tarkhnishvili & Serbinova 1993). This is based on consultation of literature (Georgian Biodiversity Database 2020, Yankoshvili et al. 2019) and a national expert (D. Tarkhnishvili, pers. comm.).

[10] The purpose of this indicator in the PA context is not to monitor logging related threats (e.g. inappropriate skipping of logs), as this is generally not happening in PAs.

The protocol focuses on up to threefold field monitoring of the presence of salamander larvae on linear transects along known breeding streams during summer, through visual observation. This is because larvae are easier to detect than adult salamanders, as they are not as strictly nocturnal and are more concentrated inside the streams. It is not foreseen to also monitor site abundance of larvae or adults, as this would require too much monitoring effort.

### *3.2.1 Identification of monitoring sites*

The indicator measures trends in occurrence and abundance along a sample of streams that are known to have a salamander population at the baseline stage. The management authority needs to first identify these streams, building on published locations (cf. Tarkhnishvili et al. 2009, Yankoshvili et al. 2019) and expert advice. This identification should proceed according to the following steps:

- Compile and map a list of 20 likely streams where the species occurs, as broadly spread out throughout MtNP/MaNP – in terms or area, altitude, steepness of territory, forest type - and at the same time as accessible as possible, based on published information and expert opinion.
- Visit the candidate sites three times (mid-June, late June, mid-July) during Year 0 of the monitoring and conduct a baseline transect survey following the standard monitoring protocol (see below)[11].
- Among those streams where salamander larvae are found during this baseline survey, select 10-15 sites for the prospective annual monitoring, based on the same criteria as listed under (1) above.
- Document location using GPS and transect using photos, for future replication by MtNP administration. Document baseline monitoring data for the selected streams as baseline for future continued monitoring.

### *3.2.2 Annual field survey*

Each transect is visited up to three times each summer, in mid-June, late June and mid-July, respectively. If the species is found at the first or second visit already, no further visits are conducted. Visits are first conducted during daytime. If no larvae are found, a second visit and search for larvae and adults is conducted during the night.

During each stream visit, the following protocol is used:

- Identify the starting point of each transect using a hand-held GPS. This should be the same across years. If during one sampling year a specific transect along a stream cannot be sampled, a nearby alternative transect shall be chosen and this shall be noted on the monitoring sheet/programme.
- Going upstream besides the stream, establish the length of the transect (ca. 200 m) using a laser distance-measuring device or a custom-made piece of string.

[11] This could be done jointly by rangers and external experts, who could at the same time provide guidance on where to look for larvae and field-train rangers how to identify and count them.

- Return to starting point. Moving again upstream besides (not inside) the stream, scan its bottom for the larvae of the species (Figure 3). Use a stick to gently turn small stones and leaves under which larvae might be hiding. Do not walk inside the stream.
- Protocol presence/absence and abundance[12] of larvae.
- Protocol water temperature, approximate water level, and any other observations considered noteworthy, using CyberTracker (cf. Indicator P1) or a monitoring sheet.
- In those cases where not larvae are found during the initial daytime visit, re-visit the site at night, implement the same protocol and also search for adult salamanders in the immediate vicinity of the streams.
- In those cases where no larvae are found during day or night at any of the sampling occasions although they were present during previous years, water samples shall be taken in pre-cleaned 500 ml PET sample bottles (provided by NERA – see below) and analysed for standard water chemistry (biological oxygen demand, concentrations of ammonium, nitrate, phosphate and chloride – cf. Sayim et al. 2009).Water analysis shall be conducted by the National Environmental Agency of Georgia, which offers water analysis services, according to the relevant technical guidance (Decree of the Government of Georgia N425 from December 31, 2013, on the approval of technical regulation of the protection of surface water bodies from pollution).
- If protocols are initially compiled on paper, enter the resulting data into a simple offline excel or access database after each field survey, into a central SMART database, or in any data management system, should such a system be installed by APA.

**Figure 3.** Larva of Caucasian salamander *Mertensiella caucasica*. (Source: Georgian Biodiversity

[12] Abundance information is not used as indicator but should nevertheless be recorded if more than one individual is found.

Database)

### *3.2.3 Data recording, compilation and analysis*

At the end of the monitoring season, the following statistics are calculated and tabulated from the raw data obtained during the field surveys:

- Number of streams where larvae were found;
- Overall number of sightings per occasion and throughout the year;
- The sampling occasion (from the up to three occasions foreseen) when larvae were first found;

The data generated in this way can be analysed further to provide consolidated estimates of site occupancy and possibly other latent parameters, using approaches and technologies such as *R unmarked* (Fiske & Chandler 2020) or similar. However, for the purpose of informing adaptive PA management, the unprocessed data as listed above are likely to be the simplest, clearest and least error-prone metric to use.

## 3.3 Interpretation of indicator in the context of adaptive PA management

Trends in the population status (occupancy, potentially spatial distribution among the sampling sites) are important input into management both of this species as a key biodiversity value of MaNP and MtNP itself, and of the forest/stream ecosystems on which it depends. From a PA management perspective, trends in any of the metrics as per Section 1.2.3 above can be interpreted in the following way:

- **Constant or increasing trend**: Good conservation status, no management response needed.
- **Sustained decreasing trend in local larvae occurrence** (three consecutive years): Need for analysis of local (level of individual streams) pressures related to forest or water quality (e.g. impact from outside the NP or other factors), and management response to reduce identified pressures.
- **Sustained decreasing trend in observed site occupancy**: Need for analysis of PA-wide pressures related to forest or water quality, pathogens or other factors, and management response to reduce identified pressures at the level of the entire PA.
- **Complex long-term spatial-temporal shifts of site occupancy** (e.g. shift in first detection rates at from first towards third field survey, decrease in occupancy of streams at low altitude with simultaneous increase at higher altitude, etc.): Need for analysis in connection to climate change and potentially need for adaptation of PA management to climate change.

## 3.4 Equipment and service needs and costs

Table 3 summarizes the equipment needs necessary to conduct the entire annual monitoring using this indicator. This assumes that standard field ranger equipment such as warm outdoor clothing/uniforms and boots as well as other personal outdoor equipment, transport and field

infrastructure as necessary, a personal computer for entering data etc. are already available to monitoring staff. Assuming an average equipment write-off period of five years, ***annual equipment costs for using this indicator within MtNP are < $ 90***.

In addition to the above, water samples from those streams where larvae have disappeared need to be analysed. The National Environmental Agency of Georgia offers services in this field. Analysis of one water sample for the variables necessary costs ca. GEL 120 ($ 40), including sample bottles. The reactive nature of this monitoring means that the number of samples needed per year cannot be determined beforehand. The Consultant proposes to generously assume five water samples per year, which would put the ***annual costs for water analysis at an additional $ 200.***

### 3.5 Staff time requirements

It is expected that one site survey would take approximately 2 hours, plus transit time to/from the monitoring station. We therefore estimate that, for one of the three survey occasions, sampling including access from /return to base would require a staff input of 3-4 person days if monitoring is carried out individually. Multiplied by up to three sampling occasions and 0.5 days for data entry and analysis per year, ***this results in an annual staff time requirement of up to 11 person (ranger) days for the use of this indicator for MtNP or MaNP***.

Combination of salamander monitoring with other monitoring, surveillance or management tasks could be considered to use transit time efficiently.

**Table 3.** Equipment needs and costs.

| Item | Purpose | Overall cost ($) |
|---|---|---|
| Clipboard (*2) | Protocol – to be used with data entry form | 3 |
| Pen (*2) | Protocol | 2 |
| Handheld GPS | Determination of GPS location, finding monitoring streams back. | 150 |
| Piece of string (200 m) | Measuring length of monitoring transect. | 10 |
| Digital camera and rechargeable batteries with charger | Documentation of monitoring plots | 75 |
| Water thermometer | Measuring water temperature | 20 |
| Electric torch (*2) | Night-time surveys | 30 |
| Map with monitoring sites | Finding monitoring sites | 10 |
| **Total ($)** | | 300 |

### 3.6 Training needs and costs

***The indicator on population status of Caucasian Salamander in MtNP can be used independently by local rangers,*** with training input from experts such as those working at Ilia State University[13].

In the interest of data quality, time and cost efficiency and the consistency of population data, the Consultant recommends that up to five local rangers (or, ideally, also the natural resources specialist of the local PA Administration) are made aware/ trained on the following skills:

- Justification and purpose of salamander monitoring;
- Use of GPS, data entry form (or user surface) and other equipment;
- Where exactly to look for larvae, how to find and identify them;
- Behaviour on sampling station to avoid erroneous results, disturbance/damage or – potentially - pathogen transmission to salamanders.

The consultant estimates that a salamander monitoring training could be conducted in about one day. If this is combined with the search for monitoring streams, the expert input related to this training/setup phase would increase to up to five days and may require consultancy, travel and accommodation costs of up to **$ 2.500**.

[13] The Consultant recommends Mr. Giorgi Yankoshvili or Ms. Lisa Karalashvili of Ilia State University for this.

# 4 Detailed protocol for Indicator P1: Infringement Records and Signs

This indicator measures the trend in any infringements of the protection regimes of MaNP and MtNP related to illegal natural resource use, visitation, or other activities, building on past infringement monitoring efforts. The main difference to previous practice is that infringement incidents will be related to patrolling effort to make these data more interpretable. This will be achieved through the Spatial Monitoring and Reporting Tool (SMART) in conjunction with CyberTracker (SMART Partnership 2017a, b).

## 4.1 Justification

There is broad consensus among stakeholders that illegal resource use – particularly poaching – is the most serious potential threat on the biodiversity of MaNP. In MtNP, there has been a steady and strong increase of visitation in recent years, which – if resumed and continued in the future – might increasingly result in infringements on the legal protection regime by visitors or businesses involved in tourism/visitation. An indicator on the number and severity of infringements on the legal protection regime in both parks is therefore proposed, because of the following reasons:

- According to the initial participatory situation analysis, which included a threat identification and rating, , half of the current threats to the key biodiversity values of both MaNP and MtNP are connected to illegal activities within the areas. One of the main objectives of both park administrations is to reduce these threats , and they are therefore interested how well they are progressing towards this objective.
- While the number of infringement incidents is currently relatively low in both PAs, this likely needs to stay this way as some of their biodiversity (e.g. small remaining populations of chamois and lynx) are highly susceptible to some illegal practices.
- SMART monitoring as the proposed approach relies heavily on the activity of rangers while at the same time recording this activity, thereby avoiding artifacts from varying patrolling intensity (cf. Indicator M1). This means that, by using this indicator, rangers will be actively involved and at the same time incentivized to play an even stronger role in law enforcement.
- The SMART approach that we propose for this indicator has the potential to contribute to more effective and efficient law enforcement in a much broader way than only related to monitoring, as it can also be used for patrol planning and data/information management related to patrolling. For instance, potential hotspots of illegal activities can be identified based on analysis of systematic geo-referenced records of signs of them;
- The indicator will be broadly applicable across the Georgian PA system once developed and tested.

## 4.2 Monitoring protocol

The protocol for the monitoring of infringements shall employ the Spatial Monitoring and Reporting Tool (SMART Partnership 2017a) in combination with CyberTracker (SMART Partnership 2017b), taking into account recent experience with this technology in Georgia (NACRES 2020). SMART is a software to design, plan, manage, monitor, document, analyse and report on law enforcement activities (patrolling) of rangers, and observations made during this patrolling that may be relevant to other indicators for adaptive PA management.

CyberTracker is a mobile application that can be used to produce GIS-referenced information using mobile devices such as smartphones. Data generated by rangers in the field using CyberTracker can be semi-automatically transferred from their mobile devices to the central SMART database of each PA.

### *4.2.1 Direct recording of infringements during patrolling, multi-scale reporting and analysis*

The SMART approach to the monitoring of patrolling activities is that all observations of infringements by rangers during patrolling are directly entered into smartphones using the CyberTracker application, and automatically georeferenced. They can also be photographically documented. This way of recording differs from monitoring protocols for other indicators, where specific sampling stations are sampled at defined intervals.

Rangers will continue to patrol along established patrolling routes following their patrol plans. They will enter their observations of infringements using GPS-enabled smartphones equipped with the CyberTracker software. Their progress along their patrolling routes as well as possible deviations due to planned exceptions or unplanned incidents will also be recorded (cf. Indicator M1). Monitoring data will be uploaded from the rangers' mobile devices to the central SMART database. They will be summarized and analysed monthly and annually, and again every three years in preparation of the next operational planning or management planning cycle.

### *4.2.2 Field monitoring*

The integrated patrolling and monitoring protocol builds on the established patrolling arrangements at MaNP and MtNP. The protocol consists of the following steps:

- Define a data collection protocol and brief rangers in its use: Which infringements to report, which information to enter for each recorded infringement, follow-up enforcement actions (e.g. referring to local police, issuing of official infringement report etc.);
- Reconsider and confirm existing patrolling routes and plans for each route (e.g. responsible rangers, frequency and time of year/day, means of transport used, criteria for choosing versions of the routes, types of data to be collected according to data collection protocol, etc.);

- Equip each patrol (i.e., each ranger or each ranger group in the case of group patrols) with a mobile device with CyberTracker installed[14];
- Rangers activate CyberTracker at the beginning of patrol. They enter necessary information and documentation (pictures) on infringements/infringement signs into smartphone directly on site (information is automatically geo-referenced). Course of patrol over time and space is recorded automatically to control for patrolling effort;
- Rangers shall also enter any additional information not related to this indicator (e.g. observations of wildlife) that may be foreseen by their patrolling plan and data collection protocol;
- Upon return to the central ranger station or park administration, data from CyberTracker are semi-automatically transferred to the SMART database of each park for further processing (see below).

### *4.2.3 Data recording, compilation and analysis*

Georeferenced infringement data will be recorded in the field as described above and transferred semi-automatically to the central SMART database at each park upon return to ranger station/park administration[15]. There data will be analysed, stored and secured. Apart from their use for monitoring purposes, they will be individually followed up, according to the legal framework, as well as general APA procedures and guidelines for surveillance and law enforcement.

The following infringement records will be recorded during monitoring and counted as separate sub-indicators under this indicator

- Poaching (illegal hunting and illegal fishing);
- Illegally carrying a gun;
- Illegal logging;
- Use of prohibited means of transport;
- Movements of visitors outside designated trails;
- Camping and bivouacking outside designated areas;
- Littering;
- Damage to or removal of flora and fauna (other than sustainable use of NTFPs in traditional use zones);
- Any additional information not related to this indicator but deemed of interest by APA and its PA administrations (e.g. observations of wildlife);

In addition to official records of infringements detected *in flagranti*, rangers shall also record and photographically document indirect signs of infringements, including the following:

- Rifle and shotgun cartridges;
- Sounds of firearms at large distance;

[14] NACRES (2020) discusses the suitability of various types of smartphone. The advice of this report should be followed when choosing types for infringement monitoring.

[15] Data collected by the considerable number of rangers who are not based at MaNP/MtNP HQ, but at remote ranger stations, will remotely transfer or temporarily store their data for later transfer to the central SMART database.

- Carcasses from poaching and remains thereof;
- Fishing gear and installations;
- Camps, fireplaces and their remains (outside of specially designated areas);
- Stumps that may have resulted from recent illegal cutting;
- Litter;
- Signs of damage and removal of flora and fauna;
- Tracks and other signs of use of prohibited means of transport;
- Other potential signs of illegal activities.

For each common type of infringement, a standard protocol of the information to be collected and documented will be elaborated by the relevant PA administration. The rangers will be briefed regarding the use of this protocol.

Statistics on infringements and infringement signs will be harvested from the central SMART database and reported at monthly, annual and three-annual intervals, in line with established reporting and planning cycles at APA.

### 4.3 Interpretation of indicator in the context of adaptive PA management

The indicator results will be used to answer the following key management questions:

- What is the trend of infringements related to illegal natural resource use and visitation on the legal protection regime of MaNP and MtNP, and specific ranger districts within both parks? (***Source:*** *Interannual comparison of statistics for infringements and signs*)
- Does visitation approach the de-facto carrying capacity of the park(s), in relation to the enforcement and visitor management capacity of the administration(s)? (***Source:*** *trend in visitation related infringements and infringement signs; > 10% annual increase sustained over three years*)
- Does the spatial and temporal distribution of patrolling intensity correspond to the distribution of documented infringements or signs thereof? Should the administration concentrate patrolling efforts in certain areas? (***Source:*** *Comparison of location of patrolling hotspots and infringement hotspots*)
- Are there any correlations between the frequency of infringements and signs thereof on the one hand, and specific investments into infrastructure, equipment, training, management procedures or incentive systems on the other hand?[16] (***Source:*** *Comparison of annual infringement data and key information on any potentially relevant investments*)
- Are there any infringements that the administration knows are happening, but where the perpetrators are never caught? (***Source:*** *Comparison of annual data on official infringement records and signs of infringements – see Section 1.2.3 above*)

[16] This could be used to identify the most efficient investments into law enforcement at MaNP/MtNP and throughout the Georgian PA system.

To interpret the raw infringement data correctly, they need to be put into relation to information on patrolling capacity/intensity. This is because otherwise positive trends in infringement statistics resulting from increased patrolling intensity might be misinterpreted as real increases in the number of infringements. There is no fail-proof formula to make this correction, but the PA administrations shall always discuss trends in infringement statistics in relation to trends in patrolling effort (see Indicator M1: Patrolling capacity/intensity).

### 4.4 Equipment needs and costs

Table 3 summarizes the equipment needs necessary to conduct the entire monitoring using this indicator, together with indicator M1 (Patrolling capacity/intensity). This assumes that standard field ranger equipment such as warm outdoor clothing/uniforms and boots as well as other personal outdoor equipment, transport and field infrastructure as necessary, etc. are already available to monitoring staff. Any items listed in the table that are already available at the administrations do not need to be purchased.

This indicator and Indicator M1 (Patrolling capacity/intensity) will share the same equipment, training and staff time investment. Assuming an average equipment write-off period of five years, ***annual equipment costs for using both indicators within one PA such as MaNP or MtNP are estimated at $ 1,350***.

Once introduced, SMART monitoring using CyberTracker could also contribute to patrol planning, other aspects of field monitoring and the processing of all monitoring data. This added value needs to be taken into consideration to put the estimated annual equipment costs for indicators P1 and M1 into perspective.

### 4.5 Staff time requirements

After a short transition period, no additional time will be required for the monitoring of infringement records and signs because one way of recording this will simply be replaced by another, less time-consuming way. The additional time to upload data from CyberTracker to the central SMART database is estimated as ca. 15 min per patrol day.

The supervision of data entry, maintenance, quality control and updating of the central SMART database will also require a certain time commitment from the responsible NP staff, but again this will replace other, even more time-intensive methods of information management and reporting and the transition to SMART monitoring should hence be a time-saver overall.

This means that the introduction of SMART/Cybertracker monitoring of infringement records and signs will reduce time expenditure for reporting on field patrolling, data storage and analysis, as well as reporting compared to the current setup, once the initial transition phase with its potential teething problems has been overcome**.**

Some additional staff time will be required for training on the use of CyberTracker (rangers) and SMART (two staff members with basic computer literacy, e.g. Head of Protection Unit, Natural Resources Specialist and/or Head Ranger).

**Table 3.** Equipment needs and costs and related requirements per PA.

| Item | Purpose | Item cost ($) | Number needed | Overall cost ($) |
|---|---|---|---|---|
| Simple, rugged smartphones with GPS, camera, charger, and CyberTracker-compatible OS | Field data collection during patrolling | 250 | 10 | 2,500 |
| CyberTracker software | Programme for field data collection | 0 | 20 | 0 |
| Medium range central desktop computer | Running the SMART database | 1,500 | 1 | 1,500 |
| SMART software | SMART database and data collection/analysis functionalities | 0 | 1 | 0 |
| Support to setup and configuration of SMART database specifically for MaNP and MtNP | Design/setup of data model, GIS layers, (e.g. on boundaries and sectors), patrol parameters, standard queries and reports | 500[17] | 2.5 | 1,250 |
| Storage media (simple desktop or laptop computers with external hard drives) | Intermediate data storage for use at remote ranger stations | 500 | 3 | 1,500 |
| **Total ($)** | | | | **6,750** |

### 4.6 Training needs and costs

***The indicator can be used independently by local rangers in cooperation with their managers and with occasional remote support,*** after some training by national or international experts such as those who have already been involved in SMART introduction in other Georgian PAs (cf. NACRES 2020), those affiliated with the SMART Partnership or international NGOs such as WWF.

The Consultant recommends that all rangers and up to four more senior managers at each PA (including the Heads of Protection Unit and Natural Resources Specialists) are trained on the following skills:

**Rangers:**

- Justification, purpose and added values of monitoring Indicators P1 and M1 using the SMART approach;
- Use of CyberTracker with smartphones to record patrols and enter observations;
- Proper use, care and maintenance of smartphones and other hardware;
- Navigation along pre-set routes with GPS units;
- Identification and classification of types of infringements and infringement signs for entering;

[17] Refers to consultant days. One-day workshop, 0.5 day preparation, 0.5 day configuration (follow-up), 0.5 day support and adaptation of database.

- Securing and uploading data from smartphones to central SMART database;
- Recording wildlife observations – direct observation, tracks, and voices.
- Criteria for deviating from standard patrolling routes.

**SMART operators** (middle managers at each PA Administration):

- Justification, purpose and added value of monitoring Indicators P1 and M1 using the SMART approach;
- Configuration, operation, maintenance, quality control and management of SMART database;
- Data input from CyberTracker and ensuring data quality at input;
- Troubleshooting using local and remote resources/support;
- Standard queries and reports, calculation of indicators based on raw data, interpretation of indicators; and
- Interpretation of monitoring results.

The consultant estimates that training on the above subjects – jointly for SMART monitoring of indicators P1 and M1 – by an experienced trainer could be conducted in about five days, including preparation and documentation. The required consultancy, travel, accommodation and subsistence costs are estimated at up to $ 3,500.

In addition, the Directors of MaNP and MtNP shall also be made aware of the benefits of the system and perhaps trained, particularly regarding the justification of these indicators and the underlying adaptive management approach, the interpretation of indicators and ways to make the most of SMART monitoring for improved law enforcement.

### 4.7 Need for organizational and procedural change to enable SMART monitoring

The introduction of SMART monitoring into the routine operations of MaNP and MtNP – be it "only" for use with a limited number of indicators or more comprehensively as an overhaul of the entire patrolling system – entails a significant change in how patrolling as a central activity of these parks is being organized. This is a challenge to both individual staff members and entire park administrations. Previous attempts at SMART introduction in other Georgian PAs have faced some resistance and have been only partly successful (NACRES 2020). Therefore, the introduction of Indicators P1 and M1 needs to be planned and implemented as an organizational change project, and needs to be accompanied by the following supporting interventions:

- All PA staff, and particularly all rangers, need to be motivated to adopt the necessary changes in procedures and apply them diligently and consistently. For this purpose, a broad joint vision for the change of patrolling/monitoring and a clear understanding of the benefits for each group of staff needs to be developed, through broad consultation.
- APA may wish to consider the introduction of special incentives for rangers in relation to patrolling and the introduction and proper use of the SMART methodology. CNF might also consider a special field allowance for ranger using SMART.

- The feasibility of the SMART approach should be demonstrated through limited small pilots first, in order to build momentum for wider introduction. In this context park-to-park learning should also be encouraged.
- The introduction of SMART monitoring and its use to measure indicators P1 and M1 needs to be fully supported by APA and the park directors. The directors need to use their role, mandate and leadership to encourage staff to apply the method properly.
- Introduction of SMART requires people to interact in new ways. A key interface in this regard is that between data collectors (rangers) and the person(s) who are in charge of introducing the data to the central SMART database, analysing and reporting it. The latter role should be clearly assigned to 2-3 specific staff members[18] in each PA with already existing basic computer literacy.
- The roles and responsibilities of the data collectors and these SMART operators should be explicitly stated, and clearly understood by all parties. Monthly feedback between data collectors and SMART operators should be institutionalized.
- All staff need to receive targeted training in line with their prospective role in SMART monitoring, including ample practice. A clear code of practice with rules for the use of smartphones (e.g. no use of social media on monitoring devices) needs to be drawn up, communicated and implemented.
- For the SMART operators, a remote on-demand helpdesk facility for queries arising during data entry and analysis, as well as reporting of the resulting information, should be made available.

The Consultant therefore recommends that the introduction of indicators P1 and M1 as a first step towards SMART patrolling and law enforcement management in MaNP and MtNP is accompanied by some change facilitation support.

[18] More than one person needs to be assigned this role and trained, in order to ensure redundancy in case of staff absence. Depending on skills and particularly computer literacy, these could be natural resource specialists, heads of protection service, and/or senior rangers.

# 5 Detailed protocol for Indicator M1: Patrolling Capacity/intensity

Patrolling and law enforcement is directly relevant to controlling all threats from illegal natural resource use, damaging behaviour or visitors and other potential illegal and/or damaging activities inside MaNP and MtNP. The main strategy of the PA administrations against such illegal activities is patrolling.

Patrolling capacity is defined here as the ability of the PA administrations to deploy a sufficient number of rangers to patrol their entire parks – particularly but not only known hotspots of such activities – at sufficient frequency throughout the seasons. The indicator of patrolling capacity is patrolling intensity, i.e. the amount of patrolling per time and area conducted by rangers of both PAs, as well as their spatial distribution throughout MaNP and MtNP[19]. This shall be measured based on the Spatial Monitoring and Reporting Tool (SMART) in connection with use of CyberTracker in conjunction with Indicator P1.

## 5.1 Justification

Patrolling and law enforcement was the only aspect of management that was considered a high priority for enhanced monitoring by all stakeholders during the indicator prioritization workshops in December 2019. An indicator on patrolling capacity/intensity is therefore proposed for the two areas, because of the following reasons:

- Patrolling and law enforcement responds to three out of the four high-priority direct threats as identified in the situation analysis for MaNP, in a much more direct way than other programmes. The situation for MtNP is similar;
- Patrolling is considered a core activity by both park administrations, into which a great part of their effort and resources are being invested;
- A clear understanding of patrolling capacity – and intensity – is a prerequisite for the correct interpretation of official data on infringements (e.g. records of illegally carrying a gun or poaching, or littering by visitors) as an indicator of the intensity of the threats resulting from them (see Indicator P1 in this report);
- The SMART approach that we propose for this indicator has the potential to contribute to more effective and efficient law enforcement[20] in a much broader way than only related to monitoring, as it can also be used for patrol planning and data/information management related to patrolling;
- The indicator of individual PA administrations' capacity for patrolling and law enforcement will be broadly applicable across the Georgian PA system once developed and tested.

[19] The use of patrolling intensity as an indicator of patrolling capacity is based on the assumption that there is strong and consistent willingness to improve patrolling on the part of the administrations of MaNP and MtNP. This assumption is deemed safe by the Consultant.

[20] The consultant notes that there is considerable room for improvement of post-detection follow-up and persecution through the legal system (e.g. by training of judges on the vital importance of biodiversity) but considers this outside the scope of this assignment.

## 5.2 Monitoring protocol

The protocol for the monitoring of patrolling capacity/intensity shall employ the Spatial Monitoring and Reporting Tool (SMART Partnership 2015) in combination with CyberTracker (CyberTracker 2020), as is the case for Indicator P1.

### *5.2.1 Continuous PA-wide monitoring of patrolling, multi-scale reporting and analysis*

The SMART approach to the monitoring of patrolling activities is that all patrolling movements of rangers are recorded and mapped for later analysis, and that additional information on them is entered by the rangers in the process. The existing standard patrolling routes of rangers in each PA will continue to be used initially[21], and their progress along them as well as possible deviations due to planned exceptions or unplanned incidents will be recorded using GIS-enabled smartphones equipped with the CyberTracker software. Other relevant observations such as those needed to measure Indicator P1 will also be entered.

Monitoring data will be uploaded as described for Indicator P1.

### *5.2.2 Field monitoring*

The integrated patrolling and monitoring protocol builds on the established patrolling arrangements at MaNP and MtNP. It consists of the following parts:

- Revisit and confirm existing standard – and, where appropriate, additional optional[22] – patrolling routes for each ranger district;
- Reconsider and confirm patrolling plans for each route (e.g. responsible rangers, frequency and time of year/day, means of transport used, criteria for choosing versions of the routes, types of data to be collected, etc.);
- Equip each patrol (i.e., each ranger or each ranger group in the case of group patrols) with a mobile device with CyberTracker installed;
- Rangers activates CyberTracker at the beginning of patrol. Course of patrol over time and space is recorded;
- Rangers enters any additional information that may be foreseen by their patrolling plan and wider surveillance and monitoring tasks;
- Upon return to the central ranger station or park administration, data from CyberTracker are semi-automatically transferred to the SMART database of each park for further processing (see below).

[21] It is not the purpose of this assignment to formulate recommendations for the patrolling systems in MaNP or MtNP, but such recommendations could arise from the use of the indicator and the analysis of its outputs, or from other events such as the occurrence of new hotspots of illegal activities that need patrolling.
[22] In some cases, there might be an increased risk of certain illegal activities in various seasons, and patrolling routes might need to be adapted accordingly.

### *5.2.3 Data recording, compilation and analysis*

Georeferenced patrolling data will be collected automatically as described above and transferred semi-automatically to the central SMART database at each park upon return to ranger station/park administration[23]. There they will be stored and secured following general APA procedures and guidelines.

The following metrics on patrolling intensity as an indicator of patrolling capacity will be calculated from the raw data following standard SMART procedures (SMART Partnership 2017):

- Time spent on field patrols by ranger district and for the entire parks;
- Patrolling distance covered by means of patrolling (food, vehicle, possibly horseback and quattrocycle) and ranger district, as well as for entire parks; and
- Ranger time spent and distance covered in defined parts of MaNP/MtNP, such as ranger districts, known hotspots of illegal activities or other relevant parts of both parks.

The quality of observations (based on a set of criteria) will also be evaluated. The frequency at which these statistics will be calculated needs to be decided jointly with APA. As with Indicator P1, monthly, annual and three-annual reporting appears justified from a management perspective.

## 5.3 Interpretation of indicator in the context of adaptive PA management

The indicator results will be used to answer the following key management questions:

- Is real patrolling intensity (in terms of time spent in the field and area patrolled), throughout the entire parks and within individual ranger districts, meeting defined targets as set out in the patrolling plans? (***Source:*** *comparison of patrolling statistics with targets in patrolling plans at monthly and/or annual basis*)
- Is the patrolling intensity and hence capacity of the entire parks, and in their critical ranger districts (i.e. these most prone to illegal activities) increasing or decreasing? (***Source:*** *interannual trends of patrolling statistics*)
- Does the spatial and temporal distribution of patrolling intensity correspond to the distribution of known, inferred or potential threats? Are there any "white spots" on the patrolling map? (***Source:*** *visual analysis of the patrolling maps jointly in the ranger team, with APA, and with external stakeholders*)
- Are there any correlations between patrolling capacity on the one hand and specific investments into infrastructure, equipment, training, management procedures or incentive systems on the other hand?[24] (***Source:*** *Annual data on patrolling intensity and key information on any potentially relevant investments*)

[23] Data collected by the considerable number of rangers who are not based at MaNP/MtNP HQ, but at remote ranger stations, will remotely transfer or temporarily store their data for later transfer to the central SMART database.

[24] This could be used to identify the most efficient investments into law enforcement at MaNP/MtNP and throughout the Georgian PA system.

- Is patrolling sufficiently unpredictable to effectively contribute to law enforcement? (***Source:*** *joint appraisal of patrolling time series and discussion among rangers*)
- Are rangers sufficiently qualified to patrol effectively using the system? Are there any training needs? (***Source:*** *consistency and quality of SMART data on patrolling intensity*).

The data on patrolling intensity will also be used to exclude artifacts from differences in patrolling intensity from interpretation of Indicator P1: Infringement records and signs.

### 5.4 Equipment needs and costs

Indicator M1 will use the same equipment as Indicator P1 (Table 3).

### 5.5 Staff time requirements

Staff time requirements for the combined use of Indicators P1 and M1 are discussed in the section on Indicator P1 above.

### 5.6 Training needs and costs

Training needs and costs for the combined use of Indicators P1 and M1 are discussed in the section on Indicator P1 above.

### 5.7 Need for organizational and procedural change to enable SMART monitoring

Organizational and procedural change requirements for the introduction of SMART patrolling and the combined use of Indicators P1 and M1 are discussed in the section on Indicator P1 above.

## References


Agency of Protected Areas of Georgia (2019). Colchic Rainforests and Wetlands: Nomination for Inscription on the World Heritage List under World Heritage criteria ix and x. Tbilisi: APA. 233+120 pp.

Anonymous (2016). Adjara Forest Adaptation Strategy, Draft. Tbilisi: TJS. 26 pp.

Celiker, N. M., C. Kaplan, E. Onogur, B. Cetinel, D. Poyraz, A. Uysal (2017). Natural dissemination of hypovirulent Cryphonectria parasitica strain used for biological control of chestnut blight. *Turkish Journal of Agriculture and Forestry* 41: 278-284.

Georgian Biodiversity Database (2019). *Red List of Georgia*. Accessed on 30 November 2019 at http://www.biodiversity-georgia.net/.

Georgian Biodiversity Database (2020). Caucasian Salamander Mertensiella caucasica. Species factsheet. Accessed on 30 April 2012 at http://www.biodiversity-georgia.net/.

Heiniger, U. and D. Rigling (1994): Biological control of chestnut blight in Europe. *Annual Review of Phytopathology* 32: 581–599

Ilia State University (2016). Provision of Services for Mtirala National Park Resource Inventory Baselines Studies and Mapping. Batumi: UNDP Georgia. 35 pp. (unpublished).

IUCN (2019). The IUCN Red List of Threatened Species. Accessed on 23 November 2019 at www.iucnredlist.org.

Karch Info Fauna (2018). Anleitung zur Erfassung der Larven des Feuersalamanders. 8 pp. Downloaded on 30 April 2020 at https://www.unine.ch/files/live/sites/karch/files/Doc_a_telecharger/Mitarbeit_Freiwillige/SASA%20Monitoring/Anleitung%20Feuersalamander%20Erhebung%202018%20d.pdf.

Mittermeier, R.A., Gil, P.R., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J. and Fonseca, G.A.B. (2004). Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions. Mexico City: CEMEX Books on Nature Series.

NACRES (2020). Assistance in introduction of SMART in Borjomi-Kharagauli and Lagodekhi PAs. Tbilisi: NACRES. 6 pp.

Nuss, D. (1992). Biological control of chestnut blight: an example of virus-mediated attenuation of fungal pathogenesis. *Microbiological Reviews*. 56(4): 561–576.

Olson, D. A. and Dinerstein, E. (2002). The global 200: Priority ecoregions for global conservation. Annals of the Missouri Botanical Garden 89:199-224.

Perlerou, C., S. Diamandis (2010). Spread of introduced hypovirulence vs. natural hypovirulence in chestnut blight. Acta Horticulturae 866: 393-398.

Rigling, D., N. Borst, C. Cornejo, A. Supatashvili, S. Prosper (2018). Genetic and Phenotypic Characterization of *Cryphonectria hypovirus 1* from Eurasian Georgia. *Viruses* 10: 687.

Sayım, F., E. Baskale, D. N. Tarkhnishvili, U. Kaya (2009). Some water chemistry parameters of breeding habitats of the Caucasian salamander, Mertensiella caucasica, in the Western Lesser Caucasus. Comptes Rendus Biologies 332 (5): 464-469.

SMART Partnership (2017a). SMART (Spatial Monitoring and Reporting Tool). A guide to getting started. Accessed on 2 November 2019 at http://www.smartconservationsoftware.org/.

SMART Partnership (2017b). SMART (Spatial Monitoring and Reporting Tool). Mobile data collection with CyberTracker. Accessed on 2 April 2020 at http://www.smartconservationsoftware.org/.

Tarkhnishvili D. and U. Kaya (2009). Status and conservation of the Caucasian Salamander (*Mertensiella caucasica*). In: Zazanashvili, N. and Mallon, D. (Editors) 2009. *Status and Protection of Globally Threatened Species in the Caucasus.* Tbilisi: WWF. Pp. 157-164.

Tarkhnishvili, D. N. and Gokhelashvili, R. (1999). *The Amphibians of the Caucasus. Advances in Amphibian Research in the Former Soviet Union.* Sofia and Moscow: Pensoft. 239 pp.

Tarkhnishvili, D. N. and I. A. Serbinova (1993). The ecology of the Caucasian Salamander (*Mertensiella caucasica* Waga) in a local population. *Asiatic Herpetological Research* 5: 147-165.

Tarkhnishvili, D. N., R. S. Thorpe, J.W. Arntzen (2000). Pre-Pleistocene Refugia and Differentiation between Populations of the Caucasian Salamander (*Mertensiella caucasica*). *Molecular Phylogenetics and Evolution* 14(3): 414–422.

Tarkhnishvili, D., Kaya, U., Gavashelishvili, A. and Serbinova I. (2009). Ecological divergence between two evolutionary lineages of the Caucasian Salamander: Evidence from GIS analysis. *Herpetological Journal* 18:155-163.

Williams, L., Zazanashvili, N., Sanadiradze, G. and Kandaurov, A. (2006). Ecoregional Conservation Plan for the Caucasus. Tbilisi, Georgia: WWF Caucasus. <http://www.wwf.de/fileadmin/fm-wwf/pdf_neu/Kaukasus_OEkoregionaler__Naturschutzplan__May06.pdf>. Accessed 3 September 2020.

Yankoshvili, G., E. Karalashvili, D. N. Tarkhnishvili (2019). Monitoring of the Habitat of the Caucasian Salamander *Mertensiella caucasica* sensu latu. Unpublished report. Tbilisi: Ilia State University. 18 pp.

## Appendix 1: Experts and stakeholders consulted

In addition to the stakeholders present at the workshops in December 2019, the following experts were consulted individually in relation to the indicators for which detailed protocols are presented in this output:

- **Indicator S1**: Mr. Lexo Gavashelishvili (Ilia State University), Mr. Christian Gönner (MEPA, CIM expert), Mr. Irakli Goradze (UNDP), Mr. Giorgi Kapanadze (APA), Mr. Benedikt Ibele (GIZ), Mr. Vasil Metreveli (Ilia State University), Mr. Joshua Royte (TNC), Ms. Nancy Sferra (TNC), Mr. Giorgi Tkhelidze (National Forest Agency), Mr. Andy Whitman (Manomet).
- **Indicator S2**: Mr. Gerald Antenhofer (Brixen), Ms. Izolda Machutadze (Shota Rustaveli State University), Mr. Vasil Metreveli (Ilia State University), Ms. Meike Piepenbrink (University of Frankfurt), Mr. Jernej Stritih (GOPA), Mr. Giorgi Lebanidze (GIZ).
- **Indicator S3**: Mr. David Tarkhnishvili (Ilia State University).

**Indicator P1 and M1**: Mr. Charles Besancon (University of Montana), Mr. Michael Hosek (Integra Group).

## Appendix 2: Short summary of the NFI methodology (Anonymous 2020)

The Field Manual for the Georgian National Forest Inventory (Anonymous 2020) is a detailed, hands-on instruction for the overall process, preparation (including equipment and resources), implementation and documentation of the Georgian National Forest Inventory, which covers all forest areas of Georgia using a 3.6 km grid.

The field manual comprises detailed guidance on the following:

- General introduction to field monitoring and assessment of variables;
- Variables assessed on sample plot level, and on concentric sample-subplots of diameters of 5 m, 15 m and 25 m;
- Assessment of dead wood and regeneration;
- Assessment of single forest trees, measurement of height, age and increment;
- Stump assessment;
- Photographic documentation and other measurements to contextualize measured variables;

The manual has been finalized in 2020, but has already been used for the baseline NFI in 2019, which continues into 2020/21. It is meant for the nationwide forest inventory. A similar manual for the forest management inventory (FMI), which uses the same terminology and concepts but a denser sampling grid and a slightly different set of variables and methodology is currently in preparation.