

HABIT-CHANGE

Report on impacts of different management practices

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1. Introduction, objectives and method

1.1. Introduction

In the project proposal of the HABIT-CHANGE project this output is described as a “report on impacts of different management practices” that includes an assessment of “different old and new management practices”. In this report management practices implemented in HABIT-CHANGE investigation areas for the preservation of protected Natura-2000-habitats are evaluated regarding their suitability to preserve a favourable conservation status under changing climatic conditions.

The European Habitats-Directive (92/43/EEC) aims at the protection and management of habitats and species to obtain a favourable conservation status. Habitats are constantly exposed to climatic and non-climatic pressures that may affect the habitats’ conservation status negatively (Salafsky et al. 2008). Protected habitats are often surrounded by an intensively used landscape. The conservation status of habitats can be impaired by agricultural practices, settlements, airborne emissions or recreational uses. If habitats are impaired by these pressures from land use and land-use change they are usually more sensitive against additional pressures from climate-change. Besides already existing land-use pressures, climate change will become a more and more important threat.

Up to now, strategies and measures in nature conservation mostly aim at the reduction of land-use pressures and improvement of resilience. The term resilience describes the ability to absorb pressures and disturbances. Resilience is defined as the amount of disturbance or change an area can withstand before it shifts to a different state. An intact habitat is more resilient to pressures than an already disturbed habitat. The concept of resilience is an important part of adaptive management (Hobbs et al. 2010). It is suggested to reduce the non-climatic stresses and improve the resilience of habitats by implementing the concept of Adaptive Management (Hansen et al. 2003).

Climate change is an important driver for changes in habitat quality. The impacts of climate-related changes vary for different habitats (see output 3.2.5: Priority matrix impacts per region and habitat) and may negatively affect the conservation status. Especially habitats with an average or reduced conservation status will be vulnerable to climate change. Nevertheless climate is only one of many factors that affect and influence the conservation status.

The management of protected habitats under climate change requires detailed knowledge about changes in exposures (temperature and precipitation), about the sensitivity of habitats, about potential impacts of climate change on habitats and about the response options to mitigate the effects of climate change on habitats. Output 3.4.1 evaluates different response options (management strategies and measures) regarding the suitability to mitigate effects of climate change and of land use. Even if management practices cannot mitigate the effects of rising temperatures or changing precipitation patterns, they may strengthen the resilience of habitats by reducing non-climate pressures in protected areas.

The knowledge about the effectiveness of measures and strategies in nature conservation is still very limited. Several reasons for the lack of a systematic evaluation of management actions were identified within the HABIT-CHANGE Project:

- Often the objectives in management plans for protected areas are not defined precisely enough. Objectives are not described with measurable criteria or parameter and time-fixed but only generally defined. If objectives are not measurable it is almost impossible to evaluate when and to what degree the objectives are reached. As a consequence the effectiveness of management measures cannot be evaluated either.
- Often a systematic monitoring plan is missing. Objectives and monitoring plan have to be developed in close correlation to each other. A systematic monitoring should provide information about the actual development of the managed natural resource over a specific period and allow managers to compare the targeted state with the actual state. The monitoring should also be used to control the effectiveness of management activities.
- Management measures and strategies are often developed by planners or management authorities of protected areas without adequate stakeholder involvement. Stakeholder involvement is necessary to ensure that all stakeholders relevant for the managed resource pursue the same objectives or at least accept and tolerate objectives and practices of nature conservation. Otherwise the risk of contra-directional activities of different stakeholders is high and the achievement of objectives of nature conservation is impossible. Therefore, all activities in protected areas and habitats have to be coordinated, and agreements about measures have to be made with all relevant stakeholders. If different stakeholders implement measures on the same site it is impossible to correlate observed effects and habitat changes to a specific management measure.
- A systematic evaluation and assessment of activities of nature conservation is usually not part of the management plan for protected areas, because the necessary human and financial resources are often not available. Experiences made with different management practices are not documented and communicated with other interested persons or groups.

Until empirical results from systematic monitoring programmes in HABIT-CHANGE investigation areas about the effectiveness of management measures for habitat conservation are available the assessment of measures had to be carried out by expert judgement. Protected-area managers have profound knowledge about measures and strategies implemented in their area, but this knowledge has been not yet systematically documented. The evaluation of already implemented measures for nature conservation in this report was done by area managers and scientific partners of the HABIT-CHANGE investigation areas.

The evaluation of measures and strategies in this report is based on the management practices that were reported from the HABIT-CHANGE investigation areas for output 3.3.1 “Report on management strategies”. The management practices actually implemented in the investigation areas are evaluated regarding their potential to obtain or maintain a favourable conservation status of the habitats under conditions of changing climate. It is expected that some strategies and measures have to be adapted, enforced or reduced to allow a climate-change adapted management.

New and adapted strategies in nature conservation that were extracted from literature and presented in Output 3.3.1, chapter 4, are also evaluated in this report. Different criteria for evaluation had to be found because the expertise of protected-area managers could not be drawn on

for the evaluation. The main question for the evaluation of suggested new adaptation strategies was which target group is addressed by the strategy. Since the HABIT-CHANGE project focuses on advice and guidance for protected-area managers we assessed which of the suggested strategies can and should be implemented by them. The strategies were also evaluated with respect to their feasibility to single out those adaptation options that can be easily implemented by protected-area managers without extensive preparation phases. For more details about the methodology please see chapters 1.4 and 3 of this report.

1.2. Objectives

The main goal of the evaluation of management practices is to provide information about management options to mitigate impacts of climate change for protected-area managers. The results of this report shall be used to adapt existing management plans for protected habitats and to integrate the evaluated response options into the climate-change adapted management plans (CAMPs). Protected-area managers will be enabled to choose new and adapted management practices for habitat conservation from this report. The integration of evaluated response options into CAMPs is the main purpose of this output.

As we learnt from several consultations with management authorities and scientific partners of the HABIT-CHANGE project, all management strategies and measures in management plans for our investigation areas are based on the assumption of stable climatic conditions. Up to now none of the management plans, management measures or strategies takes climate change into account. But some strategies and measures already implemented in the areas might be suitable and appropriate to obtain a favourable conservation status even under conditions of climate change, because they strengthen the resilience of habitats by reducing non-climatic pressures or help to mitigate the impacts of climate change.

The strategies and measures implemented in HABIT-CHANGE investigation areas do not cover the whole spectrum of possible management strategies and measures that could be implemented in protected areas to preserve protected habitats. This report is based on the measures and strategies reported for output 3.3.1 “Report about existing management strategies” from the HABIT-CHANGE investigation areas. New and additional strategies and measures, as they are proposed by scientists and institutions, were also taken from output 3.3.1.

The main objectives of this report are:

- Evaluation of existing management strategies and measures regarding their suitability to improve habitat quality under changing climate.
- Evaluation of new strategies and measures proposed in literature regarding the target group for implementation and their feasibility and effectiveness.
- Recommendations for new strategies and measures that should be integrated into climate-change adapted management plans (CAMPs) and tested in HABIT-CHANGE investigation areas.

1.3. Classification with regard to other outputs

The extensive discussion about the methodological approach for the evaluation of management practices (see below chapter 1.4 Method) led to a diversification of approaches and outputs. The results of the discussion and the different approaches are presented in four different outputs that cover different aspects of the evaluation and provide additional information about the effectiveness of management practices. This report for output 3.4.1 is considered the main outcome for this core-output in work package 3.

Output 3.4.1 A - (HABIT-CHANGE_3.4.1A invasive species management in DDBR and TNP.pdf) compiles the knowledge about the efficiency of different management options to deal with invasive plant species in selected HABIT-CHANGE investigation areas: Danube Delta Biosphere Reserve and Triglav National Park. Additionally, a compilation of three different and separately elaborated reports from Triglav National Park, Slovenia, Danube Delta Biosphere Reserve and Szent Istvan University with experiences from Balaton Uplands National Park, Körös-Maros National Park and a review of Hungarian literature is provided as output 4.6.4 "Assessment of potential neophyte invasion". The spreading of invasive species is an expected and already observed impact of climate change. Experiences from areas that successfully manage invasive species in protected areas will be included in CAMPs and management guidelines. The evaluation of established management options for invasive species is a basis for adaptation of management in other investigation areas.

Output 3.4.1 B (HABIT-CHANGE_3_4_1_B_Consequences_of_management_regime.pdf) focuses on the knowledge and experience in evaluating the effectiveness of management practices. Based on an extensive review of Hungarian literature concerning the management of wetlands the biological impacts of management practices are compiled and recommendations for a management of wetlands under climate change are given. The report shows what management measures seem to be promising under specific conditions and for the achievement of specific objectives and habitats.

Output 3.4.1 C (HABIT-CHANGE_3_4_1_C_List_of_management_measures.pdf) was provided to support the investigation areas during the evaluation of their management measures. It contains a list of management options that could be implemented additionally to existing measures in order to mitigate effects of climate change. It shows the wide choice of different management options that could be used to adapt habitat and protected area management. Though the list does not contain all possible management measures for all habitat types of Annex I of the Habitats-Directive, it may open new perspectives and inspire area managers to experiment with new measures.

This report in hand - 3.4.1 - provides information for several outputs of subsequent work packages like the spatial decision support system (SDSS), the development of climate-change adapted management plans (CAMPs), and the management guidelines and recommendations (outputs 6.1.1, 6.1.3 and 6.1.2). The results of this report are an important input for the recommendations of climate-change adapted management strategies and measures in climate-change adapted management plans (CAMPs, output 5.3.1). The results will be used for the spatial decision support system (SDSS, output 5.2.1) to integrate response options under climate change. This report is also the basis for the systematic development of models in the context of an Adaptive Management.

1.4. Method

All management activities for Natura 2000 habitats follow the objectives defined in the Habitats-Directive of the EU (92/43/EEC). “The restoration or maintenance of natural habitats of community interest shall ensure a favourable conservation status. The conservation status of a natural habitat will be considered ‘favourable’ when:

- its natural range and areas it covers within that range are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable” (Art. 1 (e) of the Habitats-Directive).

According to the “NATURA 2000 STANDARD DATA FORM”, the conservation status of habitats has to be evaluated comprising the criteria: degree of conservation of the structure and functions of the natural habitat type, and restoration possibilities.

- The degree of conservation of structure is based on a characteristic list of species and relevant elements.
- The degree of conservation of function is based on the prospects (capacity and probability) of the habitat type concerned on the site in question to maintain its structure for the future, given on the one hand the possible unfavourable influences and on the other hand all the reasonable conservation effort which is possible.
- Restoration possibilities: “The first thing to evaluate is its feasibility from a scientific point of view: does the current state of knowledge provide an answer to the ‘what to do and how to do it’ questions? This implies a full knowledge of the structure and functions of the habitat type and of the concrete management plans and prescriptions needed to restore it, that is to say to stabilize or increase the percentage of area covered by that habitat type, to re-establish the specific structure and functions which are necessary for its long-term maintenance and to maintain or restore a favourable conservation status for its typical species. The second question that may be asked is whether it is cost-effective from a nature-conservation point of view. This assessment must take into consideration the degree of threat and rarity of the habitat type.” (Habitat Directive EU 92/43/EEC).

These sub-criteria for the evaluation of the conservation status are specified by national institutions of the EU-Member states. Most countries have their own specification of the criteria for evaluation and rules for the aggregation of them.

These sub-criteria have to be synthesised and lead to an overall grading:

A: favourable conservation status (excellent conservation)

B: good conservation

C: average or reduced conservation

The methodological approach for this output should deliver reliable information about the effectiveness of management practices to obtain the goals of the Habitats-Directive to ensure the conservation of habitats of community interest in a favourable conservation status. The question was how to evaluate what a specific management measures can contribute to the conservation of habitats and what it can contribute to the mitigation of climate-change impacts.

1.4.1. Methodological approaches discussed during the concept phase

From the beginning of the project it was obvious that the evaluation and an assessment of impacts of different management practices would be a challenging task that requires coordinated action and contributions from all project partners. The description of the output in the project proposal opened different approaches for the evaluation of management practices. Different approaches and ideas were discussed with all partners on project meetings in Lake Neusiedl National Park in September 2010, in Sečovlje Salina Nature Park in April 2011 and in Balaton Uplands National Park in September 2011.

The evaluation has to focus on the management strategies and measures and to ask how they can contribute to reduce pressures and impacts of climate change and thus to maintain a favourable conservation status of protected habitats.

A **first approach** focused on the management of invasive plant species. The spreading of invasive species is considered one of the most obvious impacts of climate change. In many protected areas invasive species have been observed for several years, and various strategies and measures were developed to battle the further distribution of these invaders. The experience from HABIT-CHANGE investigation areas in management of invasive species promised to be a good starting point for the evaluation of management practices in habitat conservation. The managers of all the investigation areas were asked to report their experiences with invasive species. The most profound information came from the Danube Delta National Institute for Research and Development (DDNI) and Triglav National Park (TNP). Ákos Malatinszky from the Szent Istvan University (SIU) also provided information about the invasive species management in Körös-Maros National Park and the Balaton Uplands National Park. These two reports were compiled and provided as output 3.4.1 A for all partners of the HABIT-CHANGE project, and the contributions from the investigation areas were also the basis for output 4.6.4 “Assessment of potential neophyte invasion”.

The limited number of contributions from HABIT-CHANGE investigation areas made clear that the focus on invasive species management would not provide an adequate basis for the evaluation of management practices in protected areas. Therefore a second approach was discussed during the project meeting in Portoroz in April 2011.

The **second approach** is based on an extensive evaluation with many different criteria. Basis for the evaluation are management practices as they were reported for output 3.3.1 by 10 of 15 HABIT-CHANGE investigation areas. The evaluation of measures and strategies was planned to be performed by experts of the protected areas based on nine different criteria. The criteria for the evaluation were extracted from evaluation literature with the following questions to be answered:

- How much can a specific measure contribute to the improvement of the conservation status of a protected habitat: conservation of function, of structure and restoration possibility?
- How much can a specific measure contribute to the reduction of non-climatic pressures on habitats that impair the conservation status and the resilience of habitats? Non-climatic pressures may be overexploitation, overgrazing, intensive use or nutrient intake from land users like agriculture or forestry. (Hansen et al. 2003)
- How much can a specific measure contribute to reduce climatic pressures in habitats like changes in precipitation, temperature or water balance? (The World Bank 2011)
- How much can a specific measure contribute to handle future uncertainty? (The World Bank 2011)
- How effective is a specific measure? And with which probability will a specific measure achieve its target? Are there uncertainties about the effectiveness of measure or strategy?
- How cost-intensive are specific measures?
- Are the measure and/or the effects of the measure reversible? Does the measure allow later changes and adaptations or do they have irreversible impacts on habitats?

It was suggested that the evaluation should be graded into 3 categories (high, medium, low) inspired by the evaluation scheme of the Water Utility Climate Alliance White Paper (Means-III et al. 2008). Each criterion should be evaluated separately first, an aggregation of all evaluation criteria for the strategies and measures was discussed but not finished for implementation.

The following table 1 shows the evaluation scheme as it was discussed on the project meeting in Balaton Uplands National Park in September 2011. Each measure and strategy reported from the HABIT-CHANGE investigation areas for output 3.3.1 was planned to be evaluated with the following criteria. Separate tables were suggested for each group of habitat types (1000, 2000, 3000 etc.). The experts in the investigation areas were asked to give grades of high, medium, or low for each criterion and measure.

Table 1: Criteria for evaluation and evaluation categories

Criterion	Evaluation	Description of Evaluation
Conservation of structure	High contribution	Strategy or measure maintains or restores an excellent or well conserved structure
	Medium contribution	Strategy or measure partly maintains or restores an excellent or well conserved structure
	Low contribution	Strategy or measure does not or little maintain or restore an excellent or well conserved structure
Conservation of function	High contribution	Strategy or measure maintains or restores an excellent or good prospects
	Medium contribution	Strategy or measure partly maintains or restores an excellent or good prospects
	Low contribution	Strategy or measure does not or little maintain or restore an excellent or good prospects

Criterion	Evaluation	Description of Evaluation
Reduction of impacts of non-climatic pressures	High	Strategy or measure reduces most of the relevant non-climatic pressures without causing negative ecological side-effects
	Medium	Strategy or measure reduces some of the relevant non-climatic pressures and has little or no negative ecological side-effects
	Low	Strategy or measure does not or little reduce non-climatic pressures or has negative ecological side-effects
Reduction of impacts of changes in precipitation	High	Strategy or measure reduces impacts of changes in precipitation, like flooding
	Medium	Strategy or measure partly reduces impacts of changes in precipitation
	Low	Strategy or measure does not or little reduce impacts of changes in precipitation
Reduction of impacts of changes in temperature	High	Strategy or measure reduces impacts of changes in temperature, like drought
	Medium	Strategy or measure partly reduces impacts of changes in temperature
	Low	Strategy or measure does not or little reduce impacts of changes in temperature
Reduction of impacts of changes in water balance	High	Strategy or measure reduces impacts of changes in water balance
	Medium	Strategy or measure partly reduces impacts of changes in water balance
	Low	Strategy or measure does not or little reduce impacts of changes in water balance
Investment Attention: categories are defined reversely to allow an aggregation of different evaluation criteria later on.	high	! Only little or no investments are necessary for implementation of measures or strategy
	medium	! Medium investments, that fit in a yearly budget are necessary for implementation of measure or strategy
	low	! Measure or strategy are cost-intensive and demand high investments or investments over several years
Effectiveness and uncertainty	High/ certain	Strategy or measure is known to reach target; the outcome of the strategy or measure is certain; Strategy or measure is based on a profound knowledge about "what to do and how to do it" to manage the habitat
	Medium/ partly certain	Only little experience is available whether strategy or measure can reach target; the outcome of the strategy or measure is partly certain
	Low/ partly uncertain	No experience with strategy or measure is available; the outcome of the strategy or measure is uncertain; knowledge about what to do and how to do it is lacking
Reversibility	high	The measure or strategy itself or its impacts can be reversed easily without high investments
	medium	The measure or strategy itself or its impacts can be reversed only with considerable efforts and at medium costs
	low	Measure or strategy itself or its impacts cannot be reversed

The discussion during and after the project meeting in Balatonfüred made it obvious that the suggested approach would exceed the capacities and resources of the responsible project partners. Though interesting results were expected, the evaluation would take too much time and hardly any investigation area had experts that could evaluate all the criteria. It was decided that a much more simplified approach would be needed to meet the capacities of all project partners and to finish this core-output in time. The simplified approach is presented in the following paragraphs.

1.4.2. Implemented methodological approach for this output

Regarding the remaining time and budget available for the evaluation of management practices a simplified approach was developed by PP 6, TUB. This approach is also based on the expert knowledge of the managers in the HABIT-CHANGE investigation areas, but uses only three instead of nine criteria. Questionnaires for the evaluation were developed for those HABIT-CHANGE investigation areas that had reported management practices for output 3.3.1. Each investigation area received a questionnaire that contained only the strategies and measures they had reported from their area. Protected-area managers were asked to evaluate only those management practices they have actual experience with.

Because of the lack of a systematic evaluation of implemented management practices the degree of uncertainty in judgements had to be indicated by evaluating the measures with the categories “very likely; likely; and unlikely”. The questionnaire contained tables with a short description of the management practice as it was provided by the specific investigation area, the relevant habitat type and three columns for the evaluation criteria.

The main questions for the evaluation of management practices in the questionnaire are:

1. Can the strategy or measure be maintained effectively under the expected climate changes? (Very likely; likely; unlikely)
2. Do you have to (slightly) change or adapt the strategy or measure to still be effective under climate-change conditions? (Very likely; likely; unlikely) In what way? (please describe; e.g. mowing: changing the date for mowing, using a different machine or tool for mowing, changing the depth of cut, treatment of mulch etc.)
3. Are additional strategies and measures (absolutely) necessary to maintain and improve the conservation status of the respective habitat types under changing climatic conditions? What measures could that be? Please describe in detail.

In order to support the area managers in choosing new and additional strategies and measures for the management under climate change, a list with potential management options for habitats was provided with output 3.4.1 C “List of management measures”. The investigation-area managers were asked to pick promising management options from that list to answer the third question (see above).

Nine out of ten investigation-area managers returned the questionnaires with evaluated management measures. A total of 400 actually implemented measures for habitat management were evaluated by the experts in HABIT-CHANGE investigation areas. Those measures were assorted

regarding the managed habitat type and also regarding the strategy category they belong to. As in output 3.3.1 we defined 6 different categories of strategies, though the category ‘strategies and measures for species conservation’ was not examined anymore. All measures and strategies relevant for habitat management were assigned to one of the following categories for strategies:

1. Strategies and measures related to land and water protection and management
2. Strategies and measures related to monitoring and planning
3. Strategies and measures related to law and policy
4. Strategies and measures related to stakeholder and land user, public relation and awareness
5. Strategies and measures related to knowledge and research, science and technology

A closer look at the description of measures, strategies and proposed adaptations made clear that only measures assigned to the first category: related to land and water protection and management had a specific relation to the managed habitat type or habitat type-group. The specific management practices that are tailored for specific habitat types could only be identified in that first category. All other measures that were assigned to the four other categories for management strategies were not habitat-specific but can help to improve and preserve all the different kinds of habitats and also the entire protected area. The fact that many measures in the categories 2 to 5 were assigned to habitat types in the questionnaires for evaluation does not contravene that approach, because in the questionnaire we asked for all the relevant strategies and measures implemented in a specific area with its respective habitat types, even if they are not specifically tailored for those habitat types. As a consequence only measures and strategies assigned to “land and water protection and management” were related to the managed habitat-type group and interpreted according to the respective habitat-type group. The objective of that analysis is to develop habitat-specific recommendations for adaptation to climate change.

After assigning all evaluated measures to one of the categories for strategies, a quantitative analysis was carried out for each criterion of evaluation. The suggested adaptations and additional measures were then analysed and interpreted; the results are presented below.

For more details on the methodology applied to the evaluation of new, adapted management strategies, as they were extracted from literature, please refer to chapter 3 of this report.

2. Results of the evaluation of management practices in HABIT-CHANGE investigation areas

Only currently implemented management practices in HABIT-CHANGE investigation areas are included in the following analysis results. All measures and strategies for protected species management that cannot be related directly to protected Natura 2000 habitat management are excluded from the analysis as well.

The evaluation includes management practices that were reported from the following nine HABIT-CHANGE investigation areas:

- Balaton Uplands National Park (BUNP),
- Bucegi Nature Park (BucNP),
- Biosphere Reserve Vessertal (BRVTF),
- Danube Delta Biosphere Reserve (DDBR),
- Lake Neusiedl - Fertő Hanság National Park (LNFHNP),
- Körös-Maros National Park (KMNP),
- Triglav National Park (TNP),
- Secovlje Salina Nature Park (NPSES),
- Rieserferner-Ahrn Nature Park (RANP).

Table 1 shows how many measures in each category and specific habitat type or habitat-type group were evaluated. The highest number of measures are implemented in natural and semi-natural grassland habitats (habitat type-group 6000) which cover an area of about 30 % of all areas with protected Natura 2000 habitat types in HABIT-CHANGE investigation areas (see Output 3.2.5: Priority matrix impacts per region and habitat, table 1, page 7). There are only very few measures for temperate heat and scrub habitats (4000) and rocky habitats and caves (8000). An interpretation on the basis of so few measures cannot provide valid results. No measures were reported for the management of coastal and inland dunes (2000). Therefore the in-depth interpretation is limited to the habitat-type groups 1000, 3000, 6000, 7000 and 9000.

Table 1: Evaluated measures related to strategy categories

		Measures related to...									
		No. of measures (% per Habitat)	1. land and water protection and management	%	2. monitoring, planning	%	3. law and policy	%	4. Stakeholder Dialog, public relation, awareness	%	5. knowledge, research, science, technology
1000 Coastal and halophytic habitats	25 (12 %)	20	80,0 %	2	8,0 %	1	4,0 %	1	4,0 %	1	4,0 %
3000 Freshwater habitats	33 (16 %)	18	54,5 %	4	12,1 %	5	15,2 %	1	3,0 %	5	15,2 %
4000 Temperate heat and scrub	4 (2 %)	3	75,0 %	0	0,0 %	1	25,0 %	0	0,0 %	0	0,0 %
6000 Natural and semi-natural grassland formations	94 (44 %)	54	57,4 %	10	10,6 %	22	23,4 %	4	4,3 %	4	4,3 %
7000 Raised bogs and mires and fens	24 (11 %)	11	45,8 %	1	4,2 %	9	37,5 %	1	4,2 %	2	8,3 %
8000 Rocky habitats and caves	10 (5 %)	2	20,0 %	3	30,0 %	1	10,0 %	0	0,0 %	4	40,0 %
9000 Forests	21 (10 %)	8	38,1 %	6	28,6 %	6	28,6 %	1	4,8 %	0	0,0 %
Sum assigned	211 (100 %)	116	55,0 %	26	12,3 %	45	21,3 %	8	3,8 %	16	7,6 %
Measures not assigned to Habitat type	189	7	3,7 %	33	17,5 %	27	14,3 %	97	51,3 %	25	13,2 %
Sum total	400	123	30,7 %	59	14,8 %	72	18,0 %	105	26,3 %	41	10,2 %

Almost 31 % of all evaluated measures belong to strategy-category 1 “land and water protection and management, 26 % to category 4 “stakeholder dialogue, public relation and awareness”, 18 % to “law and policy”, almost 15 % to “monitoring and planning” and only 10 % to “knowledge, research, science and technology”. All in all, measures and strategies for “land and water protection and management” seem to be the most important management practices for habitat preservation in HABIT-CHANGE investigation areas, followed by communication practices with stakeholders and visitors.

The table shows that 55 % of all measures assigned to specific habitat types belong to category 1 for “land and water protection and management”. Those measures describe detailed management practices that differ between the habitat-type groups. The category “land and water protection and management” contains all “physical” and concrete management practices like mowing, grazing, logging and thinning in forests, the removal of invasive species or the construction of sluices for water management that are planned, coordinated and mostly implemented by the protected-area management.

The question whether the measure can be effective and successful for habitat preservation even if the climatic conditions will change as projected, served as a first criterion for the evaluation of management practices. The relevant information about the expected climate change was provided in the joint report for output 3.2.3 and 3.2.7: Climate-change impacts as boundary condition (3.2.3) + Hydrological features of selected areas (3.2.7). Protected-area managers were asked to assess the effectiveness and suitability only of those management practices they actually implement in their protected area. Because only very few systematic evaluations of different management practices are available, the assessment was carried out on the basis of expert knowledge of protected-area managers. Regarding the degree of uncertainty in the assessment all management practices had to be evaluated in the categories “very likely, likely, and unlikely”. If protected-area managers were very certain about the effectiveness of the measures they were asked to choose “very likely”. If uncertainties remained they should answer “likely” and if doubts about the effectiveness prevailed they should answer “unlikely”.

The results of the evaluation of all management practices regarding the question: “Can the strategy or measure be effectively maintained under climate change?” are presented below in table 2.

Table 2: Can the measure be maintained effectively under climate change?

1) Can the strategy or measure be maintained effectively under climate change?							
Habitat-type group	number of measures (n)	very likely	in %	likely	in %	unlikely	in %
1000 Coastal and halophytic habitats	25	14	56,0 %	9	36,0 %	2	8,0 %
3000 Freshwater habitats	33	21	63,6 %	11	33,3 %	1	3,0 %
4000 Temperate heat and scrub	4	0	0,0 %	4	100,0 %	0	0,0 %
6000 Natural and semi-natural grassland formations	94	50	53,2 %	39	41,5 %	5	5,3 %
7000 Raised bogs and mires and fens	24	17	70,8 %	3	12,5 %	4	16,7 %
8000 Rocky habitats and caves	10	7	70,0 %	3	30,0 %	0	0,0 %
9000 Forests	21	15	71,4 %	6	28,6 %	0	0,0 %
Sum assigned	211	124	58,8 %	75	35,5 %	12	5,7 %
Measures not assigned to Habitat type	189	168	88,9 %	20	10,6 %	1	0,5 %
Sum total	400	292	73,0 %	95	23,8 %	13	3,2 %

The figures in table 2 show that protected-area managers of HABIT-CHANGE investigation areas expect only about 6 % of all management practices assigned to specific habitat types not to be effective under changing climatic conditions. Together with practices not assigned to specific habitat types only 3 % of all management practices for protected habitats are expected not to be effective any more. Only in coastal and halophytic habitats (habitat-type group 1000) and in raised bogs, mires and fens (habitat-type group 7000) the share of practices expected not to be effective any more was significantly higher. One possible explanation may be that those habitats are especially sensitive to changes in temperature and precipitation patterns that lead to sea-level rise and the drying out of bogs and fens. If climate-change impacts are severe, traditional management practices may no longer be effective because they cannot mitigate or compensate the pressures and impacts of climate change.

An overwhelming majority of 73 % of all practices are expected to be effective even under climate change though this grade applies only to 59 % of the practices assigned to specific habitat types. Uncertainties about the effectiveness of management practices are higher for practices assigned to specific habitat types than for practices not assigned to habitat types.

The figures prove that most of the actually implemented management practices are expected to be successful even under climate change. For one third of the practices some uncertainties exist

concerning their effectiveness. A more detailed analysis concerning the different categories for strategies is provided in the following chapters below.

The second question for the evaluation of implemented management practices was: “Are adjustments of the measure necessary to maintain its effectiveness?” We wanted to know if measures that are generally evaluated as suitable and effective even under changing climatic conditions have to be slightly adapted and in which way they would have to be adapted. Protected-area managers were asked to judge the necessity of adjustments by “very likely”, “likely”, or “unlikely”. Additionally they were asked to name the kind of adjustments, i.e. adaptation of time or frequency for mowing, using different machines for mowing etc.

The third question for the evaluation of implemented management practices was: “Are additional measures or strategies (absolutely) necessary to maintain or improve the conservation status of the respective habitat types under changing climatic conditions? What measures could that be? Please describe in detail.” It was expected that even if some measures may be maintained successfully or slightly adjusted under climate change they would not be adequate to mitigate the impacts of climate change. We wanted to know what kind of measures or strategies were thought to be capable of supporting already implemented measures.

Table 3 gives an overview on the evaluations of questions 2 and 3 and the number of suggested adjustments and additional measures.

Table 3: Adjustments of implemented measures and suggested additional measures

Habitat-type group	No. of measures	Are adjustments of measure necessary to maintain effectiveness?						No. of suggested adjustments	No. of suggested additional measures
		very likely	in %	likely	in %	un-likely	in %		
1000 Coastal and halophytic habitats	25	4	16,0 %	7	28,0 %	14	56,0 %	10	8
3000 Freshwater habitats	33	6	18,2 %	8	24,2 %	19	57,6 %	8	6
4000 Temperate heat and scrub	4	0	0,0 %	2	50,0 %	2	50,0 %	1	0
6000 Natural and semi-natural grassland formations	94	2	2,2 %	41	44,0 %	51	53,8 %	22	25
7000 Raised bogs and mires and fens	24	2	8,2 %	9	37,5 %	13	54,2 %	5	10
8000 Rocky habitats and caves	10	0	0,0 %	6	60,0 %	4	40,0 %	0	5
9000 Forests	21	0	0,0 %	6	28,6 %	15	71,4 %	5	6
Sum assigned	211	14	6,7 %	79	37,6 %	118	55,7 %	51	60
Measures not assigned to Habitat type	189	25	13,2 %	48	25,4 %	116	61,4 %	38	54
Sum total	400	39	9,8 %	127	31,7 %	235	58,3 %	89	114

The figures in table 3 show that protected-area managers of HABIT-CHANGE investigation areas consider adjustments of their implemented management practices more or less necessary for 44 % of the practices assigned to specific habitat types (“very likely” 6,7 % plus “likely” 37,6 %). Almost 56 % of all habitat specific measures are expected to be effective under climate change without any adaptations. In all habitat-type groups the need for adjustments is expressed for less than half of all the measures (“very likely” and “likely”), only in forest habitats 30 % of the measures are requested to be adjusted. Not for all measures that have to be adjusted detailed suggestions for adjustments were made. For a total of 93 habitat specific management measures the need for adjustments was expressed, but only 51 suggestions on how to adjust the measure were made. Additional measures to support the management of specific habitat types were suggested for 60 measures. For 28 % of all

211 habitat-specific management practices additional management practices were considered necessary to maintain the conservation status under climate change.

The number of measures not assigned to specific habitat types does not differ much from measures assigned to habitat types. For a total of 73 measures (that are 38 % of 189 measures) not assigned to specific habitat types the need for adjustments was expressed (“very likely” and “likely”), but only for 38 measures concrete suggestions for adjustments were made. Almost 62 % of management practices not assigned to specific habitat types are expected to be effective under climate change without any changes. Suggestions for additional measures were made for 54 measures; that are 28 % of all measures in this category.

For all 400 evaluated management practices 89 suggestions for adjustments were made: For every fifth measure suggestions for adjustments were proposed. Additional measures were suggested in 114 cases; that is for 28 % of all 400 measures. These suggestions are a valuable basis for the adaptation of existing management practices in the process of the CAMP development.

For the in-depth analysis of results of the evaluation two different perspectives were chosen:

In chapter 2.1 all measures and evaluations are assigned to categories of strategies, as they were introduced in output 3.3.1. Each category of strategies addresses different protagonists or stakeholders who would be in charge for implementation and have the respective competences. Measures assigned to the same strategy category require similar skills, knowledge and governance.

In chapter 2.2 the measures and evaluations from the strategy category “land and water protection and management” are assorted according to the different habitat-type groups. The objective of that perspective is to develop specific recommendations for each habitat-type group and information that can be integrated into the spatial decision support system (SDSS) in output 5.2.1.

2.1. Results of evaluation regarding strategy categories

The compilation of results of the evaluation regarding different categories of strategies acknowledges that management practices in each strategy category demand different expertise, skills, knowledge of coalitions between different protagonists for implementation. Not all protected areas dispose over sufficient human resources to have experts for the different tasks in each strategy category. Cooperation and collaboration with external experts are essential to develop, plan and implement the specific management practices in each category. To improve the development and implementation of measures in different categories, matching partners, stakeholders and institutions have to be involved and addressed. For example: the adaptation of the legislative framework for protected area management requires entirely different stakeholders than the adaptation of management measures for land and water protection and management. Adaptation needs in each strategy category to be communicated to the relevant target groups with the competence, power and requested knowledge. The presentation of evaluation results regarding different strategy categories is a basis for a specific stakeholder involvement in an adaptation process that has to include all stakeholders somehow involved in nature conservation and protected-area management.

2.1.1. Measures related to “land and water protection and management”

From 400 evaluated management practices 123 can be assigned to strategies related to land and water protection and management. The strategies in this category comprise management practices that are most habitat-specific and vary between each habitat-type group. They include all physical interventions in habitats like constructing sluices, mowing and grazing grasslands or thinning and logging in forest stands. Predominantly responsible for the implementation of measures in this category are protected-area managers and their staff but also farmers that are paid by the park management. Mostly the measures are results of long-time experience and practice within the protected area. The implementation is sometimes hindered by limited financial or human resources or by conflicts with land users inside the protected area. It is expected that adjustments of these practices (except for water management) can usually be implemented directly by the protected-area management and its staff without any extensive planning and research and with limited stakeholder involvement.

Evaluated management practices

Management practices that are subsumed under the category “land and water protection and management” are all measures to control or remove invasive species, measures for habitat restoration, measures for the management of water regime with sluices, drains, channels or locks, measures for water supply, maintenance and development of water quality, fishing control, measures for access control and restriction to some areas, grazing, moving, controlled burning, reed harvesting, removal of trees, shrubs and bushes, thinning, transformation and protection of forest stands.

Almost half of all the measures in this category are expected to be effective even under climate change. For 45 % of all measures some uncertainties about the effectiveness exist, but only for less than 7 % doubts about the effectiveness under climate change prevail. It can be expected that the majority of presently implemented management practices is necessary and effective even under changing climatic conditions to maintain the conservation status of protected habitats. For the 45 % of measures evaluated with “likely” some uncertainties about the effectiveness exist but cannot be predicted precisely. For those 45 % of measures some adjustments or additional measures may be necessary to ensure their effectiveness. It is expected that most of the suggested adjustments can be directly implemented by the protected-area managers and will be described and made mandatory in the climate-change adapted management plans (CAMPs). Some adjustments and additional measures will require stakeholder involvement and cooperation with land users and also with scientists, yet for most adjustments the area managers themselves will have to be responsible.

The detailed analysis of suggested adjustments and suggested additional measures will be discussed in chapter 2.2 separately for each group of habitat types.

Table 4: Evaluation of management practices in category 1: “land and water protection and management”

Habitat-type group	No. of measures in strategy 1	Can the strategy or measure be maintained effectively under climate change?						Are adjustments of measure necessary to maintain effectiveness?			No. of suggested adjustments	No. of suggested additional measures
		very likely	in %	likely	in %	un-likely	in %	very likely	likely	un-likely		
1000 Coastal and halophytic habitats	20	11	55,0 %	7	35,0 %	2	10,0 %	4	3	13	4	2
3000 Freshwater habitats	18	8	44,4 %	9	50,0 %	1	5,6 %	2	4	12	4	2
4000 Temperate heat and scrub	3	0	0,0 %	3	100,0 %	0	0,0 %	0	1	2	1	0
6000 Natural and semi-natural grassland formations	54	24	45,3 %	26	49,0 %	3	5,7 %	2	26	25	14	9
7000 Raised bogs and mires and fens	11	6	54,5 %	3	27,3 %	2	18,2 %	1	4	6	1	9
8000 Rocky habitats and caves	2	2	100,0 %	0	0,0 %	0	0,0 %	0	0	2	0	0
9000 Forests	8	5	62,5 %	3	37,5 %	0	0,0 %	0	3	5	3	1
Sum assigned	116	56	48,7 %	52	44,3 %	8	7,0 %	9	41	65	27	23
Measures not assigned to Habitat type	7	3	43,0 %	4	47,0 %	0	0,0 %	1	1	9	0	1
Sum total	123	59	48,0 %	56	45,5 %	8	6,5 %	10	42	74	27	24

2.1.2. Measures related to “monitoring and planning”

From a total of 400 evaluated management practices 59 can be assigned to the strategy category “monitoring and planning”. Management practices related to “monitoring and planning” require a profound ecological knowledge and scientific support. Planning services are usually offered by external experts that do not belong to the protected-area management staff. Monitoring activities are only partly done by protected-area staff and rangers; very often, the processing and evaluation of monitoring data is supported by research partners. Monitoring and planning require specific knowledge by scientists, researchers or other specialists from outside the protected-area management. The adaptation and implementation of planning and monitoring takes place at the interface between the protected-area management and its staff, as well as scientific institutions or universities and external service providers that either offer monitoring data or concepts for management plans. If adjustments of management practices related to monitoring and planning are necessary a joint cooperation between the protected-area management, planners and researchers is expected to be necessary.

Monitoring and planning is necessary for all habitat types and the protected area in general. Though different habitat types require specific indicators, monitoring is necessary for all habitat types and management practices and is often limited by the lack of knowledge about appropriate indicators and sufficient financial and human resources for permanent implementation. Therefore, in this category it is not necessary to differentiate between different habitat types or habitat-type groups.

Evaluated management practices

Management practices compiled under the strategy “monitoring and planning” include the monitoring and sampling of water quality and water level; meteorological measurements; fish ecological monitoring; vegetation-ecological and invertebrate monitoring; monitoring of migration routes; creation and adaption of a time table for mowing and grazing; development of dry grassland inventory; monitoring of land-use intensity (grazing); monitoring of management effectiveness (grazing and mowing); monitoring of hunting management; assessment of current livestock populations; mapping and monitoring of valuable areas outside protected areas; inventory taking of flora, fauna and main elements of landscape; monitoring of recreational and sportive uses; visitor monitoring; identification of climbing routes and access paths; analysis of alternatives for the construction of new routes; determination of areas appropriate for sport activities; monitoring of anthropogenic activities; development of a GIS database as planning tool; identification of land owners and land use; ornithological monitoring; implementation of research results in the action plans and management; inventory taking and monitoring of traffic and transportation infrastructure and activities; elaboration of the eco-touristic map; participation in projects supporting agricultural, aqua-cultural or touristic development; determination of zones suitable for wind-power production.

The figures in table 5 below prove that almost 75 % of all management activities in monitoring and planning are expected to be effective under climate change and for 61 % no adjustments are considered necessary. For 25 % of all monitoring and planning practices some uncertainties exist and for 39 % of all measures adjustments may be necessary (“very likely” and “likely”). For a total of 23

measures adjustments are required (“very likely” and “likely”), 17 concrete suggestions of adjustments were made and 21 additional measures were suggested.

Suggested Adjustments

Examples for suggested adjustments of already implemented practices are the establishment of more measuring points to improve data; additional monitoring of new indicators; adaptation of the time tables for mowing, grazing, woodcutting and other management activities; additional assessments of needs and opportunities for ecological agriculture and sustainable land uses within the protected area to integrate information in new management plan; integration of new climate-change related content in the master plan for protected area management; additional planning to channel recreational and sportive activities in less sensitive areas; assessment and evaluation of zoning concept to integrate results in a new management plan.

Re-scheduling management activities, the integration of new topics in the management plan and the extension of monitoring activities are the main categories of suggested adjustments.

Suggested Additional Measures

Examples for suggested additional management practices that shall support the effectiveness of already implemented practices in planning and monitoring are the engagement and support by national (state) monitoring institutions to establish an efficient monitoring that cannot be done by protected-area management; more research activities to assess the bearing capacity of managed and used habitats; financing of an adequate human infrastructure to organise and participate in patrolling actions to control hunting and combat poaching; additional research and mapping of protected-area inventory; additional measures and resources for visitor and land-user education and awareness-rising; new partnerships with authorities and land users to establish sustainable land-use concepts and limit anthropogenic activities in some parts of the protected area; new strategic collaborations with different institutions and experts to support protected-area management staff; collaboration across disciplines in planning; development and climate-change projections and models to update management plans; integration of climate-change topics into planning; strengthening the role of agriculture as a provider of ecosystem services; sustainable use of natural resources (water, soil); integration of new regulations for passing and access to the protected area into management plan; integration of new topics into management plan to avoid fragmentation and provide connectivity; integration of measures for maintenance of habitat corridors and reduction of human activities in potential migration corridors into management plan.

The suggestions for additional practices show that climate-change adapted management plans will have to address much more topics and (land-use) pressures in protected areas, and develop additional measures to mitigate impacts of land-use practices. Also, more cooperation and collaboration with scientists, administrations and land users are requested to establish a sustainable land-use management. The requested integration of climate-change data and results of the impact analysis into planning and management plans will be implemented by the CAMPs for some HABIT-CHANGE investigation areas.

Table 5: Evaluation of management practices in category 2: “monitoring and planning”

Habitat-type group	No. of measures in category 2	1) Can the strategy or measure be maintained effectively under climate change?			2) Are adjustments of measure necessary to maintain effectiveness?			No. of suggestions	No. of suggested additional measures
		very likely	likely	unlikely	very likely	likely	unlikely		
1000 Coastal and halophytic habitats	2	0	2	0	0	1	1	3	3
3000 Freshwater habitats	4	4	0	0	0	2	2	3	0
4000 Temperate heat and scrub	0	0	0	0	0	0	0	0	0
6000 Natural and semi-natural grassland formations	10	7	3	0	0	3	7	3	2
7000 Raised bogs and mires and fens	1	1	0	0	0	1	0	2	1
8000 Rocky habitats and caves	3	0	3	0	0	2	1	0	0
9000 Forests	6	4	2	0	0	1	5	1	1
Sum assigned	26	16	10	0	0	10	16	12	7
Measures not assigned to habitat type	33	28	5	0	4	9	20	5	14
Sum total	59	44	15	0	4	19	36	17	21
Percentage of Sum total (= 59)		74,6 %	25,4 %	0 %	6,8 %	32,2 %	61,0 %		

2.1.3. Measures related to “law and policy”

Management practices related to “law and policy” include all kinds of access and land-use regulations and restrictions in protected areas. Restrictions and prohibitions of certain land-use practices like the ban of fertilisers and pesticides or traffic regulations belong to that category as well as contracts with land users in the area. The implementation of those measures is usually controlled by rangers and staff of the protected-area management. The category also includes measures that can only partly be implemented and controlled by the management authorities of the area, such as compensation payments for restrictions in land use, changes in size and shape of the protected area, the designation of new buffer zones around the protected area etc. To enforce legally binding land-use restrictions political authorities and administration should be involved as well as affected groups of land users. If adjustments of measures and regulations in the category “law and policy” are considered necessary an extensive stakeholder involvement is required. Objectives, measures, monitoring of implementation and effectiveness, and possible compensations have to be discussed and decided with all affected parties to ensure acceptance and success. Usually, all land-use restrictions should also be accompanied by educating and promoting measures so that land users get a better understanding of the purpose and need of land-use restrictions and the goals of nature conservation.

Evaluated management practices

Management practices compiled under the strategy “law and policy” include land-use restrictions for framers on state-owned national-park areas; regulatory activities for fishing and combating fish poaching; compensations and subsidies for extensification of land use; contracts with farmers to bring the management in line with aims of nature conservation; prohibition of fertilizers; regulation and control of grazing intensity; restrictions for off-road traffic; access restriction and regulation for visitors, tourists and land users; regulations for the collection of medicinal plants; provincial government subsidies and financing of habitat network; restrictions and limitations of recreational land use and tourism; prohibition of grazing in certain areas; marking of safety zones and buffer area; extension of protected area, new areas, protection of single trees; abandonment of forest use; long-term lease of ecologically sensible areas; facilitating the access of local communities to the financing programmes for the protected areas; supporting the development of ethno-cultural identity of the local population; compensations according to the law offered by the administration of the park for grassland conservation; maintenance of appropriate hunting practices and regulations; controlling activities in caves; establishing and marking camping sites; temporary ban of mountain biking for protection of pathways.

The figures in table 6 below show that almost 74 % of all 72 practices in strategy law and policy are expected to be effective even under changing climatic conditions, for 19 % some uncertainties exist, and only 7 % of these measures are expected not to be effective under future climate. Measures evaluated with “unlikely” refer to the legal framework and regulations that have to be modified, and to access restrictions that may be outdated due to changes in the touristic development.

Suggested Adjustments

Almost 53 % of all measures can be maintained unchanged and for 34 measures (47 %) adjustments are needed though only 17 suggestions for adjustments have been made. Suggested adjustments of existing measures to maintain their effectiveness are broader planning approaches that also consider demands of protected species; the integration of adaptation measures into existing contracts with land users; intensification of fishing regulations and control; more flexibility in scheduling management practices like mowing, depending on winter rainfall; adapting regulations for grazing intensity and seasonal duration of grazing; enforcement of access restrictions; revision of list of medicinal plants that are allowed to collect; change or heighten the protection status of some areas; new directives on adaptation to changes driven by climate change.

Suggested Additional Measures

Additional measures have been suggested for 18 currently implemented management practices (for 25 % of all measures in law and policy). Examples for suggested additional management practices to support the effectiveness of already implemented practices in law and policy are the integration of nature-conservation objectives in programmes and plans of other administrations and spatial planning; coordination and cooperation with different stakeholder and land-user groups in steering committees to avoid conflicts; additional administrative measures like access regulations, prohibition of access outside of marked trails; traffic-speed regulations; special control of waste collection; establishment of information boards; management measures to monitor and assess the conservation status habitats; stronger integration of socio-economic goals and needs of the local population in management plans; additional measures to avoid fragmentation and provide connectivity; regulations to limit number of boats and speed limits for motor boats; monitoring of traffic within the protected area; promotion of new regulations to raise awareness and publicity; more compensatory measures and subsidies for land-use restrictions; establishment of a supervision compartment within the administration of the park; promotion campaigns to improve the understanding of decisions and the importance of measures for biodiversity conservation; more visitor information; development of a traffic concept to reduce traffic within a protected area; additional land-use restrictions for recreational uses like skiing and biking.

At least 25 % of the existing management practices in law and policy have to be backed-up by additional measures to ensure their effectiveness in maintaining a favourable conservation status of protected habitats. Suggestions are aiming at better compensations for land-use restrictions, more information, education and awareness-rising measures, additional land-use restrictions and regulations and better cooperation and coordination between different stakeholders in the area.

All proposed adjustments and additional measures aim to reduce non-climatic pressures on protected areas. None of them can help to mitigate the impacts of climate change directly. But they may help to strengthen the resilience of protected habitats by consequently reducing land-use pressures from farming, fishing, settlement or tourism. The suggested adjustments and additional measures may be effective under current and future climatic conditions and they may be part of an improved management of protected habitats. Their implementation should be supported under all circumstances and climatic conditions.

Table 6: Evaluation of management practices in category 3: “law and policy”

		1) Can the strategy or measure be maintained effectively under climate change?			2) Are adjustments of measure necessary to maintain effectiveness?			3) Are additional measures and strategies necessary to maintain conservation status?	
Habitat-type group	No. of measures in category 3	very likely	likely	unlikely	very likely	likely	unlikely	No. of suggestions	No. of suggested additional measures
1000 Coastal and halophytic habitats	1	1	0	0	0	1	0	1	3
3000 Freshwater habitats	5	4	1	0	4	1	0	0	0
4000 Temperate heat and scrub	1	0	1	0	0	1	0	0	0
6000 Natural and semi-natural grassland formations	22	12	8	2	0	10	12	5	6
7000 Raised bogs and mires and fens	9	7	0	2	1	2	7	2	0
8000 Rocky habitats and caves	1	1	0	0	0	0	1	0	0
9000 Forests	6	6	0	0	0	1	5	1	2
Sum assigned	45	31	10	4	5	16	25	9	11
Measures not assigned to Habitat type	27	22	4	1	4	9	13	8	7
Sum total	72	53	14	5	9	25	38	17	18
Percentage of Sum total (= 72)		73,6 %	19,4 %	7,0 %	12,5 %	34,7 %	52,8 %		

2.1.4. Measures related to “stakeholder and land user, public relation and awareness”

Management practices related to stakeholder and land-user involvement, public relation and awareness include a wide spectrum of different communication activities. Although in the questionnaires some of the measures in this strategy were assigned to specific habitat types where they were implemented in HABIT-CHANGE investigation areas, there actually is no real correlation between habitat types and management activities focusing on communicating goals, objectives and background information of nature conservation. Generally, all measures in this strategy can be effective for the protection of all kinds of habitat types and for the protected area on the whole.

Management practices in this strategy require special skills and knowledge that differ a lot from the skills and knowledge needed for management practices for land and water protection and management (see above). All measures mentioned in this strategy should be part of a comprehensive communication strategy. Main goals of that strategy should be to provide information about the protected area, its goals and values for interested visitors and for affected land users and local communities. On the basis of this information visitors and tourists shall be guided and encouraged to behave regardful and follow the rules of the protected area. Communication with land users and other stakeholders is more difficult because those groups usually oppose against any land-use restrictions that affect their economic basis or traditional habits. Those groups have to be convinced in discussions and personal meetings. The aim is to increase acceptance for goals and measures of nature conservation.

Management practices in this strategy were reported second-most just behind practices for land and water protection and management. A total of 105 measures were assigned to this strategy and evaluated for this report, and that are 26 % of all 400 measures evaluated. This large number shows how important these practices are for protected-area managers. They are the key to reduce non-climatic pressures caused by land use or tourists and visitors.

Evaluated management practices

Management practices reported from HABIT-CHANGE investigation areas and compiled under the strategy “stakeholder and land-user involvement, public relation and awareness” include the intensification of transnational cooperation; provision of infrastructure for visitor information; promotion of sustainable recreational activities; organisation of visitor centres in areas with high touristic afflux; visitor management; environmental education and awareness-raising in villages (school programmes, forums etc.); stakeholder dialogues with land users (farmers) to establish extensive land use; visitor programmes for travelling, guided tours, excursions and hikes; exhibitions, events, installation of info points within the protected area; organisation of a World Heritage Centre; creation and regular update of websites as information and communication platform; development and publication of informative material (leaflets, posters, brochures) with educational character; organizing open-air schools and summer camps; programmes for school-classes: UNESCO schools in the region, educational resource kits; programmes for universities and adult education: excursions, lecture series and articles in media, cooperation with adult education institutions; development and maintenance of educational paths, study trails, nature trail; construction of walking paths;

construction and maintenance of high stands, hides, view towers, info tables, info desks; visitor guidance and channelling by dismantling of ways and streets; complete marking of touristic routes; special bus routes for tourists inside the protected area; support of public transportation and reduction of individual traffic; involvement of the administration in the development and approval of general urban and regional plans for the areas included in the park; construction of simple shelters or refuges for bad-weather conditions along tourist routes; involvement of NGOs in educational programmes for tourists; establish partnerships with authorities, natives and entrepreneurs for a sustainable management; establish partnerships and collaborations with educational, research and public institutions (museums, etc.); promoting the protected-area rules and regulations with billboard signs, posters, leaflets, etc.; schooling and accreditation of guides; publication of informative material (maps, posters, postcards, flyers, videos etc.); involvement of local media in promotional conservation activities; elaboration of a strategy for sustainable tourism; implementation of the eco-touristic certification system; creation of a public database available on the internet to collect information, claims, and suggestions from the civil society; organisation of celebrations of important environmental events such as international-convention anniversary days, founding of a protected area etc.; support of local communities in producing and trading of traditional artefacts or food; participation on forums organised for farmers by agricultural authorities; organisation of events to promote and highlight the local traditions; elaborate and publish an atlas of terrestrial plants.

The figures in table 7 below show that an overwhelming 90 % of all practices in this strategy are expected to be effective under climate change. Only for less than 10 % some uncertainties about the effectiveness still exist (“likely”). Activities in communication, cooperation and education can support nature-conservation goals at all times and under all circumstances, but, of course, the content has to be updated to include climate-change related topics and problems.

Suggested Adjustments

Adjustments of existing practices are considered necessary for 44 % of all measures while 56 % can remain unchanged. The 24 suggestions for adjustments of presently implemented management practices include the relocation of touristic spots and areas that might be affected severely by climate change; updating information on websites and printed info-material to include knowledge about impacts of climate change to show ways to mitigate carbon emissions; adaptation of visitor guidance and channelling according to expected impacts of climate change; construction of more refuges for bad-weather conditions for visitors; new access restriction and closure of areas very vulnerable to climate change; including aspects of climate change in eco-tourism certification and visitor guidelines; including climate change in all educational curricula and programmes; integration of climate-change knowledge into stakeholder and land-user dialogues and negotiations; increasing communication about expected impacts of climate change in all communication-related activities; limitation of the camping areas in vulnerable parts; increasing collaboration across disciplines when planning and developing visitors guidance and information; expanding web-based information.

The suggestions are focused on two main topics: firstly; the information about climate change and its impacts in the protected area have to be made available for all visitors, stakeholders and interested

parties. All existing educational and informative publications and guidelines have to be updated and relevant climate-change information has to be integrated. Secondly, the touristic infrastructure has to be adapted to expected impacts of climate change. Vulnerable areas have to be closed for the public, more shelters for expected heavy weather have to be provided and access restrictions implemented to reduce non-climatic pressures on areas and habitats sensitive to climate change.

Suggested Additional Measures

The suggested adjustments of already implemented management practices have to be supported by additional management activities to ensure the effectiveness of current management strategies under climate change. 29 suggestions were made for measures that could support activities in stakeholder and land-user involvement, public release and awareness.

The suggestions include new coordinated transnational projects with climate-change concern; stricter implementation of management plan regulations; enforcement of park regulations by more rangers; new and additional education programmes; active limitations of touristic development of the area; building new alliances: a network of potential contributors to help implementing the conservation strategy; development of new websites and web-content for protected area; establishing a dissemination network for information material inside and around the protected area; enlargement of protected area management staff; restrictions for touristic activities: limitation of number of boats, speed restriction for motor boats; additional measures to avoid fragmentation and provide connectivity between habitats; active lobbying for green management standards and quality criteria and participation in administrative circles and NGOs; updating and providing data about observed impacts of climate change; adapting of all management strategies to climate change; translation and dissemination of the most relevant documents produced by different international conventions; increasing the focus on socio-economic activities of local communities to integrate climate change topics; monitoring of touristic activities in the protected area; development of a strategic plan for sustainable tourism; increasing of involvement and participation of tourists in research activities and ecological education activities; new research and monitoring programmes to analyse climate-change related impacts and visitor impacts, risk management and vulnerability assessment; adaptation of legislative framework for the Natura 2000 network.

The suggestions for additional supporting management measures cover the whole spectrum of management practices in all different strategies starting from measures in land and water protection and management and ending with more research and scientific investigations. All communicative activities must be supported by valid and accessible information about the protected area, its treasures and the expected impacts of climate change. The main challenge for all practices in this strategy is to translate scientific knowledge into easily understandable information that helps tourists, visitors and land users to adapt their habits and behaviour towards a more sustainable manner. Communicative activities must be supported by regulations, restrictions, a legislative framework, an adapted monitoring concept and new strategies for visitor management. Some of the suggested practices are already implemented in protected areas and have been evaluated under other strategies. The suggestions show that those activities have to be increased and enforced to adapt management to the challenges of climate change.

Table 7: Evaluation of management practices in category 4: “stakeholder and land user, public relation and awareness”

		1) Can the strategy or measure be maintained effectively under climate change?			2) Are adjustments of measure necessary to maintain effectiveness?			3) Are additional measures and strategies necessary to maintain conservation status?	
Habitat-type group	No. of measures in category 4	very likely	likely	unlikely	very likely	likely	unlikely	No. of suggestions	No. of suggested additional measures
1000 Coastal and halophytic habitats	1	1	0	0	0	1	0	1	0
3000 Freshwater habitats	1	1	0	0	0	0	1	0	2
4000 Temperate heat and scrub	0	0	0	0	0	0	0	0	0
6000 Natural and semi-natural grassland formations	4	3	1	0	0	2	2	0	3
7000 Raised bogs and mires and fens	1	1	0	0	0	1	0	0	0
8000 Rocky habitats and caves	0	0	0	0	0	0	0	0	3
9000 Forests	1	0	1	0	0	1	0	0	2
Sum assigned	8	6	2	0	0	5	3	1	10
Measures not assigned to Habitat type	97	89	8	0	14	27	56	23	19
Sum total	105	95	10	0	14	32	59	24	29
Percentage of Sum total (= 105)		90,5 %	9,5 %	0 %	13,3 %	30,5 %	56,2 %		

2.1.5. Measures related to “knowledge and research, science and technology”

Management practices related to knowledge, research, science and technology usually rely on cooperation with and support from external scientific institutions like universities or research centres. In most protected areas the management staffs do not have enough man power and expert knowledge to implement the necessary research works that cover all aspects of biodiversity. The reported 41 management practices in this strategy make up 10 % of all management measures implemented in HABIT-CHANGE investigation areas. The activities cover a wide spectrum from mapping and monitoring studies to specialised and long-term investigations.

Evaluated management practices

Management practices evaluated for this report are research studies on functions (production, regulation, support) and services of fresh-water, brackish and marine deltaic ecosystems; mapping of lake-bed morphology with hydro-acoustic methods; macrophyte mapping of lake bays; hydrological studies; monitoring studies in grasslands and reed communities; research and studies of karstic systems; research on future tourism activities; mapping of bogs; ground-water models; digital elevation model; implementation of research results in the action plans and management; impact assessments; research on the diversity of habitats and species; research on the structure and dynamics of socio-economic and cultural activities; updated maps in GIS; assessment of invasive species and elaborate precautionary measures for their management; selection and formulation of indicators to define the state of ecosystems; detailed studies on the interactions between recreational uses and fauna.

Research activities are often very habitat-specific. 16 out of 41 implemented practices were assigned to specific habitat types or habitat-type groups which may give hints on habitat types where research is needed most because of a lack of knowledge and understanding. But it can also be assumed that knowledge about habitat types and ecosystems is still insufficient so that more research is needed in all ecosystems, especially when it comes to assessments of impacts of climate change.

In the evaluation almost 98 % of all research, mapping and monitoring activities were expected to be still necessary and useful under climate change. Gaining more information and knowledge about protected landscapes and habitats is an urgent task and a basis for the adaptation to climate change. All recent research activities are expected to be needed under changing climatic conditions, too.

Suggested Adjustments

More than 70 % of all research activities can be continued without any adjustments. For 30 % adjustments are “likely” or “very likely” necessary but only four suggestions were made. These include integration of vulnerability assessment into existing research concepts; additional consideration of processes also correlated to climate change in mapping concepts; increasing the frequency of monitoring for bogs to find relations to real climate conditions and climate-change rates. The suggested adjustments basically aim at the integration of climate-change information and data into the research concepts.

Suggested Additional Measures

For the evaluated 41 activities 22 suggestions for additional measures and activities were made. These include additional activities to monitor and assess the conservation status of species and habitats; additional models to predict changes in a lake-river system, point source, and water quality; additional mapping activities; research studies with regard to the potential effects of climate changes; additional impact assessments for climate-change impacts; collaboration with specialised institutions; intensification of cooperation with specialists and authorities; increase of human and financial resources in research; increasing educational and public awareness activities; reinforced implementation of land and water protection and management measures; reinforced implementation of research results in protected-area management; development of technical and human infrastructure in protected areas; involvement of more specialists in the evaluation and monitoring of the species diversity; more assessments of vulnerability and resilience of habitats and species; identification of indicators for vulnerability and resilience of habitats and ecosystems; monitoring of renewable natural resources as a basis of sustainable use.

The suggestions for additional management practices prove that even more research is urgently needed to understand the impacts of climate change on natural systems. Knowledge and understanding of ecosystem processes, vulnerability and resilience are essential for the protected-area management under climate change. Methodological approaches within the HABIT-CHANGE project already provide the necessary information about potential impacts of climate change, but this information still seems to be inadequate. More research is needed for a scientifically based management of protected habitats. Management authorities of protected areas are usually not adequately equipped with scientific staff. Cooperation with universities, specialist and research institutions are essential for the implementation of the suggested research activities. Basis for more ecosystem research is the adequate funding and financing of these activities. Budgets for research are political topics that have to be discussed and negotiated in parliaments and political institutions. Demands to increase budgets and activities in research have to address political and scientific institutions. Protected-area managers can emphasise the need for more research and provide data, infrastructure and support for more research activities. They can also actively approach scientific institutions for more cooperation.

Table 8: Evaluation of management practices in category 5: “knowledge and research, science and technology”

Habitat-type group	No. of measures in category 5	1) Can the strategy or measure be maintained effectively under climate change?			2) Are adjustments of measure necessary to maintain effectiveness?			No. of suggested adjustments	No. of suggested additional measures
		very likely	likely	unlikely	very likely	likely	unlikely		
1000 Coastal and halophytic habitats	1	1	0	0	0	1	0	1	0
3000 Freshwater habitats	5	4	1	0	0	1	4	1	2
4000 Temperate heat and scrub	0	0	0	0	0	0	0	0	0
6000 Natural and semi-natural grassland formations	4	4	0	0	0	0	4	0	5
7000 Raised bogs and mires and fens	2	2	0	0	0	1	1	0	0
8000 Rocky habitats and caves	4	4	0	0	0	4	0	0	2
9000 Forests	0	0	0	0	0	0	0	0	0
Sum assigned	16	15	1	0	0	7	9	2	9
Measures not assigned to Habitat type	25	25	0	0	2	3	20	2	13
Sum total	41	40	1	0	2	10	29	4	22
Percentage of Sum total		97,6 %	2,4 %	0 %	4,9 %	24,4 %	70,7 %		

2.2. Results of the evaluation regarding habitat-type groups

The compilation of results of the evaluation regarding different groups of habitat types is the basis for the habitat-specific adaptation of management practices under climate change. Habitat-specific recommendations are needed for the development of the spatial decision support system (SDSS, output 5.2.1) and for the development of climate-change adapted management plans (CAMPs, output 5.3.1). The following analysis is focused on recommendations for the management of specific habitat types under climate change.

The analysis of reported management practices revealed that only management practices subsumed under the strategy category “land and water protection and management” are habitat-type specific. Although management practices in other strategy categories were also assigned to specific habitat types or habitat-type groups, they are not habitat-specific but could be as well implemented (more or less adjusted) in all other habitat types. In this part of the presentation of evaluation results only measures and management practices assigned to strategy-category “land and water protection and management” are analysed in depth.

2.2.1. Coastal and halophytic habitats (1000)

20 land and water protection management practices were assigned and evaluated to the habitat-type group 1000: “Coastal and halophytic habitats”. Nearly all of them refer to inland habitats. The measures consist of approximately equal shares of the following types of measures:

- hydrologic measures,
- removal or prevention of invasive plants,
- regulation of access by humans,
- regulations for mowing, and
- regulations for grazing.

More than half of all the evaluated measures (55 %) are expected to be effective under changing climatic conditions, too. Those 55 % include the removal and prevention of invasive plants, regulations of access by humans, regulations of mowing and regulations of grazing.

Only two measures (10 %) were no longer expected to be effective under climate change. Those are measures for the management of habitat type 1530 „Pannonic salt steppes and salt marshes“. The first measure impaired by climate change is the removal of invasive species with heavy machines that can work only on frozen soil during the winter. The expected temperature rise in winter and shorter frost periods seem to make this measure impossible in the future. Instead of machines workers will have to do the removal by hand or adapted grazing concepts have to be developed. The second measure probably affected by climate change is grazing with cattle breeds that may suffer from extreme heat and cold. It is expected that our present breeds are not adapted to different climates. As an option for adaptation the change of cattle breeds with more resistance and resilience is suggested.

For seven measures (35 %) some uncertainties about their suitability and effectiveness under climate change still exist. Protected-area managers considered it „likely“ that they can be continued under climate change. Affected are measures for the „maintenance of water regime“ and „water supply“ but also regarding the removal of invasive plants, the prevention of uncontrolled access by humans, mowing, and grazing. These judgements show that water management and the availability of water are connected with uncertainties and possible adjustments very doubtful. The adaptation and adjustment of grazing and mowing to changing climate and weather seems to be easier, and respective suggestions were made.

Eight additional measures and strategies were suggested to support the implemented management practices. Three suggestions can be assigned to the category „law and policy“. Suggested additional measures are: a) the development of national and international conservation strategies for coastal and halophytic habitats because local approaches are insufficient, b) increased involvement of different national ministries to solve land-use problems and enforce implementation of regulations in nature conservation, c) national strategies for the management of invasive species.

To support measures for the maintenance of water regime the development of a national monitoring strategy is suggested. As additional management measures the construction of more locks in drain channels to support the maintenance of groundwater regime is suggested. Also new regulations to allow spring-time floods are demanded to improve the retention of remaining water in hollows until summer.

The implementation of all suggested additional measures requires intensive cooperation and communication with political institutions and land users. They depend on the political support for goals in nature conservation and on professional stakeholder involvement.

2.2.2. Coastal sand dunes and inland dunes (2000)

Although some habitats of habitat-type group 21 „Sea dunes of the Atlantic, North Sea and Baltic coasts (+ Black Sea)“ and 22 „Sea dunes of the Mediterranean coast“ exist in HABIT-CHANGE investigation areas no management practices for those habitat types were reported for output 3.3.1 and for the evaluation in 3.4.1. The habitat types are not in those parts of the investigation areas that were selected for in-depth investigations.

2.2.3. Freshwater habitats (3000)

Three different HABIT-CHANGE investigation areas reported management practices for the sub-group 31 „Standing water habitats“. Although habitat types of sub-group 32 „Running water“ exist in HABIT-CHANGE investigation areas, no management practices for these habitats were reported and evaluated.

The evaluated management measures can be subsumed under the following types of measures: hydrologic measures, maintenance and/or development of water quality, maintenance of natural dynamics and hydrology, water supply, regulation of reed cutting, removal of invasive plants. Approximately half of all 18 measures assigned to „land and water protection and management“ are expected to still be effective under climate change („very likely“). For one third of the practices some uncertainties about the effectiveness under climate change exist. Those are measures that depend

on the available water resources and concern the management of water regime: regulation and rising of water level, water supply, maintenance of natural dynamic and hydrology. The effectiveness of those management practices in obtaining a favourable conservation status of freshwater habitats strongly depends on the actual development of climate change exposure and its impacts on water balance. Since climate scenarios contain huge uncertainties regarding the development of precipitation patterns and sums, the effectiveness of potential management responses is also chained to these uncertainties.

Suggested additional measures to support the effectiveness of the implemented management practices aim to buffer extreme oscillations of high and low-water levels. Suggested is the transition of surface water from other surface waters and rivers during drought periods to raise the water level, though chances for implementation are expected to be very slight. Adaptations in the maintenance of ditches to allow discharge of water were also proposed. To support the management of invasive species, greater contributions and efforts in education and awareness rising are recommended.

Management practices to maintain or improve the water regime in an area affect all land users in that respective area, especially in agriculture and forestry. Those stakeholder groups and their interests have to be involved in the planning and implementation of adapted management practices to convince them of the necessity and to build up acceptance.

2.2.4. Temperate heat and scrub (4000)

Habitats of this habitat-type group exist only in one HABIT-CHANGE investigation area, and only four management practices were reported and evaluated. Measures include the removal of shrubs (manual or by grazing or mowing) that are expected to be “likely” effective under climate change. Controlled burning as an additional management option is discussed critically, and chances for implementation are expected to be very low. The limited number of reported measures and evaluations does not allow any further analysis and interpretation.

2.2.5. Natural and semi-natural grassland formations (6000)

Almost half of all management practices assigned to „land and water protection and management“ are implemented in natural and semi-natural grassland formations in HABIT-CHANGE investigation areas. Two thirds of these 54 management measures consist of regulations for the cultivation of grassland. Grazing and mowing are the most important practices and are reported most frequently. Complementary measures are the manual removal or cutback of shrubs and the burning or removal of invasive plants. The extensification of agricultural practices was also reported but only insufficiently specified by “regulations regarding fertilization” or “regulations for the use of chemical plant protection products”. Another type of management practices aims at the restoration of habitats (e.g. by sowing, enhancement, extensive agricultural practices, natural succession). Very few measures were reported for the restoration of (ground)-water regime and water supply which are implemented only in habitat types of sub-group 64 (“Humid meadows”).

It is remarkable that only very few measures are no longer expected to be effective under climate change (three measures). But for half of all management practices some uncertainties about their effectiveness exist so they were evaluated with “likely”, and a fair amount of adjustments are suggested. Adjustments of frequency and time of mowing, the adaption of intensity or seasonal duration of grazing and the adaption of cattle breeds with higher resistance to extreme weather have

the highest priority (and are easy to implement). The following adjustments are mentioned only once: modified mowing management, adaption of frequency of removal of trees, shrubs and bushes, rotation of crops, adaption of seed mixtures for restoration measures and water retention (relevant in 6400-habitats).

Additional measures and strategies to support the effectiveness of already implemented measures could be the active management of the water regime to buffer the fluctuation of water level during floods, water supply, and retention. Judging by the number of suggestions, additional management practices aiming at the water balance seem to be the most important ones. Also the support of natural succession by the use of cut grass from a „good quality habitat“, and/or by removal of shrubs and invasive plants is recommended just as the protection of grazing cattle from additional extreme-weather shelters.

Adjustments of management practices for natural and semi-natural grassland formations seem - at least partly - easy to implement, depending on the annual weather conditions. All suggested adjustments and additional measures concerning the local or regional water balance in the area require coordinated action with all land users and stakeholders (especially water authorities) affected. Once again: intensified stakeholder involvement and awareness-rising are a prerequisite for the success of all adaptations.

2.2.6. Raised bogs and mires and fens (7000)

Eleven different management practices were reported and evaluated under the strategy “land and water protection and management”. Despite this limited number of presently implemented management practices it is very likely that habitats of this habitat-type group will be heavily impacted by climate change. This expectation is reflected in the high number of suggestions for additional strategies and measures to maintain and improve the conservation status under climate change.

Current management measures in raised bogs and mires and fens basically consist of grazing, mowing and removal or cutting back of trees, bushes, shrubs. These measures can be continued effectively under climate change. Problems are expected regarding the water balance and availability of water. Consequently several adjustments and additional measures for water- management measures are suggested to maintain and improve the conservation status of habitats under climate change: retention, dismantling of constructions for water canalisation, draining, outflow, and additional water supply.

As in all other habitat types the regulation of water balance and strategies for water management require a wide stakeholder involvement and agreements with all land users and authorities affected.

2.2.7. Rocky habitats and caves (8000)

Rocky habitats and caves exist only in two HABIT-CHANGE investigation areas. Only two management practices related to „land and water protection an management“ were reported and evaluated. Both aim at visitor guidance and access restrictions and are expected to be effective (“very likely”) even under climate change.

2.2.8. Forests (9000)

All management practices for „land and water protection and management“ that were reported and evaluated are either assigned generally to the whole habitat-type group 9000 or they are assigned to the sub-group 91 „Forests of temperate Europe“. Although habitat types of sub-group 94 „Temperate mountainous coniferous forests“ exist in HABIT-CHANGE investigation areas, they were not reported and evaluated in the questionnaires.

Only eight of 21 management practices for this habitat type belong to strategies related to “land and water protection and management”. Evaluated were approximately equal shares of measures for the protection of species and habitats (selective thinning, protection of deadwood), silvicultural measures (maintenance of mosaic patterns in older stands, transformation of forests with non-indigenous species to indigenous ones) and measures for the removal of invasive species. Most measures are expected to be “very likely” effective under climate change. Only in habitat type 91E0 “Alluvial forests” uncertainties about their effectiveness under climate change exist for the management measures for “transformation to indigenous species and combat against invasive (forest) species”. It is expected that climate change will boost the spreading of invasive tree species and increased efforts for the preservation of a favourable conservation status are necessary. Although the habitat type “alluvial forest” is especially depending on sufficient water supply, no adjustments or additional strategies concerning the water regime were suggested.

For all habitat types in habitat-type group 9000 “Forests” additional measures to maintain the conservation status are suggested. These include the maintenance or promotion of rare tree and shrub species to enhance the climate-change adaptive potential, the protection of forest edges for seed trees and for antagonists of pest insect species, the removal of tree species that are foreign to habitat types and that hold a higher climate-change adaption.

3. Evaluation of new and additional strategies and measures to cope with climate change

The wide choice of suggested response options for adaptation to climate change was extracted from different publications and journal articles and are compiled in the tables in output 3.3.1, chapter 4. The suggestions prove that adaptation has to be integrated in all possible strategies and activities of nature conservation: from adjustments of the legal framework to educational and scientific efforts to designation and management of protected sites. Adaptation to climate change has to become a comprehensive task for all protagonists involved in the wide field of nature conservation.

Different approaches for the evaluation of suggested adaptations and new strategies are already developed and published for example by Hagerman and Chan (2009), Hagerman et al. (2010) and by Cabeza and Midgely (in: Berry et al. 2008). Those publications provide valuable information on possibilities for the classification and evaluation of suggested adaptation strategies, but they do not focus on the needs, competences and capabilities of protected-area managers and therefore will not be followed up in this chapter.

One goal of the HABIT-CHANGE project and particularly of this output is to identify the possible contributions of protected-area managers to the adaptation to climate change. In view of the development of climate-change adapted management plans (CAMPs) we want to identify those adaptation options that can be integrated into the CAMP or be implemented and tested directly in the respective protected area. Therefore we developed an approach for evaluation that starts from the perspective of protected-area managers. The evaluation of new and additional strategies and measures for adaptation has the objective of singling out those adaptation options that can be implemented by protected-area managers and/or become part of an adapted management plan.

Output 3.3.1, chapter 4 contains lists with a total of 336 suggested strategies and measures for adaptation in nature conservation that were extracted from scientific literature, guidelines and project reports. Strategies and measures were categorised and presented in separate lists for 6 strategy categories:

- land and water protection and management,
- monitoring and planning,
- law and policy,
- stakeholder and land user, public relation and awareness,
- knowledge and research, science and technology and
- species conservation.

Since the focus of the HABIT-CHANGE project lies on the conservation of protected habitats, the suggested strategies for species conservation are not evaluated in this chapter. This exclusion is based on the assumption that all species depend on specific habitat conditions that can be developed or improved by managing the respective habitat types. If a habitat type is preserved in a

favourable conservation status it should provide the biotic and abiotic conditions for the survival of protected species. Other criteria that influence the conservation status of protected species such as functional connectivity or competition between species could not be related directly to protected habitat types and therefore were not included in the evaluation.

In a first step the number of suggestions for new strategies and measures for adaptation was reduced by summarising similar strategies. Similar or closely related strategies and measures were further aggregated to condense their number for the evaluation. A main criterion for the summary was the goal of the strategy: strategies with identical goals were summed up. Also strategies that would require the same kind of management measures for implementation were summarised. That way the suggestions from different authors and literature-sources were summed up to 82 suggested strategies and measures for the evaluation in this chapter.

The evaluation of suggested new strategies for adaptation had to use a methodological approach that is different from the approach applied for the evaluation of already implemented management practices. The evaluation is not done by protected-area managers from HABIT-CHANGE investigation areas but by scientific partners from IOER and TUB. The methodological approach follows the concept of the HABIT-CHANGE project to provide protected-area managers with relevant information for the adaptation of their management activities and management plans. We are mainly interested in new and adapted strategies and measures that can be directly implemented by the managers of protected areas. Therefore the first criterion for evaluation was the target group.

Target group: Does the suggested strategy address the competences and task of a protected-area manager? Can it be implemented directly in the protected area? The first filter or evaluation criteria applied to the list with 82 suggestions asks if the suggested strategies aim at the target group of protected-area managers. Only if this question is answered positively (Yes) the suggested strategies will be evaluated together with the following criterion:

Feasibility: Can the strategy or measure be implemented without changes in the legal framework, without long planning and preparation procedures, without further scientific evaluation? Are they easy to implement because they are detailed enough for implementation? May specific management measures be directly derived from the strategy? Though different criteria for evaluation are summed up in this category the main question is whether obstacles may exist that could hinder the implementation of the strategy or measures and their integration into an adapted management plan?

The evaluation of suggested strategies and measures was based on the knowledge about typically implemented management practices in HABIT-CHANGE investigation areas. Management practices, as they were reported from our investigation areas, represent the range of management practices that are either directly implemented by the management authorities or at least initiated and supported by them. Presently implemented management practices cover the range of tasks and competences that is at hand of the protected-area managements. On this basis the suggested new and additional management practices were evaluated if they follow already implemented strategies and measures and fit into the topical tasks and competences of management authorities.

The list with suggested strategies and measures and with the evaluation results for each suggestion is added to this report as Appendix 1 to make the evaluation transparent and understandable. Appendix 1 also gives a detailed overview on suggested adaptation strategies.

3.1. Results of the evaluation of suggested adaptations in literature

3.1.1. Proposed strategies related to land and water protection and management

Suggested adaptations related to “land and water protection and management” were summarised to 32 different suggestions for strategies and measures. Most suggestions are formulated as strategies on a general level and may imply a set of different concrete management measures that are not specified in the suggestions. Although most suggestions need further specifications before they can be implemented in protected areas they are precise enough to describe the field of action and the kind of required activity.

Whether protected-area managers are directly addressed by the suggested strategy or measures depends on the tasks and executive authority, and competence of protected-area managers which may vary (between) from nation to nation and even (between) from region to region. In some nations protected-area managers may have budgetary power to acquire land and pay compensation funds for land-users, in other nations only regional or national institutions have that competence. For the evaluation we assumed the greatest possible competences and power of protected-area managers. Even if they do not have full competence that may promote, initiate and support the implementation of suggested activities and play a vital role in the process of adaptation.

Knowing that most management practices cannot be planned and implemented by the protected area management without any external support or previous stakeholder involvement, we considered all suggested strategies addressed to protected-area managers which can be initiated by them and thus essential contributions are provided.

From all 32 suggestions related to “land and water protection and management” 30 can be implemented directly or at least initiated by protected-area managers. Those suggestions include (concrete) management practices for the management of invasive species, the reduction of non-climatic threats and pressures, habitat protection and restoration, adaptation of forest stands, carbon mitigation, prescribed burns, adaptation of water management, or visitor guidance. But they also include more abstract or programmatic suggestions such as the maintenance of viable ecosystems, focus on sensitive biomes, restoration of habitat and system dynamics etc. that need further specification and preparation with scientific studies and stakeholder dialogues. Still, protected-area managers can play a vital role in triggering new developments and concepts to prepare the implementation in their protected area. Therefore we consider protected-area managers as a responsible target group of those suggested adaptations.

From 30 generally suitable suggestions for adaptations 25 are considered to be feasible for implementation in the near future and without disproportional preparation costs and efforts. Some suggestions are considered feasible because they concern core tasks and management practices that are already implemented in protected areas. Other suggestions need further specifications but are considered generally applicable by protected-area managers if they are well prepared and coordinated with relevant land users and stakeholders.

The suggested management strategies that are evaluated positively (“Yes”) under both aspects (protected-area managers as target group and generally feasible) define options for adaptations in protected area management that should be compared with already planned and implemented management practices of HABIT-CHANGE investigation areas to identify new and additional response options that were not yet in the focus of protected-area managers. In the process of the development of climate-change adapted management plans (CAMPs) those new and additional response options shall be carefully checked with regard to their integration into the CAMP.

The comparison of suggested adaptations with suggestions for additional management practices suggested by protected-area managers and compiled in chapter 2 of this report, helped to identify those adaptation options HABIT-CHANGE investigation area managers either had not thought of so far or considered as not suitable for their area.

The evaluation of presently implemented management practices in HABIT-CHANGE investigation areas focused on the management of protected Natura 2000 habitats. Strategies for the “protection of natural habitat and system dynamics, ecosystem processes as regeneration and succession” as suggested in literature cannot be applied to these habitat types because in most habitat types natural succession will impede a favourable conservation status.

Proposed adaptations that are in principle suitable for the integration into CAMPs

Most proposed new strategies and measures are not really new to protected-area management. A comparison of suggestions from literature with the list of already implemented management practices in HABIT-CHANGE investigation areas (see chapter 2) shows that most management practices are already being implemented. Management practices going beyond present practices to be considered for the adaptation of existing management plans are:

- 1. Focus on sensitive biomes and vulnerable ecosystems and species:** The prioritisation of management practices for especially sensitive ecosystems and habitats is one main objective of the sensitivity analysis within the HABIT-CHANGE project. On the basis of sensitivity maps and potential impact maps protected-area managers of HABIT-CHANGE CAMP areas will be enabled to increase and intensify their management efforts in those habitats that are considered very sensitive. Results of the HABIT-CHANGE project will help protected-area managers to implement this suggestion from literature.
- 2. Increasing ecosystem redundancy and buffers:** This strategy is difficult to implement in protected areas because it requires the development of new habitats in different parts of the protected area. Sensitive habitats have to be expanded and newly created in areas where they did not exist before. Measures for habitat restoration may help to increase redundancy but they are expensive and time-consuming. Buffers around sensitive habitats are more likely to be expanded but require changes in land-use practices which must be prepared by stakeholder dialogues.
- 3. Facilitate natural (evolutionary) adaptation:** A natural adaptation in protected Natura 2000 habitats may conflict with existing conservation goals. Up to now the main objective of protected habitat management is to maintain a favourable conservation status. If habitats are allowed to adapt naturally to new climatic conditions some key species and functions may disappear. The facilitation

of natural adaptation therefore should be tested first outside protected Natura 2000 habitats to observe in which direction habitats develop.

4. Increase management efficiency: To assess the efficiency of management practices, information about the effectiveness of management practices is necessary but also about invested financial and human resources. To increase management efficiency is a goal that should be pursued generally in protected areas but that does not focus on the management of climate-change impacts. Efficient management is necessary at all times, today and under climate change.

The closer look at the suggested new and additional management practices shows that most of the suggested adaptations are either already implemented in protected areas or adopted and implemented within the HABIT-CHANGE project and especially in CAMP areas. Some other suggestions are more difficult to implement and their potential contributions to an adaptation to climate-change management of protected habitats needs further research.

For the whole set of suggested adaptations and evaluation results please see Appendix 1.

3.1.2. Proposed strategies related to monitoring and planning

Twenty-five different suggestions for adapted management strategies can be assigned to monitoring and planning. Sixteen of them are expected to address competences and tasks of protected-area managers. Thirteen are expected to be feasible without disproportional preparation costs and efforts, though three of them need further specifications. Three proposed strategies are considered not to be feasible because they require extensive scientific information, preparation and long-term planning.

The vast number of suggestions related to monitoring and planning reveals the urgency to increase activities in this category. The monitoring of changes in ecosystems and habitats is the basis for the adaptation of management. Current monitoring activities do not cover climate-induced changes in habitats and ecosystems, but within the HABIT-CHANGE project suitable indicators and monitoring concepts are developed. The integration of climate-related topics into management planning is also considered one of the most important tasks of the project. Consequently the adaptation of management plans and the integration of climate-change related information into the plans is one of the main objectives of the HABIT-CHANGE project that is in a consistent line with the suggestions from literature.

Most suggestions aim at the integration of new methodological approaches in planning and management for protected areas. Suggested are climate-change scenarios, the implementation of an adaptive management, the definition of time-bound and measurable actions or to increase management efficiency. Most of the suggestion can be implemented by protected-area managers as far as they are involved in the planning process and the development of management plans.

The suggested use of climate change scenarios to maximise potential conservation gains is part of the working programme of the HABIT-CHANGE project. Climate change scenarios were used for the impact analysis in work package 3 and 4 and are the basis for the development of climate change adapted management plans.

The suggested proactive adaptation of management and intensification and improvement of management is also part of the HABIT-CHANGE project. The development of CAMPs is based on the concept of an Adaptive Management that aims at the improvement of management practices. The suggestion is actively implemented within the HABIT-CHANGE project in six CAMP areas.

3.1.3. Proposed strategies related to law and policy

Thirteen different suggestions for adapted management strategies can be assigned to law and policy. Only five of them are expected to address the competences and tasks of protected area managers, and only three of those are expected to be feasible for implementation without disproportional preparation costs and efforts.

The suggested expansion of existing and creation of new protected areas, corridors and ecological networks can only be prepared and organised by national and regional institutions with an adequate political mandate. Already existing protected areas usually play only a minor role in the process of designation and protection of new protected areas. The target groups of these suggestions are politicians, political and administrative institutions and NGOs. The same arguments apply to suggestions such as institute government reform, introduction of payment for environmental services schemes, or re-evaluation of capabilities of existing legislation.

Protected-area managers can engage in the suggested expansion of existing and the creation of new protected forest areas as well as the protection of primary forests as far as they are inside their protected area. This requires a change in conservation policies and management or zoning concepts.

3.1.4. Proposed strategies related to stakeholder and land user, public relation and awareness

Seven different suggestions for adapted management strategies can be assigned to stakeholder and land user, public relation and awareness. Six of them refer to competences and tasks of protected-area managers. Only land-use changes and the establishment of sustainable land-use practices in the matrix around protected areas must be initiated by other protagonist than protected-area managers. One main aspect in the suggestions is to increase of interdisciplinary collaboration. New and additional coalitions, partnerships and the intensification of stakeholder involvement are expected to create win-win-solutions in the field of adaptation to climate change. Collaborations are urgent because all land users will have to face the impacts of climate change and develop adaptation strategies. To avoid conflicts and contrary strategies, the planned adaptations of all land users and stakeholders should be coordinated. Basis for coordinated adaptation efforts is the communication of knowledge about climate change (including education programmes for the public). Additional suggestions from literature aim at the integration of mitigation (reduction of carbon emissions) into management activities and the coordination between adaptation and mitigation to avoid conflicts between both tasks. The acquisition of property and new approaches in visitor management are also suggested. If land is owned by public authorities - as, for instance, a protected area - adapted management practices can be implemented more easily because personal and economic interests of land-owners do not have to be considered. Conflicts between nature conservation and land users can be reduced if management strategies are implemented first on property that is owned by the protected area. New approaches in visitor management may help to reduce non-climatic pressures from areas that are very sensitive to climate change.

3.1.5. Proposed strategies related to knowledge and research, science and technology

The five suggestions assigned to knowledge and research, science and technology are addressed at the scientific community. None of them can directly be implemented by protected-area managers, though they may support research activities by providing data from the protected area and collaborating with scientific institutions. The knowledge about ecosystems is still too inadequate for a proper assessment of all the impacts of climate change and a prediction of possible changes. Increased research activities and the development of technical solutions require adequate funding that must be met by political institutions with the budget authority. Protected-area managers can only communicate the need for more research to responsible institutions.

3.2. Relevance of suggested additional strategies and measures for the adaptation of existing management plans

The evaluation of new and additional strategies and measures suggested in literature, namely to adapt nature conservation and protected area management to climate change showed that 57 of the suggested 82 different strategies for adaptation can be implemented or at least initiated by protected-area managers. Only 25 suggestions (30 %) address target groups and protagonists in governmental, scientific or administrative institutions that are responsible for the political and legal framework of nature conservation or for the provision of sufficient knowledge about climate change and its impacts on ecosystems.

Regarding the feasibility of suggested strategies and measures, 10 of the 57 strategies proposed are considered not to be feasible without disproportional efforts. Although the feasibility depends very much on the individual situation of the protected area (human and financial resources, existing collaborations, research activities etc.), the national legislative framework and existing conflicts or cooperation with stakeholders and land-users, the suggestions from literature were evaluated regarding the expected workload and necessary efforts for the implementation.

As a result of the evaluation 47 different suggested adaptation strategies are considered relevant and suitable for an implementation by protected-area managers. Not every strategy may be suitable for all areas, some aim at specific habitat types like coastal or marine or forest habitats. The list with 47 generally appropriate response options to manage the impacts of climate change is an important input for the development of climate-change adapted management plans. CAMP areas have to check every suggestion carefully and decide whether it is suitable and promising for their respective area and if it should become part of the adapted management plan, CAMP. The list of suggested adaptation strategies in Appendix 1 should be used as a checklist for the development of adapted management plans. Each CAMP area should check which of the suggested and positively evaluated strategies and measures can be integrated into the CAMP.

The comparison between the suggested new strategies and already implemented management practices proves that most suggested management practices are already in the focus of protected-area managers and even partly implemented, although not all management practices are implemented in all HABIT-CHANGE investigation areas. Most suggestions related to monitoring and planning are part and content of the HABIT-CHANGE project which includes the use of climate-change scenarios, the sensitivity and impact analysis and the development of adapted management

plans. The intensification of stakeholder involvement is part of the CAMP process, too, but it has to be admitted that is not a well-established management strategy in all investigation areas so far.

Suggestions for adaptations from literature are mostly general strategies that need further specifications to be “translated” into concrete management measures. Management practices reported from HABIT-CHANGE investigation areas are more specific and detailed. Many practices for land and water protection and management are assigned to specific habitat types.

4. Conclusion and recommendations

Profound knowledge about the effectiveness of management practices in nature conservation is essential for an effective and efficient management of protected habitat types in protected areas and to assess the contribution of different practices in obtaining goals and objectives in nature conservation. Unfortunately only very few systematic evaluations of the effectiveness of management measures exist and usually they do not refer to the climatic conditions under which they were implemented. Often they focus on measures for species conservation and not for habitat conservation. Therefore the expert knowledge from our investigation areas was essential to assess the effectiveness of management practices under topical and future climatic conditions.

For the development of climate-change adapted management plans, the already implemented management practices were evaluated to see how effectively they may support the achievement of a favourable conservation status under future climatic conditions. Based on the experience with implemented measures, their suitability for management under climate-change conditions was assessed. The knowledge about the effectiveness of today's management measures was the basis for the assessment of their effectiveness under climate change.

The evaluation by protected-area managers showed that almost 59 % of all management practices assigned to specific habitat types are expected to be successful in the future. Together with measures not assigned to specific habitat types they make up 73 % of all currently implemented management practices. For 36 % of the habitat-type-specific measures and 11 % of not-habitat-type-specific measures there are still uncertainties about the effectiveness. These measures deserve special attention because they may have to be adapted or abandoned. For less than 6 % of the measures assigned to specific habitat types it is expected that they will fail under changing climatic conditions.

The lists with implemented management practices and suggested new and additional strategies and measures shall be used as a „pool“ of possible response options to manage the impacts of climate change. HABIT-CHANGE CAMP areas are asked to check the lists and search for management options that are not yet implemented in their area but were evaluated positively in other investigation areas or recommended in literature. All the implemented management practices are listed in output 3.3.1, and suggested and evaluated adaptation strategies from literature are presented in Appendix 1 of this report.

The CAMPs will help to implement the concept of Adaptive Management (for detailed description please see output 3.2.5 „Toolset for adaptation“), which includes an experimental implementation of different management practices expected to be promising in obtaining the conservation goals. Adaptive Management is an approach to test different management practices and find out which measure is the most effective and efficient under clearly defined and monitored conditions. For some of the presently implemented management practices in HABIT-CHANGE investigation areas there are still uncertainties about their effectiveness under climate change. Asked if the measures can be maintained effectively under climate change those with uncertainties were evaluated with “likely”. If the success and effectiveness is unpredictable, an adapted monitoring programme for the climate-change adapted management plans (CAMPs) should pay extra attention to these measures and

permanently monitor the implementation and the actual effects and impacts of these measures. An adapted monitoring programme is part of the CAMPs and has to include indicators to monitor the conservation status of protected habitats but also of the success of implemented management practices. For all management practices with uncertainties about their effectiveness a monitoring programme to observe the implementation and its effects has to be developed and become part of the CAMP. The results of output 3.3.1 and 3.4.1 are the basis for the selection of management practices that should be implemented and tested in HABIT-CHANGE investigation areas.

When promising adaptation measures are chosen from the lists of potential management responses (see chapter 2 and Appendix 1), protected-area managers have to keep in mind that the impacts of management practices may vary considerably in their effectiveness, depending on local conditions (soil, water-balance, micro-climate etc.) and non-climatic pressures (from land-use or recreational uses). Appropriate management practices have to take local conditions into account, and must integrate only those adaptation options into CAMPs that seem promising under given circumstances.

To develop a monitoring programme that can track changes in the conservation status of protected habitats, observe future climate impacts and to evaluate the effectiveness of implemented management practices, will be one of the greatest challenges for the development of adapted management plans. Besides that, the intensification of stakeholder involvement seems essential for preparing and implementing adaptations that are related to all aspects of water-regime management. Measures to improve the retention of water, to avoid droughts and flooding have to be discussed and coordinated with many land users and authorities. Managing the local and regional water regime is the most effective strategy to mitigate the direct impacts of climate change. Changes in precipitation patterns can only be compensated by measures that manipulate the water regime. No management practices are known to mitigate or compensate the impacts of rising temperatures. Stakeholder dialogues with water authorities and water consumers will therefore be the key for the adaptation to climate change.

Whether the adaptation to climate change in protected areas can be combined with national, regional and local efforts to mitigate emissions of carbon dioxide and other greenhouse gases remains the one open question. Mitigation of greenhouse gases is not yet part of protected area management, though in some areas projects are started (see for example Secovlje Salina Nature Park). Conflicts between adaptation to climate change and mitigation of greenhouse gases can be avoided if both strategies are synchronised and possible effects of off-trades assessed in advance. Some of the suggestions for adaptation from literature suggest an integration of mitigation into protected-area management. We want to encourage protected-area managers to examine to what extent they can integrate mitigation efforts and practices into the climate-change adapted management plans and to seek for win-win-solutions between adaptation and mitigation.

5. Literature

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6. Appendix 1

Evaluation Table New and Additional Strategies and Measures

Proposed Strategies related to land and water protection and management

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
1	Reduce existing non-climate-related threats and pressures from human use (i.e. invasive species, fragmentation, pollution, human-wildlife conflicts)	Yes	Yes (but needs further specification)
2	Aggressively prevent establishment of invasive non-native species, remove them from wetlands if they impair functions	Yes	Yes (but needs further specification)
3	Protect natural habitat and system dynamics, ecosystem processes as regeneration and succession	Yes	Yes
4	Identify and protect current and predicted future refuges from climate change on all scales: acquire necessary land	No (on continental to regional scale) Yes (on local scale)	Yes (examples in literature)
5	Restore habitat and system dynamics, restore forest in protected areas	yes	No, because restoration needs preparation and long term planning

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
6	Restore key habitats and ecosystems and vegetation, that have been comprised or lost	Yes	No, because restoration needs preparation and long term planning
7	Focus on sensitive biomes and vulnerable ecosystems and species	Yes	Yes (but needs further specification especially in terms of sensitivity and vulnerability)
8	Maintain viable ecosystems and populations of species	Yes	Yes (but needs further specification on minimum viable population, minimum habitat size etc.)
9	Mitigation: protect carbon stores within protected areas, limit CO ₂ emissions, adopt and develop low emission management and farming methods	Yes	Yes, depending on sources of CO ₂ within protected area
10	Protect forest catchments	Yes (as far as they are inside protected area)	Yes
11	Select appropriate mixes of species for afforestation	Yes	Yes
12	Establish or strengthen long-term tree seed banks	No	
13	Increase ecosystem redundancy and buffers in both natural environments and plantations	Yes (especially relevant for development and buffer zones, Not for natural and strictly protected areas)	Yes (but needs further specification)

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
14	Facilitate natural (evolutionary) adaptation by using e.g., prescribed fire, silvicultural treatments to shorten regeneration times and promote interspecific competition; promote diverse age classes and species mixes, a variety of successional stages, and spatially complex and heterogeneous vegetation structure	Yes	Yes
15	Reduce stand densities and abating fuels and widely spaced thinning and shelterwood cuts to prevent severe wildfires and insect outbreaks	Yes	Yes (but limited to buffer zones and development areas)
16	Prescribed burns, wildland fires and reduction of fuel loads to prevent catastrophic fires	Yes	Yes (often used in North America, but unusual in Europe)
17	Introduce sustainable, moderate grazing practices in grasslands	Yes	Yes (but needs further specification)
18	Increase wetland protection by adapting water sector and restoration of water regulating services of wetlands, headwater protection, reduction of water extraction and withdrawals, restore natural hydrologic regimes, manage water resources	No	
19	Schedule dam releases to protect stream temperatures, dam flow management for natural flow regime	Yes	Yes (e.g. Grand Canyon National Park also practiced in Saxony)
20	Restoration of riparian and instream habitats, channel reconstruction, floodplain restoration; increase physical habitat heterogeneity in channels, conduct river restoration	Yes (for small water courses)	Yes
21	Protection of thermal refugia and for valued aquatic species at risk to the effects of early snowmelt on river flow	Yes	Yes
22	Removal or retrofit of dams	Yes	No (because it needs scientific information, preparation and long term planning)

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
23	Create wetlands and off-channel basins for water storage and reduction of erosion during high flow periods	Yes	No (because it needs scientific information, preparation and long term planning)
24	Removal of sediment, removal of barriers to upstream migration in rivers and streams	Yes	Yes
25	Plant riparian vegetation, use drought-tolerant plant varieties to help protect riparian buffers and refugia	Yes	Yes
26	Shifting access points or moving existing trails for wildlife or river enthusiasts	Yes	Yes
27	Placement of snow fences to increase snow pack in rocky and mountain habitats	Yes	Yes
28	Protect tidal marshes from erosion with oyster breakwaters and rock sills	Yes	Yes
29	Preserve and restore vegetation in tidal marshes, seagrass meadows, and mangroves, restore estuarine habitats with room for retreat as sea level rises	Yes	Yes (e.g. Škocjanski Zatok Nature Reserve)
30	Remove structures that harden the coastlines, impede natural regeneration of sediments, and prevent natural inland migration of sand and vegetation after disturbances, prohibit bulkheads and other engineered structures on estuarine shores	Yes	Yes (e.g. Waden Sea NP/Sylt)
31	Maintain landscape complexity of salt marsh landscapes, maximize habitat heterogeneity in marine protected areas, protect full breadth of habitat types	Yes	Yes
32	Replicate habitat types in multiple areas	Yes, if in same protected area	No, requires preparation and long-term planning

Proposed strategies related to monitoring and planning

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
1	Use climate change scenarios to maximise potential conservation gains, to foresee impacts on protected areas and to develop best management practices; introduce effective forecasting of climate trends and population ecological modelling to protected area staff	Yes	No (because it needs scientific information, preparation and long term planning)
2	Use predictive models to decide where to situate new protected areas and to anticipate major changes, improve predictive capacity by addressing scale problems	No	
3	Make management experiments to improve adaptive management; use flexibility in the planning guidelines and explore new management models to develop management actions and maximise effectiveness; implement stabilising measures;	Yes	Yes (but needs further specification)
4	Support incremental learning and gradual achievement of management goals	Yes	Yes
5	Proactively adapt management: practice adaptive management with a portfolio of approaches and options for flexibility, choose culturally appropriate options	Yes	No (because it needs scientific information, preparation and long term planning)
6	Adaptive planning and management to improve the matrix around reserves; manage the matrix (outside protected areas), increase permeability of landscapes	No	
7	Intensify and improve management, define time-bound and measurable actions plans, prioritise actions, increase management effectiveness, conduct integrated management of nutrient sources	Yes	Yes
8	Increase management efficiency by using a management effectiveness assessment framework and building management capacities	Yes	Yes

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
9	Modification of management plans: integrate predicted climate change and its impacts into planning, adopt long-term and regional perspective in planning, modelling, impact assessments and management, develop adaptation strategy now, quantify potential impacts and adaptive capacity for conservation planning, focus on mitigation and adaptation	Yes	No (because it needs scientific information, preparation and long term planning)
10	Increase and maintain basic and long-term monitoring programs, monitor ecosystems, ecotones and gradients, develop and integrate climate change and key indicators into monitoring programmes to monitor future changes in climate and ecosystem responses, use monitoring results to design adaptive management strategies	Yes	Yes (but needs further specification)
11	Increase interdisciplinary collaboration; establish broadscale planning at national and regional and transboundary level in the context of disaster risk management plans, assess the role of ecosystems in disaster prevention; establish collaboration with local communities and indigenous peoples in and around protected areas	No (for national and regional level) Yes (for local level)	Yes (but needs further specification)
12	Re-asses conservation goals and adaptation measures; consider costs and benefits of adaptation measures in the context of the likelihood of success; Establishing baselines for key conditions and species against which to measure future changes	Yes	Yes (but needs further specification)
13	Assess the suitability and effectiveness of existing management tools and mechanism under climate change	No	
14	Develop guidelines for climate sensitive restoration and for adapting protected area management strategies, use simple decision rules for reserve planning; develop and refine methodologies for site management under climate change; develop guidelines for funding options for protected areas	No	
15	Review timing of management activities, have rapid-response strategy prepared to assess ecological effects of extreme events as they occur	Yes	Yes
16	Planning and implementing control measures against harmful invasive species and procedures for translocation of species that cannot move quickly enough	Yes	Yes

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
17	Do vulnerability assessments: determine objectives and scope, gather relevant data and expertise, assess components of vulnerability, apply assessment in adaptation planning; Identify audience, user requirements, and needed products; engage key internal and external stakeholders; establish and agree on goals and objectives; identify suitable assessment targets; determine appropriate spatial and temporal scales; select assessment approach based on targets, user needs, and available resources;	Yes	Yes
18	Gather relevant data and expertise: review existing literature on assessment targets and climate impacts; reach out to subject experts on target species or systems; obtain or develop climatic projections, focusing on ecologically relevant variables and suitable spatial and temporal scales; obtain or develop ecological response projections	Yes	Yes
19	Assess components of vulnerability: evaluate climate sensitivity of assessment targets; determine likely exposure of targets to climatic/ecological change; consider adaptive capacity of targets that can moderate potential impact; estimate overall vulnerability of targets; document level of confidence or uncertainty in assessments	Yes	Yes (Sensitivity maps, NatureServe Climate Change Vulnerability Index)
20	Apply assessment in adaptation planning: explore why specific targets are vulnerable to inform possible adaptation responses; consider how targets might fare under various management and climatic scenarios; share assessment results with stakeholders and decision-makers; use results to advance development of adaptation strategy and plans	Yes	Yes
21	Develop assessment methods to measure the value of wider protected area benefits; assess cost benefits of different adaptation options; develop methodologies to factor the potential for mitigation and adaptation within protected areas; improve methods for protected area effectiveness assessment to include mitigation and adaptation; develop methods for calculation carbon trade-offs between different management strategies; assess and redefine existing certification schemes to address issues of climate change within certification	No	
22	Assessment of environmental and social impacts of climate change	No	

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
23	Avoid conflicts between CO ₂ mitigation and nature conservation	No	
24	Protect natural peat by protecting entire watersheds that feed into peat areas	No	
25	Link the management of protected areas and buffer zones into land use planning and management systems at landscape level which manage economic activities	No	

Proposed strategies related to law and policy

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
1	Increase number and size of reserves, establish new small and large strictly protected areas in predicted ranges and in areas of high heterogeneity and high resistance to climate change, linear reserves oriented longitudinally, new protected areas for generally underrepresented freshwater and marine biomes and mountains and ecological units	No (regional to national level)	
2	Secure existing preserves, extend and redesign protected area system	No (regional to national level)	
3	Expand existing and create new protected forest areas, protect primary forests	Yes, if forests are already inside protected area	Yes

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
4	Create and expand networks: Connect protected areas with buffer zones, corridors, stepping stones, flexible zoning around reserves Improve functional connectivity of protected areas by reducing fragmentation, removing barriers for dispersal, establishment and maintenance of wildlife corridors	No (mostly relevant outside protected areas, but could have application for special habitats)	
5	Land acquisition around rivers to enable restoration	Yes	Yes
6	Manage water resources and human stressors such as overfishing and excessive inputs of nutrients, sediments, and pollutants	Yes	Yes (but needs further specification)
7	Establish dynamic marine protected areas	No	
8	Choose conservation policies that engage local users; use multiple designations and management approaches, implemented with prior informed consent by local communities	Yes	No
9	Institute government reform, enhance capacities to address climate change, Create institutional flexibility, Augment the workforce and stretch budgets to institute adaptation practice	No	
10	Improve support for interdisciplinary, multi-institutional research, Add climate change expertise; train resource managers and other personnel in climate change science; Ensure effective management of protected areas	No	
11	Re-evaluate capabilities of existing legislation; Drafting legislation to accommodate potential change	No	
12	Introduce Payment for Environmental Services schemes, Incorporate the role of protected area systems into national climate change strategies and action plans; Address mitigation by reducing the loss and degradation of natural habitats	No	

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
13	Ensure strong political support for the maintenance and expansion of protected areas	Yes	No (because this is a long term effort)

Proposed strategies related to stakeholder and land user, public relation and awareness

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
1	Increase interdisciplinary collaboration; increase collaboration with agricultural sector; improve inter-agency, regional coordination and multi-sector approaches at different scales; work with watershed coalitions; leadership by those with power, senior management, government agencies; establish cross-national collaboration; create coalitions and partnerships; implementation of the full range of governance types to encourage more stakeholders to become involved in declaring and managing protected areas	Yes	Yes (but needs further specification)
2	Create education programs for public about land-use practices and effects on and with climate to raise awareness; provide education opportunities for management staff to learn and network about climate change; use social networks for education about climate change	Yes	Yes
3	Assure involvement of stakeholders: Increase communication of knowledge about climate change impacts to policymakers and stakeholders; initiate dialogue among stakeholders; increase social acceptance of shared resilience goals, identify management authorities/agencies with similar goals, share information and create coalitions and partnerships; inform public and promote consensus-building on tough decisions; invite input from a broad range of sources to generate buy-in across stakeholder interests; use minimum standards for stakeholder consultation and active involvement in REDD schemes	Yes	Yes (but needs further specification)
4	Promote personal action plans among employees to reduce emissions; manage park service and visitor use practices to prevent people from inadvertently contributing to climate change = reduce emissions	Yes	Yes (but needs further specification)

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
5	Soften land-use practices in the matrix around protected area; improve the matrix surrounding the refuge by partnering with adjacent owners	No	
6	Acquire property for system expansion	Yes	Yes (but needs further specification)
7	Introduce new approaches for visitor management	Yes	Yes

Proposed strategies related to knowledge and research, science and technology

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
1	Improve modelling and analysis capacity, integrate multiple global change drivers; validate model results with empirical data; predict effects of climate change on ecosystems, communities, populations; practice proactive research on climate change; study social agency and human decision making; evaluate policies that use historic conditions; develop methodologies to identify carbon storage and sequestration potential; manage research activities to make information readily available to protected-area managers; assess goods and services offered by protected areas; assess the tradeoffs associated with protected area management adaptation measures; do research on carbon sequestration in grasslands and on insect borne diseases; use the paleological record and historical ecological studies to identify environments buffered against climate change	No	
2	Improve restoration techniques for wetlands, rivers and the matrix	No	
3	Increase investment in climate related research; train more taxonomists;	No	

No.	Description of suggested management strategies or measures	Protected-area managers as target group? (Yes/No)	Feasible (Yes/No)
4	Study ecotones and gradients; Study effectiveness of corridors; study processes of change at multiple spatial and temporal scales; study changes in populations; study response of undisturbed areas	No	
5	Undertake management training: to plan for climate change; provide detailed training for managers and rangers covering technical, managerial and social issues; work out the best management strategies for carbon storage	No	