How much Wilderness is left in Europe's Wilderness Areas?

A Comparative Analysis of Selected Wilderness Areas in Central Europe

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Declaration

I hereby declare that the work in this master thesis is the result of my own investigation. Wherever contributions of others are involved, every effort is made to indicate this clearly. The work has further not been submitted to any other institution in any form.

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Graz, May 30th, 2017

Preface and Acknowledgements

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Abstract

The present thesis analyses various definitions of wilderness, as well as their applicability in Europe. The organisations behind these definitions work with different backgrounds and strategies, leading to a variety of interpretations what wilderness actually is, not just in theory but especially in the field.

The definitions in use in Europe categorise wilderness in two stages according to various factors, such as the extent of past and present human activities, time or size. The analysis of four selected wilderness areas in Central Europe, based on a self-developed categorisation framework, tries to find out if such a theoretical categorisation of wilderness and its dynamics can be applied in practise.

The four presented areas mainly differ in their history of usages and the consequences for nature arising from them. Despite of, for example, clear cuts for the iron production hundreds of years ago or decades of usage as a military training ground until the fall of the Iron Curtain, today all areas show characteristics of wilderness. This underlines the power of nature if it is granted enough time and space as well as no intervention in its processes. The arising challenges and conflicts coming along with wilderness protection, or rather non-intervention management, which is essential for it, will be addressed as well. Focus will be put on densely populated and economically heavily used regions such as Austria and Germany. A critical discussion of the most important aspects of wilderness protection in Europe will form the end of this thesis.

Zusammenfassung

Die vorliegende Arbeit analysiert Definitionen von Wildnis, sowie deren Umsetzung, in Europa. Die Organisationen, die hinter diesen Definitionen stehen, arbeiten mit unterschiedlichen Hintergründen und Strategien, was eine Vielzahl an Auslegungen, was Wildnis letztendlich ist, nicht nur theoretisch sondern insbesondere in der Praxis, zur Folge hat.

Die Definitionen, welche in Europa Anwendung finden, teilen Wildnis anhand verschiedener Aspekte, wie das Ausmaß vergangener und derzeitiger menschlicher Aktivitäten, Zeit oder Größe, in zwei Stufen ein. Ob eine solche theoretische Unterteilung der Dynamik von Wildnis der Praxis gerecht wird, versucht diese Arbeit anhand einer selbst erstellten Kategorisierung herauszufinden, auf Basis derer vier ausgewählte Wildnisgebiete in Mitteleuropa analysiert werden.

Die vier präsentierten Gebiete unterscheiden sich besonders anhand ihrer Nutzungsgeschichte und den daraus entstehenden Folgen für die naturräumlichen Gegebenheiten. Trotz Kahlschlägen zur Eisengewinnung vor hunderten von Jahren oder einer jahrzehntelangen Nutzung als Truppenübungsplatz bis zum Fall des Eisernen Vorhangs, weisen heute alle Gebiete Wildnischarakter auf und unterstreichen damit die Macht der Natur wenn ihr ausreichend Zeit und Platz eingeräumt sowie nicht in ihre Prozesse eingegriffen wird. Die auftretenden Schwierigkeiten und Konflikte, die mit Wildnisschutz beziehungsweise Prozessschutz, welcher dafür ausschlaggebend ist, in dicht besiedelten und wirtschaftlich stark genutzten Regionen wie Österreich und Deutschland einhergehen, werden ebenso näher beleuchtet werden. Eine kritische Diskussion der wichtigsten Gesichtspunkte von Wildnisschutz in Europa bildet den Abschluss dieser Arbeit.

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List of Abbreviations

BOKU	University of Natural Resources and Life Sciences
BFN	German Federal Office for Nature Protection
BMLFUW	Austria Federal Ministry for Agriculture, Forestry, Environment and Water management
CDDA	Common Database on Designated Areas
EU	European Union
EWS	European Wilderness Society
EWQA	European Wilderness Quality Standard and Audit System
NGO	Non-Governmental Organisation
NP	National Park
NSG	Naturschutzgebiet (Nature Reserve)
ÖBF	Austrian Federal Forestry Office
OÖ	Oberösterreich
PAN (Parks)	Protected Area Network (Parks)
WWG	Wilderness Working Group
WWF	World Wide Fund For Nature

List of mentioned plants and animals

Animals:

English	*German*	*Scientific term*
bark beetle	Borkenkäfer	Scolytinae
bat	Fledermaus	Microchiroptera
chamoix	Gams	Rupicapra rupicapra
eagle	Adler	Aquila
German heath	Heidschnucke	Ovis ammon f. aries
ibex	Steinbock	Capra ibex
lynx	Luchs	Lynx lynx
red deer	Rotwild	Cervus elaphus
roe deer	Rehwild	Capreolus capreolus
ural owl	Habichtskauz	Strix uralensis
vulture	Geier	Aegypiinae, Gypaetinae, Cathartidae
wild boar	Wildschwein	Sus scrofa
wolf	Wolf	Canis lupus
woodpecker	Specht	Picidae

Plants and plant communities:

English	*German*	*Scientific term*
alpine meadow	Almwiese	–
alpine pasture	Alm, Almweide	–
beech	Buche	Fagus
heather	Heidekraut, Heide	Ericaceae
larch	Europäische Lärche	Larix decidua
mire	Moor, Sumpf	–
mugo pine	Bergkiefer, Latschenkiefer	Pinus mugo
spruce	Gemeine Fichte	Picea abies
swiss pine, swiss stone pine	Zirbenkiefer, Zirbe	Pinus cembra
wooded pasture	Waldweide	–

1. Introduction

1.1. Problem Formulation

Wilderness and its protection seem to be a universal remedy against climate change and other man-made or natural threats nowadays. The terms wilderness, rewilding and restoring became fashionable during the last years and can be found, to some extent, on the agenda of every international nature protection organisation (IUCN, WWF, EU). However, even with this new focus on wilderness, the definition of the term per se remains controversial, as it knows a broad variety of definitions and interpretations depending on regional and cultural background as well as language and purpose. These differences in definitions make it difficult to choose an appropriate one for protecting reasons. And although the protection of wilderness or wilderness-like areas is dealt with in several nature protection legislations, such as the Natura 2000 network and the IUCN categories, they often just touch the surface of the topic, cover just parts of its aspects or even interrupt the development of wilderness to secure a favourable conservation status (EUROPEAN UNION 2013; IUCN 2017 a; IUCN 2017 b).

The discussion on how to adequately define wilderness and consequently on how to protect it is often based solely on a scientific foundation. But as, in the end, wilderness is a social construct that only results from the contrast with cultivated land, the emotional aspects which arise from this contrast should be taken in account as well.

Various papers and authors, such as AYKROYD, T. (2013) or LUPP, G. et al. (2011), already dealt and deal with this controversial topic of defining and differentiating wilderness. These discussions often lead to a categorisation of wilderness depending on various factors such as the extent of past and present human activities, time or size. The question whether a dynamic process like wilderness can or should be categorised, forms the starting position for this thesis.

An internship at the European Wilderness Society during the summer of 2015 raised various questions concerning the similarities and the differences of Europe's Wilderness areas. In particular, the different influences of past and present human activities brought up the question of differing "qualities" or categories of wilderness. As the concept of primary and secondary wilderness is reaching its limits in Europe a closer look will be taken on the classification of wilderness and wild areas in chapter 2.2.1. This categorisation was introduced by the Wilderness Working Group, a subgroup of the Wild Europe Initiative, and further taken on by the European Wilderness Society, which subdivided it into four labels to distinguish different wilderness qualities. A critical exposition of these concepts and their underlying definitions will form the basis for the final discussion on their applicability in a

European context in chapter 3 and 4. This discussion will be complemented by a self-developed concept of wilderness categories based on which an attempt to compare four selected wilderness areas in Europe will be carried out.

1.2. Research questions

To confront and moreover clarify the problems formulated in the previous chapter, the following research questions have been formulated. These questions will be discussed and answered in the course of this thesis:

- How is wilderness defined in global and European contexts?
- Which categories and phases of wilderness can be distinguished in Europe? What are the differences between them and does it make sense to differentiate between them?
- Which categories and phases can be found in Europe and how do these wilderness areas differ from each other? Which aspects do they have in common?

1.3. Methodology

The basis of this thesis is a comprehensive literature research, which adequately outlines the topic of wilderness protection and clears up definitions and terms. Further information and insights were gathered during guided interviews, carried out via phone or Skype, with several experts in the field of wilderness and environmental protection:

- *Max Rossberg* B.Comm, MMS - Chairman European Wilderness Society
- *Ing. Vlado Vancura* - Deputy Chairman European Wilderness Society and Director of Wilderness Development at the European Wilderness Society
- *Mag. Dr. Michael Jungmaier* - founder and head of E.C.O. Institute for Ecology,Head of the international Master Programme "Management of Protected Areas" at the Alpen-Adria University of Klagenfurt
- *DI Dr. Christoph Leditznig* - director of the Wilderness Dürrenstein
- *Dr. Erich Mayrhofer* - manager of the National Park Kalkalpen and Kalkalpen Wilderness

Building up on the theoretical foundation, a categorisation framework for four selected wilderness areas in Central Europe was elaborated. This framework organises wilderness in three categories and deals with the natural features, the current and past human interventions and their effects inside and outside the wilderness areas, with the

management, the size and zoning of the wilderness areas, as well as with the international relevance and implementation in national and international environmental protection legislations. The factor time will be considered here as well. The areas were chosen due to available data and their different designations as wilderness areas. These bullet-points, as well as their differences and their similarities will be critically discussed for all four areas.

1.4. Delimitation of the Topic

Only definitions of wilderness for protective purposes and applicable in the European context are taken in to account for this thesis. Consequently, this thesis does not offer a complete list of available definitions on wilderness and wild areas or similar, just an overview. Furthermore, not all available concepts dealing with subtopics, such as naturalness and its measuring will be dealt with, as this would go beyond the scope of this thesis. The definitions and concepts presented were chosen due to their importance and applicability in Europe. The four wilderness areas chosen for the comparison analysis in chapter 3 were selected due to the availability of comprehensive data as well as for the presence of a contact person.

2. Analysis of the term Wilderness

2. 1. The controversy of the term wilderness

2.1.1. Conversion and varieties of the social perception of wilderness

What we think of when we talk about wilderness strongly depends on where we come from, geographically and culturally, which language we speak and in which context we use the word (LUPP, G. et al. 2011). But most of all it depends on our personal point of view about nature and culture what we personally think is natural and what is not. Moreover the emotions arising from wilderness, or simply what we feel when we are confronted with something "wild", strongly shape how we feel about protecting it. While someone might find wilderness exciting, romantic or worthy of protection, someone else might find it frightening, intimidating, dangerous or futile. Such negative feelings towards wilderness are deeply rooted in the history of mankind as humans tried to defend and assert themselves against nature and its uncontrolled processes to guarantee their surviving for thousands of years. Therefore it can be seen as a great cultural achievement of our civilisation's evolution that we give value to wilderness again and allow it to be and to develop (WWF Österreich 2016).

It takes not only a lot of self-confidence and courage to take the risk of preserving wilderness but also strong commitment, as it demands a long-term vision and no compromises. The decision to preserve wilderness and to let wilderness develop is also founded on hope, as we believe that preserving pristine nature, as well as stopping to interfere in nature might help us to slow down climate change and its effects or even reverse some of them and in the end "save" nature and consequently us (KUITERS, A.T. et al. 2013 a, EUROPEAN UNION 2013). But this just proves again that humans think nature needs them to survive. So, indubitably, a bad conscience plays a role here too.

But as our cultural and geographical background, as well as our feelings determine what we think wilderness is, what is it in a conservation context? In German the word "wild" means something wayward, self-determined or uncontrolled, but is also associated with something looking messy (LUPP, G. et al. 2011; Umweltverband WWF Österreich, 2017 a). Therefore not only a landscape, where nature can function self-determined and uncontrolled by humans can be called wilderness but also an abandoned garden or a factory site. So despite numerous definitions what wilderness could or should be, in the end it is like MURRAY (1968) assumed: "Wilderness is what men think it is" (In: HUBER, M., JUNGMAIER, M. 2016).

However, as we talk about wilderness in a conversation context, it is necessary to find a way to differentiate wilderness or at least to define what is not wilderness. By doing this, we realise that wilderness, as an untouched natural landscape, only works in contrast with its counterpart: cultivated land, such as farmland or cities. Only this comparison lets wilderness

exist. Untouched nature, without any human action or consideration, would exist without any value (LEDITZNIG, C., PEKNY, R., 2011). This makes wilderness a place of desire and imagination, which cannot be explained by purely rational definitions. This "myth" of wilderness is in contrast with rationalism and creates a reality which can be experienced by humans (BELLINGER, G., 1989; LUPP, G., 2002).

If we simply see wilderness as the opposite of cultivated land, it would be an area governed by undisturbed natural processes without any human activities. The term undisturbed refers to anthropogenic interventions and influences but its specific meaning stays an subjective one. Together with air and water pollution, as well as nutrient input and the intense exploitation of fossil energy sources, no place on earth is still truly undisturbed. Consequently this kind of wilderness cannot be found on earth anymore (LEDITZNIG, C., PEKNY, R., 2011). Even newly emerging territories, such as glacier forefields or volcanic islands, which are seen as the only true primary wilderness areas on earth by some environmentalist, are exposed to these formerly mentioned far-reaching human influences. The discussion that areas like glacier forefields result from the man-made climate change goes even further and opens up the discussion - what is still unimpaired by humans? Even the composition of animals and plants has been influenced by humans for thousands of years as we decided to hunt, domesticate or eradicate some species but spare others (LEDITZNIG, C., PEKNY, R., 2011). These decisions had equally far-reaching and long-term impacts on nature as the man made air and water pollution.

If we want to define wilderness on the basis of nature we have to confront ourselves with what exactly nature is and what not and if it does include humans and their actions or not. This discussion is essential, not only for wilderness and its protection, but for the protection of nature in general. Elaborating on it, however, would be too extensive for this thesis.

But with this in mind, definitions of wilderness need to be clear with what they expect wilderness to be or not to be and which parts humans are allowed to play in it.

The ideal case would be that humans do not intervene at all and just observe. But as unhindered processes in wilderness areas have unexpected outcomes and consequently also influence their surroundings, a lot of conflicts can arise and interventions to a certain extent may become necessary. To define what exactly "a certain extent" is lies, again, in human hands and demands a professional expertise as well as sure instinct (PEKNY, R., LEDITZNIG, C., 2009).

On the other hand, under specific conditions human interventions might even be essential to create wilderness. Putting areas out of use, no matter if near-natural ecosystems or heavily used by humans, is a first step to recreate wilderness or wilderness-like areas but might need specific restoring interventions to lead such areas to a self-determined development. The time spans necessary to re-establish wilderness in such areas most certainly exceeds

our own lifetimes, but makes these potential wilderness areas not worth any less, compared to already existing wilderness. Consequently, it could be claimed that already the decision to leave areas to their own and to not intervene anymore creates wilderness (LEDITZNIG, C., PEKNY, R., 2011; Umweltverband WWF Österreich 2017 b).

With all these things in mind, what does wilderness mean on a densely inhabited and heavily utilised continent like Europe? TROMMER (1997), cited in HUBER, M., JUNGMAIER, M., (2016) p. 2, calls "the European wilderness mainly a cultural phenomenon being a contrast to civilization". But even if we see wilderness as a cultural phenomenon, its conservation asks for a more individual definition and a concept that "reflects the current natural and spatial conditions as well as the cultural context" (HUBER, M., JUNGMAIER, M. 2016, p. 2). Though there are several definitions for wilderness available in Europe, LUPP, G. et al. (2011) p. 567 stated that the discussion in particular lacks a spatial definition, which can be seen as an "indication for strong ethical and religious, educational as well as cultural motifs in the demand for wilderness." LUPP, G. et al. (2011) p. 597 further conclude that wilderness is more a "state of mind" (NASH, R. 2001) and, as already mentioned, a "mental construct" (VINCENZOTTI, V., TREPL, I. 2009). This leads us back to wilderness being a place of desire and imagination and points out very clearly that this emotional approach has to find a place in the generally scientifically based definitions of wilderness.
Wilderness is therefore best examined by an interdisciplinary approach, combining biological and social, as well as emotional elements (BORZA, E., VANCURA, V. 2009). Numerous authors and organisations have developed definitions and concepts of wilderness, some more multidimensional than others, but the discussion about the designation and differentiation of wilderness, as well as the role humans play there is still a controversial one.

2.1.2. Wilderness protection in a historic context

When thinking about wilderness, we rather have pictures of untouched and wide landscapes somewhere in Canada, Siberia or Africa in our heads than of Central European forests. This can be partially traced back to the development of the term "wilderness" by experiencing the pristine landscapes of the New World since the 16th century as a counter-pole to the cultivated landscapes of Europe. These untouched landscapes were therefore granted an aesthetical and ethical value by writers, artists and painters who advocated their protection (LUPP, G. et al. 2011).
The idea of wilderness formed the basis for the designation of the first National Parks in North America in the second half of the 19th century (Yellowstone National Park 1872). The focus of these first protections were the aesthetic qualities and recreational opportunities of the parks (LUPP, G. et al. 2011).

John Muir, a Scottish naturalist and preservationist, brought in a more integrative approach including fauna and flora as well as geological features (NASH, R. 1989; MEYER, J.M. 1997). After that, Aldo Leopold, an American author, scientist and environmentalist, suggested a more holistic protection concept in his "land ethic", which includes not only all living creatures but also soil and water. He emphasised the intrinsic value of protecting nature as such and in particular to protect unchanged nature (LEOPOLD, A. 1948; NASH, R. 1989). These ideas and approaches resulted in the US Wilderness Act of 1964 (BUNDESAMT FÜR NATURSCHUTZ 2016; LUPP, G. et al. 2011).
The first designated wilderness areas in North America still shape our understanding of wilderness. Most people, as well as most international definitions, think of primary wilderness, meaning no signs of human activities, when talking about wilderness. Even though we know that North America had been shaped by humans before the Europeans settled there. However, it is important to mention that this idea of wilderness is built on and can only be perceived in contrast to man-made cultivated landscapes and is therefore a human mental figure (BUNDESAMT FÜR NATURSCHUTZ 2016; LUPP, G. et al. 2011).

Even though the term wilderness per se is not new to Europeans, wilderness as a concept for nature conservation in Europe just gained momentum during the last two decades (EUROPEAN WILDERNESS SOCIETY 2014 b; LUPP, G. et al. 2011). An essential step for wilderness protection in Europe was the adoption of the “European Parliament Resolution on Wilderness in Europe” in 2009, which called on the European Commission to (AYKROYD. T. 2013, p. 2):

- "Develop a clear definition of wilderness
- Mandate the European Environment Agency to map existing wilderness areas in Europe
- Undertake a study on the values and benefits of wilderness
- Develop an EU wilderness strategy
- Catalyse the development of new wilderness areas through restoration
- Promote the values of wilderness together with NGOs & local communities"

A special focus was put on the integration of the wilderness concept into the Natura 2000 network. In February 2009 the Wild Europe Initiative started a joint effort to promote the wilderness concept, including personnel from the European Commission and the Council of Europe, alongside European conservation organisations such as EUROPARC, WWF, PAN Parks, IUCN, UNESCO, Rewilding Europe and more (AYKROYD, T. 2013). This was followed by the "Conference on Wilderness and Large Natural Habitat Areas" in Prague in 2009 where representatives from governments, conservation agencies, NGOs and academic institutions met and developed the "Message from Prague", a set of recommendations from

the participants on policy, research, awareness raising and partnerships concerning wilderness. Furthermore, a first definition of wilderness was created for the Conference and the Wilderness Working Group, part of the Wild Europe Initiative, was established. The Wilderness Working Group worked up a draft paper “Discussion Draft: A Working Definition of European Wilderness and Wild Areas”, in cooperation with the Wild Europe Initiative partner organisations. These criteria were updated during the WILD10 conference in Salamanca in 2013 (EUROPEAN WILDERNESS SOCIETY 2014 b).

One year later the European Wilderness Society, a non-profit and non-government organization of professional wilderness and wildlife specialists, was established and introduced the European Wilderness Preservation System, now European Wilderness Network, which consists of wilderness areas across Europe audited by the European Wilderness Quality Standard and Audit System (EWQA). This European Wilderness Quality Standard and Audit System is based on the former PAN-Parks criteria and was developed in cooperation with the IUCN (EUROPEAN WILDERNESS SOCIETY 2017).

2.1.3. Reasons to protect wilderness

Areas or landscapes are protected because they have a certain value that society grants them. Such values can be for the ecological services or the material goods they provide for society or simply because of their beauty (MACHADO, A. 2004). Moreover, certain areas stand for a certain collective heritage or patrimony which makes them likely to provide important social and cultural services. The intention of the US Wilderness Act, for instance, was to preserve landscapes, that still had the same quality as they had before European settlers came to America, for future generations to enjoy and experience (AYKROYD, T. 2013).

Intact nature offers particular non-ecological services and values, such as the opportunity to experience solitude, beauty, nativeness or freedom which makes it worth protecting as well. However, wilderness is a philosophical challenge for our human-centred society, as it demands not only conscious non-utilisation and restraint towards nature but also humility and courage as the allowance of unpredictable developments questions our self-conception (WWF Österreich 2016).

On the other hand, measurable ecological benefits of intact nature and ecosystems are the heart of nature protection. It is a matter of common knowledge that intact ecosystems are more resilient to external influences and pressures, maintain structural and functional diversity on a high level and therefore offer a better chance to sustain the delivery of ecosystem services to society.

The EUROPEAN UNION (2013) p. 39 collected a set of ecosystem services wilderness areas provide:

- "refuge areas for endangered and undiscovered species
- sensitive habitats with highly adapted fauna and flora, which would be lost forever if modified by human interventions
- uninfluenced reference laboratories where evolutionary processes still continue
- providing important ecosystem services and addressing climate change through carbon sequestration and flood mitigation"

These aspects and services are not only performed by primary wilderness but also by secondary wilderness and rewilding areas. Especially, these secondary wilderness and rewilding areas are important to observe and understand the dynamics of rewilding nature from formerly cultivated lands (EUROPEAN UNION 2013; WWF Österreich, 2016).
Apart from these already mentioned benefits, wilderness cannot be seen as the ultimate goal in nature protection or the one solution, for example against climate change. Wilderness is not always the appropriate and most suitable conservation approach for an area, as it strongly depends on what is meant to be protected there. It can be stated that, for example, when it comes to numbers of species, anthropogenic ecosystems, such as meadows, may host a higher number of species than wilderness areas. This leads to the point that wilderness per se does not automatically increase biodiversity, if the factors number or rarity of species as well as time are taken in account. As the termination of management measures in an area would lead to natural succession habitats change and disappear and with them the species depending on these habitats (LUPP, G. et al. 2011).To preserve the specific state of a habitat that hosts most species or the most endangered species other approaches, such as the Natura 2000 approach of striving for and preserving a favourable conservation status, are more suitable (EUROPEAN UNION 2013).

2.2. Definitions, Categories, Phases and legal framework of Wilderness

2.2.1. Definitions

The previous chapter showed how different and widespread approaches to the term "wilderness" can be, depending on cultural and social background, geographic location or individual perception. To protect or restore wilderness, it is necessary to set a consistent definition for wilderness and wilderness related terms in order to achieve the conservation goals (AYKROYD, T. 2013). Furthermore, this chapter will take a closer look on the most important definitions of wilderness for protecting reasons in Europe but will not give a

complete list of all definitions found during the literature review, as this would go beyond the scope of this thesis.

Given the variety of definitions for wilderness (in Europe), when it comes to protecting it, the majority of them are based on the ideas of the definition of the US Wilderness Act of 1964. Certainly one reason for that is, that the US Wilderness Act is seen as one of the first definitions of wilderness with the intention to preserve it. However, it cannot be applied to Europe to its whole extent simply because it is based on a country with the size of the United States of America.

I. US Wilderness Act of 1964

The US Wilderness Act was resolved on 3 September 1964 with the intention to keep areas worth preserving from "being occupied and modified by increasing population, accompanied by expanding settlement and growing mechanization". Those areas should be "designated for preservation and protection in their natural condition to secure for the American people of present and future generations the benefits of an enduring resource of wilderness" (WILDERNESS ACT 1964, p. 1). The main aim of preserving these particular areas was and is to enable future generations to experience what the country was like before the first European settlers arrived in America (LUPP et al. 2011).
The National Wilderness Preservation System was introduced by this Act to administer thefederally owned wilderness areas for "the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use as wilderness, and so as to provide the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness" (WILDERNESS ACT 1964).

The US Wilderness Act defines Wilderness as "areas where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain". Furthermore, the Act describes wilderness as "areas of undeveloped land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural condition" (WILDERNESS ACT 1964, p. 1). In particular, this means that those areas show or contain following four conditions (WILDERNESS ACT 1964, p. 1):

1. They were primarily shaped by the forces of nature and show no signs of human activities.

2. They offer excellent opportunities to experience solitude as well as "a primitive and unconfined type of recreation".
3. They are of sufficient size to adequately protect their condition, which are at least five thousand acres.
4. They may contain features which are valuable for science, education, history or scenery.

It is important to mention that the Act contains several exceptions for human use or human influences. For example if the use of aircraft and motorboats or livestock grazing within areas designated by the Act are already established there, they can still be permitted to certain restrictions which are considered desirable by the Secretary of Agriculture. The same goes for fire, insect and disease control if necessary. Similarly handled are the exploration for water resources and the establishment as well as maintenance of already existing reservoirs, water conservation works, power projects and transmission lines as well as road construction and maintenance necessary for development and use of the former facilities. They are permitted in accordance with regulations deemed desirable if they are of public interest and "will better serve the interests of the United States and the people thereof than will its denial". Commercial services necessary for recreational or wilderness purpose may be allowed to a specific extent too (WILDERNESS ACT 1964, p. 5). Furthermore exceptions are made for already existing mining and mineral leases sites in wilderness areas. Exploration, drilling, mining and production as well as all necessary side processes can be performed as long as "they serve their purpose" (WILDERNESS ACT 1964, p. 4).
Despite this extensive list of exceptions, the Act follows a holistic approach. However, not all issues addressed in this definition can be applied in Europe. On the other hand, the four conditions of this definition address important key parameters of wilderness which can be found, to some extent, in every European based definition of wilderness (WILDERNESS ACT 1964).

II. IUCN

Basis for most definitions of wilderness found in Europe are the IUCN definitions for strict nature reserves (category 1a) and wilderness areas (category 1b). It has to be mentioned that these definitions take up the thoughts of the US Wilderness Act.

The International Union for Conservation of Nature (IUCN) developed the Protected Areas Categories and their underlying criteria based on which protected areas worldwide have been certified since 1948. The decisive factor for these categories is the management objectives of the protected areas (IUCN 2017 c).

Strict Nature Reserve (Category 1a):

Primary aim of such areas is to protect biodiversity and natural features in areas with limited and strictly controlled human visitation, use and impact. The preservation of intact regionally, nationally or globally outstanding ecosystems, species as well as geodiversity features formed by nature forces in a state as undisturbed by human activity as possible is the main objective. Cultural and spiritual valuable natural features are included in this definition as well. Considerate implementation of research for environmental monitoring and education are permitted as such areas can serve as baseline areas from which all avoidable access and human influence has been excluded. Europe offers few areas without any signs of human intervention, therefore restoration through natural processes or time-limited interventions are tolerated here if required (IUCN 2017 a).

Wilderness Area (Category 1b):

These large unmodified or slightly modified areas that retained their natural character have no permanent or significant human habitation and are protected to preserve their natural and intact condition. Main objective is to preserve the long-term ecological integrity of such natural areas which are free of any significant human activities or infrastructure. The areas should be of sufficient size to protect the native biodiversity, as well as the ecological and natural processes and ecosystems which are dominant there. The possibility to experience solitude is another characterisation of those areas.

Access for minimally invasive education and research activities as well as for the public, though on levels and of a type that will preserve the qualities of the area, are permitted here.

Wilderness areas of category 1b enable indigenous communities to keep on their traditional nature-based lifestyle if in ways compatible with the conservation objectives and protect the relevant cultural and spiritual values. However, the only indigenous communities concerned by this are the Sami people in Northern Europe. Consequently, human presence is not a limiting factor. Restoration activities, such as mentioned for Category 1a, can be realised here as well (IUCN 2017 b).

These two IUCN categories mainly differ in size, as category 1b areas are mostly larger than category 1a areas and in their accessibility for humans. Category 1 areas differ from Category 2 or 6, categories that can host wilderness-like areas as well, in their management of visitors and human activities (IUCN 2017 a; IUCN 2017 b).

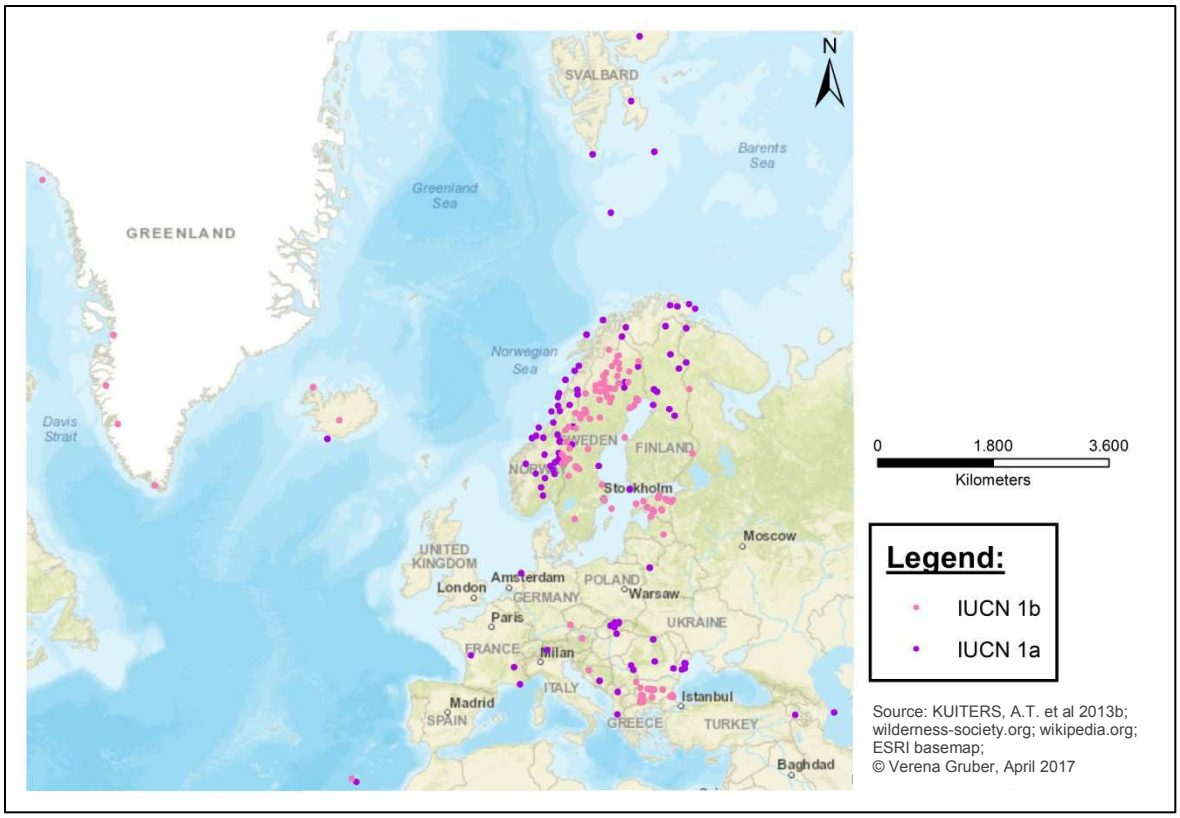

Figure 1: Overview of IUCN 1a and 1b Areas in Europe; Status 04/2017 (Source: KUITERS, A.T. et al. 2013 b, extended by personal research); no guarantee of completeness due to data availability and data errors; own illustration with ArcGIS 10.5)

Figure 1 offers an overview of the current distribution of IUCN 1a and 1b areas. As expected, the majority of IUCN 1 areas can be found in northern countries such as Norway, Sweden or Finland. Various studies support this picture, such as KUITERS, A.T. et al. (2013 a). Also some countries in Southeast Europe, for example Romania and Bulgaria, host a large number of IUCN 1 areas. The significant lack of such areas in the rest of Europe can be lead back to various reasons. According to ROSSBERG, M. (2017) and VANCURA, V. (2017) one of the main reasons probably is that the responsibility to establish IUCN areas lies in the hands of the national governments and depending on how important the government rates nature protection, in particular the protection of untouched and wilderness-like areas, a lot of effort is put in the establishment of such areas or not. Of course this is a complex issue where subjects such as financing, scientific equipment of the country and presence of national or international nature protection organisations play an import role too. Another important reason for this distribution is, according to these two experts, that the IUCN is not certifying areas by themselves. Every country has a person, organisation or ministry in charge of doing that, for example in Germany the Federal Office for Nature Protection (BFN) and in Austria the Federal Ministry for Agriculture, Forestry, Environment and Water management (BMLFUW). Based on how this person, organisation or ministry interprets the IUCN criteria the designated areas are actual wilderness or not and more or fewer areas are

designated as IUCN 1a or 1b in the end (KUITERS A.T. et al. 2013 a). The special focus on 1a or 1b areas of individual countries, for example Norway or Sweden, is another consequence of that.

Furthermore the IUCN criteria were developed for a global context, so they are the same all over the world, which complicates their application on a European context. These differences in the interpretation and consequently the implementation of national provisions and legislations impede the international comparability of the designated areas and consequently diminish the significance of their certification. Of course, the actual existence of areas worthy of this protection is the essential issue (ROSSBERG, M. 2017; VANCURA, V. 2017).

Summing up, this map does not directly show the actual distribution of wilderness areas in Europe, but rather the distribution of the value countries assign to wilderness and its protection.

III. European Union:

The European Union defines wilderness through the Natura 2000 legislation, though the protection of wilderness or the establishment of wilderness areas are not directly part of the legislation. Wilderness protection was first referred to in the EU Biodiversity Strategy, which contains the Natura 2000 legislation, in the course of the forestry target, action 12. This target deals with biodiversity measures in forestry plans and contains an obligation to "preserve wilderness areas", which play an important role for the preservation of old-growth forests (SYLVÉN, M., WIDSTRAND, S. 2015).

In February 2009 the EU set a political mandate to address the protection and comeback of wild nature through the "European Parliament Resolution on Wilderness in Europe". This resolution instructed the European Commission with the development of a clear definition of wilderness and the European Environment Agency to map existing wilderness areas in Europe. Furthermore, this resolution commissioned a study on the benefits and values of wilderness and the development of an EU wilderness strategy coherent with the Birds and Habitats Directives. Special attention was given to the effective protection of wilderness and the cooperation with NGOs and local communities. In 2013, the Wilderness Working Group, as part of the Wild Europe Initiative, developed the following consensus definitions of wilderness and wild areas in Europe, which are also agreed on by the European Commission. A map of existing wilderness in Europe was provided by the Wildlife Research Institute of Leeds University (AYKROYD, T. 2013; SYLVÉN, M., WIDSTRAND, S. 2015; WILD EUROPE 2017).

“A **wilderness** is an area governed by natural processes. It is composed of native habitats and species, and large enough for the effective ecological functioning of natural processes. It is unmodified or only slightly modified and without intrusive or extractive human activity, settlements, infrastructure or visual disturbance (WILDERNESS WORKING GROUP cited by AYKROYD, T. 2013)."

This definition covers relevant aspects of the EU level guidance on management of the Natura 2000 framework and the EU nature legislation, as well as the international commitments on protection of biodiversity. It is designed to be applicable in all bio-geographical regions of the EU Member States and therefore focuses on ecological elements (EUROPEAN UNION 2013). Furthermore, this definition of wilderness explicitly incorporates the IUCN definition for category 1b "Wilderness Area" and the definition of the US Wilderness Act, but is more specific in the stipulation of natural condition. Thus, this incorporation shows that the basis of most available wilderness definitions are alike (AYKROYD, T. 2013).

“**Wild areas** have a high level of predominance of natural process and natural habitat. They tend to be individually smaller and more fragmented than wilderness areas, although they often cover extensive tracts. The condition of their natural habitat, processes and relevant species is, however, often partially or substantially modified by human activities such as livestock herding, hunting, fishing, forestry, sport activities or general imprint of human artefacts (WILDERNESS WORKING GROUP cited by AYKROYD, T. 2013).”

This definition of wild areas shows similarities with the IUCN category 2 but is more likely to be ranked between the categories 1b and 2. The conversation focuses on restoration and rewilding measures to improve the wilderness quality, as well as on linking ecological corridors to create a wilderness network. Restoration or rewilding measures involve processes and measures which aim to lead an area back to its natural condition where it is able to sustain itself without any human influences. Such processes and measures can be the reintroduction of native wildlife as well as the eradication of invasive species, the reinstatement of natural processes by allowing them to happen unrestricted, the planting of external seed sources, the removal of artificial drainage or the reinforcement of the ecological connection to adjacent areas to support the migratory movement of species (AYKROYD, T. 2013). Wild areas are much more likely to be found in Europe, though not all definitions in use clearly separate wild areas from wilderness areas.

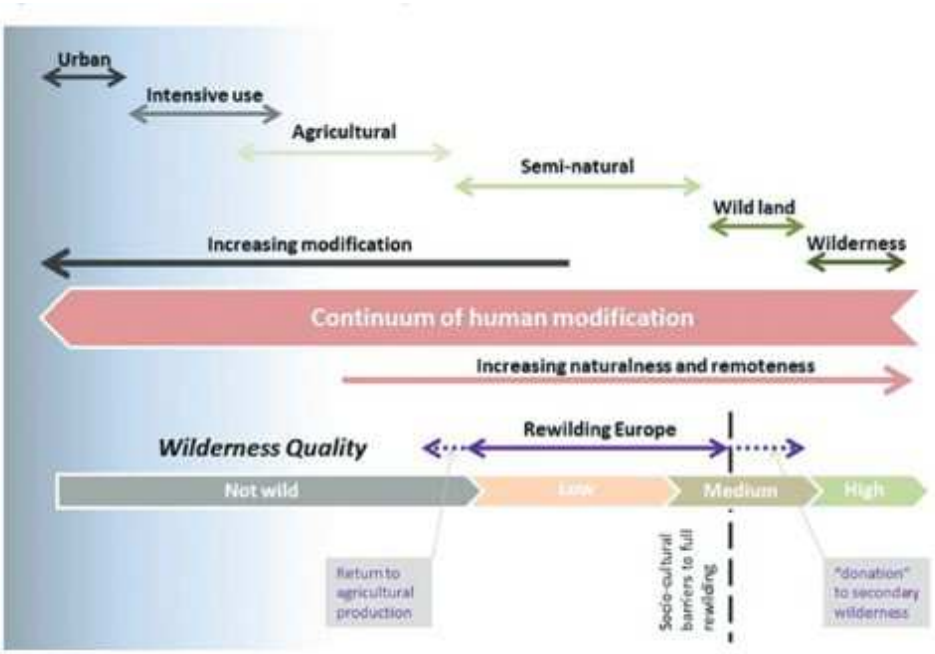

Figure 2: The Wilderness Continuum Concept (after Leslie) (Source: CARVER, S. 2014, p. 7)

The Wilderness Working Group based their definitions on the concept of the "wilderness continuum", shown in figure 2, which was originally formulated by NASH, R. (1982) and refined by LESLIE, R. G., TAYLOR, S. G. (1985). This concept measures the degree of wilderness of an area along a continuum with primary wilderness at one end and urban environments and forestry at the other end. Habitat and the modification of processes, as well as human activities determine the position of an area on this continuum (ORSI, F. et al. 2013). Restoration and rewilding measures can move an area up the continuum to reach a wilder state or finally "wilderness". However, the main difficulty of this continuum is to locate the point or threshold that defines wilderness, which is according to ORSI, F. et al. (2013) affected by individual perceptions.

As stated by AYKROYD, T. (2013) this continuum provides the backdrop to a comprehensive strategy for wilderness conservation, involving protection, restoration and rewilding. He further states that a long-sighted wilderness strategy has to be based on the four conservation biology principles and should "strive to establish wilderness areas across a wide spectrum of ecosystems." These four conservation biology principles are: "1. all native ecosystems should be represented in a protected areas system; 2. viable populations of all native species should be maintained and allowed to fluctuate in a natural way; 3. ecological and evolutionary processes such as free flowing rivers, wind, fire and impact of herbivores and carnivores must be ensured; 4. the system should be designed and managed so that it is resilient to both short-term and long-term change, including climate" (AYKROYD, T. 2013, p. 18).

These definitions of wilderness and wild areas by the Wilderness Working Group have not only been approved by the EU but were also adopted by the European Wilderness Society for their European Wilderness Quality Standard and Audit System. Consequently, this definition, shared by more than one organisation and actively used to certify wilderness and wild areas in Europe, can serve as a foundation for a common understanding of wilderness in Europe (HUBER, M. & JUNGMEIER, M. 2016).

Some countries in Europe, such as Germany and Finland, developed their own definitions of wilderness and implemented them in their nature protecting legislations.
Germany's "National Strategy for Biodiversity" includes various bullet points concerning wilderness and its protection. The strategy sets the goal to make room for wilderness and its development on 2% of Germany's national territory until 2020. Furthermore, 5% of the forested area should get the chance to develop naturally until 2020, as forests are seen as the most important ecosystems to realise these goals. Other ecosystems categorised as suitable for wilderness are coastal and flood plain areas, lakes, bogs and moorlands, alpine and rocky landscapes, former military areas and post-mining landscapes (BUNDESAMT FÜR NATURSCHUTZ 2016; FINK, P. et al. 2013). In 2012 a conference of experts organised by the federal office for nature protection of Germany defined wilderness in Germany as follows:
"Wilderness areas in terms of the National Strategy for Biodiversity are areas which are of sufficient size, unfragmented and free from any use in order to guarantee a permanently unaffected flow of natural processes without human activities" (FINK, P. 2013)
Other countries simply implemented official definitions, like the IUCN or EU definitions, in their nature protecting legislations. The National Parks Austria, for example, recently developed a concept for wilderness and non-intervention management in the core zones of the Austrian National Parks which recommends the establishment of wilderness areas within their core zones (MAYRHOFER, E. 2017). Non-intervention management means no intervention through human activities and is of particular importance for wilderness and its development. Natural processes and phenomena can happen and develop freely, unhindered and without any disturbances. This consequently leads to dynamic ecosystems and habitats (EUROPEAN UNION 2013). Additionally, WWF Austria offers a definition for wilderness, as well as a wilderness programme until 2025 (UMWELTVERBAND WWF ÖSTERREICH 2017 b). Table 1 gives a short overview of the most important definitions of wilderness in Europe.

Table 1: Overview of wilderness definitions in Europe (Source: EUROPEAN UNION (2013) p13-14)

Organisation	*Definition*	*Ecological aspects*	*Anthropogenic and social aspects*
US Wilderness Act	A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognised as an area where the earth and its community of life are undisturbed by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions.(WILDERNESS ACT 1964)	- untrammelled biophysical and biological elements - no human habitation or control - primarily affected by natural forces - at least 5,000 acres (~2,000 ha)	- opportunities for solitude, primitive and unconfined type of recreation - features of scientific, scenic or historical value
IUCN	1a: Primary aim of such areas is to protect biodiversity and natural features in areas with limited and strictly controlled human visitation, use and impact. The preservation of intact regionally, nationally or globally outstanding ecosystems, species as well as geodiversity features formed by nature forces in a state as undisturbed by human activity as possible is the main objective (IUCN 2017a).	- preservations of outstandingly intact ecosystems, species and geodiversity features - dominance of nature forces	- culturally and spiritually valuable natural features - research and monitoring - limited human visitation, use and impact
	1b: A wilderness is a large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition (IUCN 2017b).	- large area - unmodified - no permanent habitation - preservation of natural condition	- research and monitoring - traditional nature-based lifestyle of indigenous communities
Wilderness Working Group (Wild Europe Initiative)	A wilderness is an area governed by natural processes. It is composed of native habitats and species, and large enough for the effective ecological functioning of natural processes. It is unmodified or only slightly modified and without intrusive or extractive human activity, settlements, infrastructure or visual disturbance.	- large natural area - predominance of natural processes - no human habitation - no intervention	- experience of spiritual quality
	Wild areas have a high level of predominance of natural process and natural habitat. They tend to be individually smaller and more fragmented than wilderness areas, although they often cover extensive tracts. The condition of their natural habitat, processes and relevant species, however, is often partially or substantially modified by human activities such as livestock herding, hunting, fishing, forestry, sport activities or general imprint of human artefacts (AYKROYD 2013).	- smaller and fragmented areas - high level of predominance of natural processes - human modifications of habitats, processes and species	
Germany - BfN	Wilderness areas in terms of the National Strategy for Biodiversity are areas which are of sufficient size, unfragmented and free from any use in order to guarantee a permanently unaffected flow of natural processes without human activities (FINK, P. 2013).	- dominated by unguided developments and processes	

2.2.2. Aspects and Qualities of Wilderness

Similar to the definition of the US Wilderness Act, the definition by the Wilderness Working Group is based on four basic qualities of wilderness: naturalness, undisturbedness, undevelopedness and scale (EUROPEAN UNION 2013). Some definitions further divide these four qualities into more detailed aspects, though in the end they can mostly be integrated into these four major qualities.
The "Wilderness Register and indicator for Europe" by KUITERS, A.T. et al. (2013 a), for instance, follows the definition of wilderness from the EUROPEAN UNION 2013, though their working definitions are more explicit on the biological and anthropogenic qualities of wilderness. On the basis of those four qualities a set of measurable criteria was developed breaking down naturalness, undisturbedness, undevelopedness and scale into more detailed aspects and directly addressing disturbing factors. These criteria correspond with the European Wilderness Quality Standard and Audit System (EWQA) by the European Wilderness Society, who actively certify wilderness areas according to these criteria (EUROPEAN WILDERNESS SOCIETY 2014 b). The complete set of criteria, as well as a table of protected areas listed in the CDDA database (Common Database on Designated Areas) with wilderness qualities according to those criteria can be found in KUITERS, A.T. et al (2013 a).

2.2.2.1. Naturalness

The term naturalness, in particular how to measure it and where to draw the baseline against which it is measured, is discussed heavily among scientists (EUROPEAN UNION 2013; HUBER, M., JUNGMAIER, M. 2016; LUPP et al. 2011). There have been frequent attempts to measure the naturalness of landscapes and ecosystems with various approaches. For example, a comparison with the potential natural vegetation, proxy indicators such as distance to roads, settlements and modified land cover or on the basis of indicator species. However, all of these approaches first and foremost reflect a scientist's opinion on what is naturalness and as a result wilderness. Nevertheless, a closer look will be taken on two approaches in the following:

- The concept of hemeroby origins from ecology and is an index for human influence on habitats, vegetation types and ecosystems. The ordinal scale consists in most cases of seven degrees and starts with *ahemerob* - the lowest human influence, also referred to as "natural or non-disturbed landscapes". The scale continues with *oligohemerob* – near-natural, *mesohemerob* – moderately influenced, *euhemerob* – strongly influenced,

polyhemerob – unnatural and *metahemerob* at the upper end, describing the highest human influence and "totally disturbed and artificial landscapes" such as urban areas with no vegetation (KLOTZ, S., KÜHN, I. 2002; KOWARIK, I. 1988).

- MACHADO (2004) discusses various approaches to the term naturalness in his paper. Among other things he proposes the *Naturalness Categories* which are an index solely based on measurable aspects of an ecosystem. It does not include non-material criteria or values of nature-like solitude or beauty as they are not linked to ecology.

  The scale reaches from 10 – *maximum naturalness,* which is accomplished when 100% of an ecosystem's elements are natural and there is zero anthropic energy input, to 0 – *minimal naturalness*. This is achieved when there is maximal anthropic energy input and 100% of the elements are of anthropic origin.

  MACHADO (2004) p.7 lists the following criteria to identify the state of naturalness:

  - "biotic elements, since they themselves, as well as their disposition in the environment can be natural or anthropogenic.
  - the addition of energy or matter to a system by humans
  - the physical change of the geomorphology or the disposition of physical elements in the environment
  - extraction of biotic or abiotic elements from the system
  - fragmentation of the natural system by infrastructure
  - change of dynamics, since natural environments turn cultural when the dynamics of the system begins to be dependent or governed by human activity or their energy inputs."

  MACHADO (2004) defines three basic and often interrelated causes for the artificial alteration of ecosystems: "the incorporation of new elements such as exotic species or pollutants; the relocation or loss of its own elements; and the change in fluxes and dynamics normally due to the input of additional energy." The presence of humans should be included in ecosystems, although problems might arise in interpreting whether their presence is natural or not.

Both concepts make it possible to describe an ecosystem's naturalness, though they are more applicable in small and distinct ecosystems and are more difficult to apply in larger areas where various ecosystems overlap and interact. They both trace "the unnatural" back to human influence or rather that human influence and the presence of humans is diminishing or downgrading an ecosystem's naturalness. The discussion of the meaning of words such as "natural", "unnatural" or "artificial" would go too far here but deserves reflective thinking and a flexible and open mindset as there is neither a right nor a wrong interpretation of those terms.

The Guidelines on Wilderness in Natura 2000 (EUROPEAN UNION 2013, p. 11) describe naturalness as follows: The aspect of naturalness comprises the naturalness of vegetation and species, as well as the natural processes. Vegetation and associated species can be labelled as natural if they result from the evolutionary history of their ecosystem and environment. An area primarily shaped by the forces of nature unaffected by human activities can be called natural. To enable future evolution and adaption to changing conditions, the whole ecosystem, instead of only the occurring species, should be preserved. The spatial and temporal scales of the ecosystem's processes have to be identified in order to ensure sufficient space for its natural functions and formation of structures over time. Geographic and habitat conditions are the deciding factors for the minimum size of an ecosystem.

In addition to the already presented, several authors such as AYKROYD, T. (2013) or SYLVÉN, M., WIDSTRAND, S. (2015) highlight the importance of apex species at the top of an ecosystem's food chain. Their disappearance can be responsible for extensive disruptions to an ecosystem's trophic cascade which negatively affects natural functions and resilience, as well as biodiversity of global ecosystems.

2.2.2.2. Undisturbedness

Undisturbedness means that nature and its processes can function freely and unhindered without any human control or intervention. The US Wilderness Act describes this state as "untrammelled" and includes opportunities to experience solitude within the aspect of undisturbedness (WILDERNESS ACT 1964).
To ensure the undisturbedness of a protected area administrative or statutory measures might become necessary (EUROPEAN UNION 2013). Such administrative or statutory measures include regulations, legal provisions, management plans and zonation systems. They should include wildlife and wildfire management, as well as infrastructure within and outside of a protected area for regional and supra-regional purpose, such as roads, power lines or water reservoirs. The term "visual disturbance" comes in play here. Measures should also deal with forms of traditional land use from local and indigenous people, livestock grazing, visitor access and motorised access (KUITERS, A.T. et al. 2013 a).

2.2.2.3. Undevelopedness

In this context an area can be described as "undeveloped" when it shows no signs of past human activities. This means, there are neither settlements nor habitation nor any other

human objects such as roads, fences or power lines which may affect the ecological processes in any direct or indirect way (EUROPEAN UNION 2013). Direct and indirect influences on an area or ecosystem from outside, such as air or light pollution, can be difficult to determine and trace back (APLET et al. 2000). The term ecological intactness can be used here, meaning a high percentage of original ecosystems and complete or near-complete native flora and fauna assemblages (KUITERS, A.T. et al. 2013 a).

An area's undevelopedness can be measured, among other things, by the number of or distance to settlements or other human artefacts or by analysing the length and density of the road network (MAYRHOFER et al. 2015, ORSI et al. 2013, PLUTZAR et al. 2013). A crucial factor when it comes to undevelopedness is time because even after an area was put out of use or disturbing factors were removed their aftermaths may still cause disturbances.

2.2.2.4. Scale

Scale is a central aspect for the definition of wilderness as it plays an essential role in species diversity of ecosystems and the effective ecological functioning of natural processes. Larger sized areas provide opportunities for a more varied spectrum of habitats and support a viable metapopulation as it makes successful movement of individuals of local populations between the habitats more likely (EUROPEAN UNION 2013).

KUITERS, A.T. et al. (2013 a) state that the spatial scale necessary to maintain the ecological integrity of an area determines its minimum size, whereas this depends on the ecosystems involved. Furthermore, a certain size is often required to enable the protection of whole landscapes. Apart from the ecological importance of sufficient size, the extent of a protected area can influence the perception of wilderness. For example, visitors may only experience solitude if an area is big enough to avoid human gathering (LUPP, G. et al. 2011).

The surroundings of a protected area must also be taken in account when speaking of sufficient size as the quality of surrounding landscapes determines the ecological connectivity and consequently the functioning of the ecosystem within the protected area. The visitors' experience of an area is affected by its surroundings as well.

On the other hand, the IUCN definitions for category 1a and 1b do not advise any minimal size for wilderness areas. However, some countries add a minimum size limit to the IUCN standards within their national territory. The Swedish Environmental Protection Agency, for instance, decided that "areas should be larger than 1000 ha in northern Sweden and larger than 500 ha in southern Sweden" to be labelled as IUCN categories 1 (KUITERS, A.T. et al. 2013 a, p. 21).

The former PAN Park Foundation established the European Wilderness Preservation System. This system contained protected areas which were assessed under criteria established by them either as "Wilderness Partners" or as "Certified PAN Parks". Protected areas labelled as "Wilderness Partner" had an "ecologically unfragmented wilderness area of at least 1000 ha with the potential to grow up to 3000 ha". Certified PAN Parks had an "ecologically unfragmented wilderness area of at least 10 000 ha" (KUITERS, A.T. et al. 2013 a).
Wild Europe stated in their "Working Definition of European Wilderness and Wild Areas" that any new areas labelled as wilderness should have a core area of at least 3000ha. Whereas, to ensure the effective ecological functioning of natural processes a minimum size of 10 000ha is considered to be reasonable (AYKROYD, T. 2013). The Wilderness Register by KUITERS, A.T. et al. (2013 a) et al take on this minimum size of 3000 ha for a wilderness core zone.

REIF, A. (2013) on the other hand proposes five qualities of wilderness, namely size, habitat continuity, rareness and endangerment, connectivity and absence of fragmentation and fifth, representativeness. Two of these qualities, rareness and endangerment, as well as representativeness, are not frequently picked up in other definitions. The point "rareness and endangerment" is obsolete when talking about wilderness as it is by definition a rare and therefore endangered state of nature. The point of representativeness leads to the discussion of phases of wilderness such as primary or secondary wilderness. This topic will be dealt with in chapter 2.2.3.
To sum up, it can be argued that a clear distinction of ecological and anthropogenic aspects of wilderness is difficult, though the aim or background of a definition depend on how these aspects are weighted.

2.2.3. Categories and Phases of Wilderness

As already mentioned in previous chapters, there are various types and categorizations of wilderness. However, the most common one in Europe is the classification in "Wilderness" and "Wild Areas", picked up in the definitions of the EU. The classification in "Primary Wilderness" and "Secondary Wilderness" is a rather theoretical and less practical one and is topic of various academic discussions to distinguish the qualities of wilderness areas. As the definitions of "Wilderness" and "Wild Areas" have already been stated, this subchapter will discuss the concept of "Primary and Secondary Wilderness", as well as other interpretations of the matter.

SCHERZINGER, W. (1996), cited in LUPP et al. (2011) p. 5, suggests seven types of wilderness.

- *Artificial Wilderness*: "areas actively designed for nature experiences and which are managed accordingly (LUPP et al. 2011, p. 5)."
- *Temporary Wilderness*: a management practice comparable to natural forestry.
- *Wildering:* of former agricultural or urban land that can be found in small abandoned backyards and or on large military areas.
- *Renaturing*: areas where land management practices such as logging or mowing are stopped. SCHERZINGER, W. (1996), suggests that, on a larger scale, this could be considered "Secondary Wilderness".
- *Wilderness-cell:* have relicts of "real wilderness" in form of "small remnants of untouched nature that have been preserved over time (LUPP et al. 2011, p. 5)." These cells, however, are too small to provide all structures and processes of an entire ecosystem.
- *Primary Wilderness*: areas that are extensive enough to provide space for natural processes and for viable populations of large predators. In other words, primary wilderness is described with no signs of past or present human interventions and where natural processes have sufficient space to function freely. Furthermore, native species and vegetation can be found there.

Concepts describing wilderness or naturalness mostly place primary wilderness on their upper end of the scale, for example the wilderness continuum or the Naturalness Categories by MACHADO, A. (2004), who calls the state of an ecosystem *maximum naturalness*, when all its elements are natural and there is zero anthropic energy input, which can be seen equal to primary wilderness.

Small patches and cells of primary wilderness have been identified by researchers across the continent, such as the primeval forest "Rothwald" in Austria. Some are protected and labelled as IUCN 1a areas, others are integrated into other protected areas, for example National Parks or Natura 2000 areas, which do not have wilderness as their main protective aim.

As Europe is a densely inhabited continent where humans and their activities take up a lot of space and their influences can be seen everywhere, hardly any areas are left where nature can function freely and unhindered. Furthermore, many areas, in particular forests, have been used in the past, for example for coal or iron production, but have developed without any human interference since then or have been actively or passively restored. This leads to a lot of secondary habitats and ecosystems, making most wilderness areas found in Europe to secondary wilderness as human influences or activities are either documented or traces of them can still be found. Additionally, the abandonment of land opens up new opportunities

for ecosystem and habitat development and consequently is of major importance for secondary wilderness development (AYKROYD 2013).

The already introduced definitions of wilderness and wild areas by the Wilderness Working Group also classify wilderness in two categories. This definition of wilderness focuses mainly on ecological elements of an area but explicitly incorporating the IUCN definition for category 1b, human interventions are ascribed a place here as well (AYKROYD, T. 2013; EUROPEAN UNION 2013). The focus in wild areas lies on re-establishing wilderness after human interventions via restoration or rewilding measures. Wild areas, according to this definition, are therefore mostly areas which had been used by humans in the past but were put out of use at some point. Areas like this could therefore also be rated as secondary wilderness.
The European Wilderness Society also uses these definitions for wilderness and wild areas but classifies them into their four Standards: Platinum, Gold, Silver and Bronze. Areas meeting the Platinum or Gold Standard can be seen as wilderness whereas Silver and Bronze Standard refers to wild areas. The main difference between the four standards, however, is their size and the extent of human activities. The term "wilderness" is used in all four categories and both types of areas for the purpose of the communication strategy of the organisation (EUROPEAN WILDERNESS SOCIETY 2014 b).

Another attempt to categorise wilderness comes from KOWARIK, I. (2005 a), cited in cited in LUPP et al. (2011) p. 4, presented in table 2. It describes four dimensions of wilderness which are classified in two categories.

Table 2: Wilderness Categories by KOWARIK, I. (2005 a); (Source: LUPP et al. 2011, p. 4)

Traditional Wilderness		*New Wilderness*	
1st dimension	2nd dimension	3rd dimension	4th dimension
remnants of virgin forests	land and forests set aside for natural processes; managed with the non-intervention concept	fallow and unmanaged land in cities and suburban areas, resulting from structural changes in the industrial sector and demographic changes	so-called "nature experience wilderness", focuses on environmental education and nature experience, offers a place for personal freedom

A relevant factor for all classifications of wilderness is time. Primary wilderness is mostly described with terms such as "virgin", in the sense of an original, pure or natural condition which has not been changed, touched or spoiled, or "native", meaning animals or plants naturally existing in a place, or maybe even "pristine" meaning not developed or changed in any way and left in its original condition (MACHADO, A. 2004; Oxford Dictionary 2017). The concepts of naturalness by KOWARIK, I. (2005 b) on the other hand states, that

Retrospective Naturalness assumes a composition of vegetation that existed before humans shaped and changed the land, whereas *Prospective Naturalness* is characterised by self-establishing species, including neophytes.

How would one rate a secondary forest that developed freely without any human interference after having been felled in the past? It will end as a natural and intact system, but can it be labelled as pure, pristine or virginal in the sense of untouched nature? And will the plants growing and animals living there be native (MACHADO, A. 2004)? According to KOWARIK, I. 2005 b this forest would be rated as *Prospective naturalness* as it did not exist before humans interfered and is characterised by self-establishing species. But are there any ecosystems left in Europe that fulfil these strict criteria of *Retrospective naturalness* (LUPP, G. et al. 2011)? These are the essential questions when it comes to separate primary wilderness from other stages of wilderness. Further questions arise from this too, such as the short and long-term, direct and indirect degree and extent of artificial or human influence on nature in a global context.

The concept, as well as the discussion of primary and secondary wilderness, which rates wilderness on the presence of human activities, is a rather academic one and is difficult to apply in the European context as it simply lacks areas to fulfil its characteristics. In a global context one could rate untouched parts of the Amazon rainforests or Antarctica as primary wilderness and "downgrade" from there on to secondary wilderness and so forth. As wilderness per se does not depend on a specific habitat it is theoretically possible to apply this concept in Europe and simply rate most wilderness areas as secondary wilderness and only the few small remains of primeval landscapes and newly emerging areas as primeval wilderness. This, however, leads to another downside of this concept as the extent and gradations secondary wilderness would take on in Europe are manifold. Human influences in wilderness-like areas on the whole continent reach from signs of forestry during the middle ages to former military areas. Summarizing all of them in just one category would not do justice to their qualities, as well as to downgrade some and upgrade others and therefore distort the concept as a whole. Consequently, this concept is suitable for a global context but needs to be customised when talking about Europe.

In practice the concept of wilderness and wild areas, already mentioned in chapter 2.2., is taken on by numerous organisations in Europe, such as the European Wilderness Society. This concept grants the past and present human influences on the European continent more space and includes rewilding areas, which are essential when talking about wilderness in Europe. It combines primary and secondary wilderness in the category wilderness and introduces a "new" category for re-establishing wilderness, namely wild areas, although these wild areas could also just be seen as a sub-category of secondary wilderness. However, this concept still consists of only two categories, which is again too close-meshed

to do justice to all stages and forms of wilderness in Europe. A third category on the upper end of wilderness or a division of the category "wilderness" would be a solution here.
The wilderness continuum on the other hand acknowledges the dynamic of nature and the different stages an area can have over time. Areas can move up or down the continuum over time with primary wilderness on the upper end and cultivated land on the lower end. This dynamic of nature and culture, and in particular wilderness, results in various stages close to primary wilderness but not yet there. Most areas will never reach the upper end of this continuum but this should not be the "goal" of protecting them anyway. So it is necessary to find a concept which suits all or at least more stages of wilderness. The wilderness continuum is therefore an appropriate tool to define wilderness, even though there is no specific baseline marking wilderness in general, no matter which stage of it. The previously discussed aspects and qualities of wilderness try to offer such a measurable baseline but, as already mentioned, even with them it is still difficult to draw a clear line.

2.3. Legal Framework and Management challenges

Reasons to protect wilderness are manifold which leads to a variety of interpretations how to conserve it depending on national or international legislations. Chapter 2.2. already presented the most important definitions of wilderness in Europe. The following chapter will discuss current incorporations of wilderness in existing protected area networks, as well as the compatibility and contradictions of different protection approaches such as "non-intervention management" or maintaining a "favourable conservation status". This chapter further offers a closer look on common management challenges in wilderness areas.

2.3.1. Legal Framework and integration in existing protected area programmes

The foundation of every protected area is formed by a suitable integration in the national and international nature conservation legislations (EUROPEAN UNION 2013). As just a few countries in Europe implemented wilderness in their national nature conservation legislations, this chapter will only deal with international legislations and protected area programmes relevant for wilderness conservation.
The only independent international protection categories having the protection of wilderness as a main aim are the IUCN categories 1a and 1b. The only organisation solely focusing on wilderness as well as actively certifying it is the European Wilderness Society. The European Wilderness Network introduced by the European Wilderness Society, however, builds on already existing protected areas which host wilderness, but do not necessarily have wilderness as a main aim.

Consequently, wilderness areas can be found in various categories of protected areas, such as nature reserves, Natura 2000 sites or different IUCN categories. These categories can overlap within one area. This is why approximately 4% of the Natura 2000 network is also strictly protected as IUCN categories 1a or 1b. On the other hand nearly all IUCN category 1 sites show an overlap with the Natura 2000 network as well (EUROPEAN UNION 2013).
Chapter 3.3. offers two examples for the integration of wilderness areas within the core zones of National Parks, which are IUCN category 2 (IUCN 2017 d). The complications coming along with the overlap of wilderness areas and National Parks mostly arise from the fact that interventions are allowed in all zones of National Parks. Stopping them consequently leads to conflicts.
However, not just the IUCN categories 1 and 2 can host wilderness. Finland, for example, protects wilderness under IUCN category 6 (protected area with sustainable use of natural resources). Finland's Act on Wilderness Reserves from 1991 defines "the preservation of the wilderness character of an area, to protect Sami culture and the traditional subsistence of these areas and to enhance possibilities for multiple use of nature (EUROPEAN UNION 2013, p. 16)." In this concept human use is an essential part of the wilderness character of an area as traditional human activities, such as reindeer husbandry, hunting, fishing and the collection of berries and mushrooms, as a part of the local culture. Furthermore, these activities provide income for the Sami people and are therefore essential for their livelihood. Additionally, the forests in these wilderness areas are kept in a natural state. By ensuring these activities, it is intended to protect the character of the Finnish wilderness areas from other permanent human interventions such as road constructions or mining (EUROPEAN UNION 2013; FINCK, P. et al. 2013).

The EU Biodiversity strategy represents one of the most important legislations for nature and biodiversity protection in Europe. The European Commission launched their latest strategy, dealing with wilderness related issues in May 2011. This strategy aims to halt and reverse biodiversity loss by 2020 "by reducing the pressure on nature and ecosystem services in the EU by anchoring biodiversity objectives in key sectoral policies." The main reasons for biodiversity loss are therefore picked up by six main targets, presented below, and twenty actions (EUROPEAN UNION 2013, p. 19):

1. "full implementation of existing nature protection legislation and network of natural reserves, to ensure major improvements to the conservation status of habitats and species
2. improving and restoring ecosystems and ecosystem services wherever possible, notably by the increased use of green infrastructure
3. ensuring the sustainability of agriculture and forestry activities

4. safeguarding and protecting EU fish stocks
5. controlling invasive species, a growing cause of biodiversity loss in the EU
6. stepping up the EU's contribution to concerted global action to avert biodiversity loss"

According to numerous authors (AYKROYD, T. 2013, EUROPEAN UNION 2013, EUROPEAN WILDERNESS SOCIETY 2014 b, SYLVÉN, M., WIDSTRAND, S. 2015, etc.), wilderness can play a crucial role in stopping biodiversity loss in the long-term. Although the strategy does not directly aim to protect or preserve wilderness, it includes wilderness preservation indirectly in some of their targets. Target 2, action 6b, addresses the need for wilderness when it comes to green infrastructures as wilderness areas host various ecosystem services which can reduce fragmentation of ecosystems and would further improve the coherence of the Natura 2000 network. Target 3, action 12, deals with the integration of biodiversity protection in forest management. Forest management plans should therefore include a range of measures, from which one is the preservation of wilderness areas (EUROPEAN UNION 2013; FINCK, P. et al 2013).

The most important tools of the EU biodiversity policy are the Birds and Habitats Directives. These directives form the legal framework for the Natura 2000 network and aim to ensure the maintenance or restoration of species and habitat types to a favourable conservation status as well as to secure their long-term survival across their natural range. The EUROPEAN UNION (2013) summarises the favourable conservation status of a species as "a situation where a habitat type or species is doing sufficiently well in terms of quality and quantity and has good prospects of continuing to do so in the future."

Article 10 of the Habitat Directive can be seen as the most important regulation for wilderness as it deals with matters of natural processes and their sufficient scale as well as with maintaining and developing wildlife corridors or stepping stones for migration and dispersal of wild fauna and flora (EUROPEAN UNION 2013; FINCK, P. et al. 2013).

Article 4(1)b and 4(1)d of the Birds Directive also include several important points concerning wilderness as they deal with the vulnerability of species to habitat changes and "species requiring particular attention for reasons of the specific nature of their habitat" (EUROPEAN UNION 2013; FINCK, P. et al. 2013). More detailed explanations concerning this topic can be found in EUROPEAN UNION (2013).

However, the main intention of the EU Biodiversity strategy and the Natura 2000 network is the conservation of biodiversity and not of wilderness. Therefore, a wilderness approach might just be the most effective management tool for some specific Natura 2000 sites which host species or habitat types of community interest that demand a certain degree of wilderness and dynamic natural processes to maintain or achieve a favourable conservation status. Furthermore, wilderness also encompasses dynamic changes of ecosystems and habitats which lead to temporal and local fluctuations of their size and spread, as well as to

the development of new habitats. This is why for most Natura 2000 sites a wilderness approach will not be the most suitable form of management. As in general, the Natura 2000 network protects a certain state of the ecosystem, the most favourable conservation status, and does not exclude economic activities from protected areas within its network (BORZA, E., VANCURA, V. 2009; EUROPEAN UNION 2013;). These two points are therefore major reasons for conflicts in spaces where wilderness areas, no matter which organisation certified them, and Natura 2000 areas overlap or are integrated within each other. To fulfil the respective protection aims of these two protected area categories, different management approaches are necessary. The maintenance of a favourable conservation status in Natura 2000 sites might include species or habitats which need ecological requirements that depend on human interferences, such as low intensity agriculture, and is therefore conflicting with non-intervention management and consequently with wilderness management. Appropriate zonation, such as in the Königsbrücker Heide Nature Reserve in chapter 3.3.1., can be a solution here.
A comprehensive discussion of this cooperation of conservation interests can be found in EUROPEAN UNION (2013).

2.3.2. Management challenges

Wilderness protection does not necessarily imply no management or inactive management. There are specific measures that have to be taken in order to achieve wilderness in the first place or to preserve it. This chapter will not discuss any particular management measures in detail as there are various papers and organisations already doing so, for example AYKROYD, T. (2013), EUROPEAN UNION (2013), EUROPEAN WILDERNESS SOCIETY (2014 b) or PEKNY, R., LEDITZNIG, C. (2009). So this chapter will rather offer insights into commonly arising management challenges in wilderness areas mentioned in those papers.

Conflicts with the management or rather with the non-intervention management of wilderness areas are mostly based on the different management approaches inside and outside of the respective areas. Consequently, these conflicts are not solely found in wilderness areas but in protected areas with non-intervention management or similar approaches in general.
Problematic situations, in particular, arise when it comes to the handling of bark-beetle outbreaks or other pest species. That is why the transition to natural vegetation in forests should happen gradually to prevent large-scale infestations (PEKNY, R., LEDITZNIG, C. 2009). In forests already in a natural state, infestations will most certainly occur in a smaller extent. This is why areas such as the Wilderness Dürrenstein, presented in chapter 3.3.3. are actively converting the few spruce monocultures left within the protected area to further

reduce the susceptibility to bark-beetle outbreaks. Human intervention might be necessary though, to prevent severe damage to native plant species that might lack natural resilience. Surveillance of pest outbreaks and damages are therefore essential, in some cases even eradication might be necessary to prevent further outbreaks and to protect surrounding areas of economic utilisation from infestation (EUROPEAN UNION 2013).

The control of certain animal diseases, for example rabies, regulated by European or national legislations may demand measures, like surveillance, vaccination or even culling of infected animals (EUROPEAN WILDERNESS SOCIETY 2014 b). These sensitive measures are often in conflict with the requirements of wilderness management and therefore require close cooperation between authorities managing the wilderness areas and authorities implementing animal health measures.

The handling of natural disasters, such as forest fires or severe winds and windfall, and their local and regional aftermaths are also a controversial topic in wilderness management. One approach to minimise the extent of forest fires is to promote a native or natural composition of forest habitats, as a natural forest composition is known to be more resilient against fires as monocultures. There are also species and habitats that depend on fire in their life cycles or are evolutionary adapted to natural fires. However, depending on the degree of deviation from the native habitat composition this approach takes a lot of time and human intervention might be necessary. Furthermore, this approach is just suitable for forests in protected areas without any economic interest as its implementation in industrial forest would get in the way of their commercial interest which is based on fast growing tree species with regular predictable outputs. So again, the issue of natural forest fires only becomes a problem when fires spread to adjacent commercial forest or threaten human infrastructure. The same applies for windfalls as the leaving behind of fallen trees for deadwood production in wilderness areas can cause pest outbreaks which might spread to surrounding areas. Conflicts arising from overlapping or integration of wilderness areas and other protected area categories whose main aim is not wilderness protection, such as the Natura 200 network, have already been discussed in the chapter 2.3.1.

To prevent most of these conflicts, all authors dealing with the topic of wilderness management, such as AYKROYD, T. (2013), EUROPEAN UNION (2013), EUROPEAN WILDERNESS SOCIETY (2014 b) or PEKNY, R., LEDITZNIG, C. (2009), agree that a committed management team, as well as a thought-through management plan are essential. This management plan should pick up and deal with crucial issues such as the area's legal framework, its zonation, the connectivity and ecological linkage with surrounding areas, necessary needs for restoration or rewilding measures or the handling of invasive species, as well as natural disasters such as forest fires. It should further treat topics like visitor guidance, research and monitoring activities.

A management plan also has to phrase clear short and long-term protection targets as they are necessary to monitor impacts and efficiency of the management measures. Furthermore, targets which are based on the current state of the ecosystem, regulate where and to what extent restoration measures are required (EUROPEAN UNION 2013). Without a clear set of targets, the chances of conflicts with surrounding areas, visitors or any economic interests are much more probable.

Another important topic that has to be taken in to account is the handling of local or indigenous communities living in the surroundings or inside a wilderness zone or traditionally depending on the area in some way. Since the establishment of such a strict protection area consequently affects their access or might even lead to their exclusion from this certain area, complex questions about access and use of resources arise. Therefore, it is necessary to involve local and indigenous communities in the development of a wilderness management plan (EUROPEAN UNION 2013).

Special attention should also be paid to the relationship between the public and the wilderness area. The public's acceptance of non-intervention management and its effects, as well as of access rules and restrictions can be of vital importance and definitely facilitate the implementation of such measures. It should be a key task of a wilderness area's management to transport the cause as well as "the bigger picture" of wilderness protection to the public to raise its awareness and gain its support.

To sum up, the involvement of various stakeholders, such as landowners, local communities and businesses, tourism organisations, agriculture and other interest groups, in the development of a wilderness area's management plan is necessary to create a feasible long-term management strategy (EUROPEAN UNION 2013).

3. Comparative Analysis of selected Wilderness Areas

3.1. Present status of wilderness areas in Europe

There are currently two organisation certifying wilderness areas, IUCN and the European Wilderness Society, whereas just the latter is focusing solely on wilderness (IUCN 2017 c; ROSSBERG, M. 2017). The European Wilderness Society is a non-profit and non-government organisation of professional wilderness and wildlife specialists, which was established in 2014. They are building up on the former PAN-Parks Network that certified areas based on the first edition of the European Wilderness Quality Standard and Audit System (EWQA 1.0). The EWQA builds on the EU-conform Wild Europe definitions of "wilderness" and "wild areas". The European Wilderness Society adapted and further developed the EWQA and excluded the focus of wilderness tourism PAN Parks formerly had. The current edition of the EWQA can be found in EUROPEAN WILDERNESS SOCIETY (2014 a). Based on the EWQA the European Wilderness Society introduced the European Wilderness Network, which consists of Wilderness Areas, an umbrella term for all wilderness habitats, WILDIslands, WILDForests, WILDCoasts and WILDRivers. Those categories are further certified with platinum, gold, silver or bronze standard depending on their wilderness quality and size. (EUROPEAN WILDERNESS SOCIETY 2014 a; EUROPEAN WILDERNESS SOCIETY 2017).

The IUCN, on the other hand, does not have a specific focus on wilderness protection or certifying wilderness. The categories 1a and 1b are just two of their seven Protected Areas Categories, labelling areas hosting uninfluenced or little influenced nature with little to no human interference, in other words wilderness. The IUCN created specific criteria for all of those Protected Areas Categories, however, with a global background, complicating their application in Europe, as it has already been discussed in chapter 2.1.2. Even though the Protected Areas Categories of IUCN shows complications in Europe, the IUCN categories 1a and 1b are still the most widespread certifications of wilderness areas in Europe. Figure 3 clearly demonstrates this.

Looking at figure 3, it has to be taken in account that the IUCN is a well-established organisation in the field of nature conversation as well as wilderness certification and is consequently operating in the field for a much longer time than the European Wilderness Society. So even though the two organisations have different approaches to the topic they work on a consistent basis as the last draft of the EWQA was developed in cooperation with the IUCN (ROSSBERG, M. 2017; VANCURA, V. 2017).

Furthermore, it has to be mentioned that figure 3 just shows wilderness areas officially labelled as such. Wilderness areas or wilderness-like areas embedded in other Protected Areas Categories, such as IUCN category 2 or 6, as well as any other protected area or not

protected at all, are not depicted. Therefore, figure 3 cannot be used as an overview of Europe's wilderness potential but only as an overview of the current certified wilderness areas.

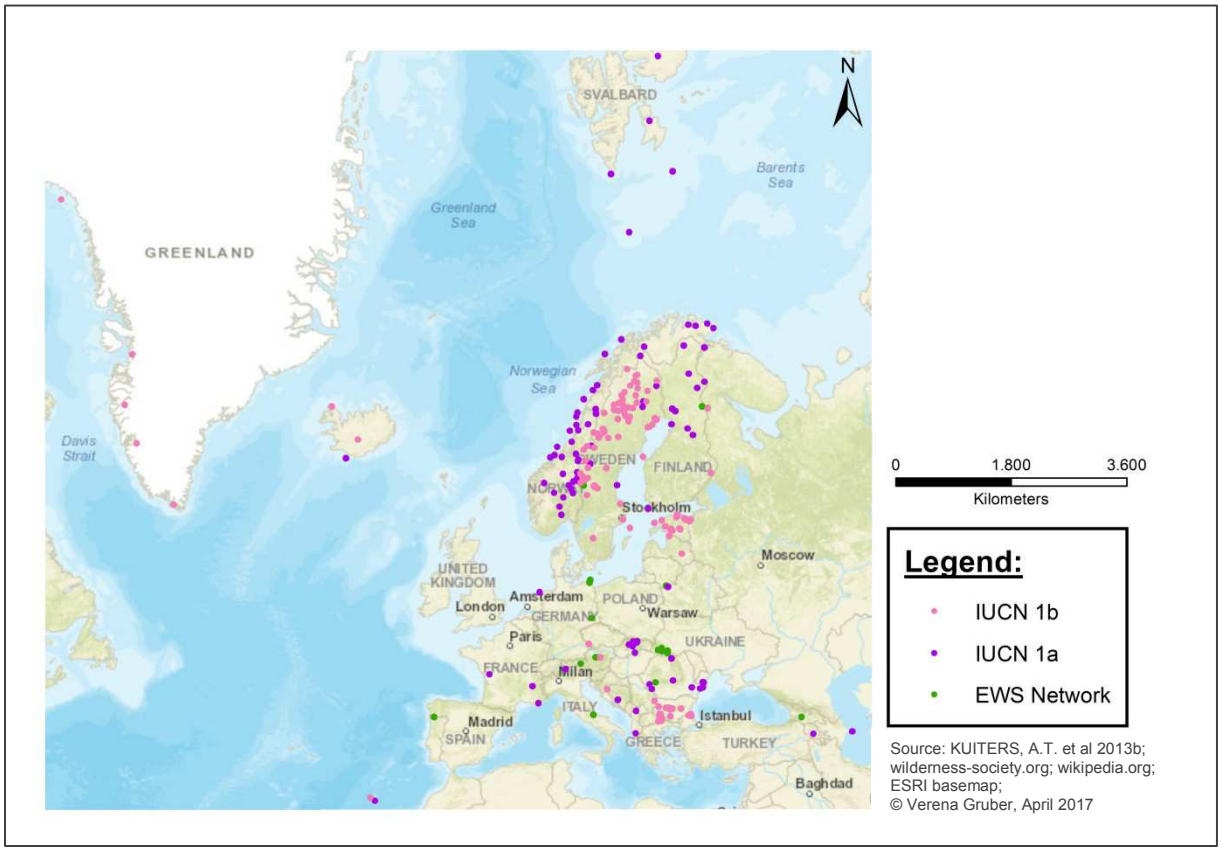

Figure 3: Overview of IUCN 1a and 1b areas and the European Wilderness Network of the EWS, Status 04/2017 (Source: KUITERS, A.T. et al. 2013 b, extended by personal research); No guarantee of completeness due to data availability and data errors; own illustration with ArcGIS 10.5)

3.2. Categorisation framework

This chapter offers an attempt to categorise wilderness in Europe. In order to do this, four certified wilderness areas in Europe were chosen to serve as examples of the various stages and versions of wilderness. Two areas are fully certified by the European Wilderness Society (Kalkalpen Wilderness and Hohe Tauern Wilderness). One was quick audited by them with a planned full certification in 2017 (Königsbrücker Heide), according to ROSSBERG, M. (2017), and the forth is an ICUN 1a and 1b area (Wildnisgebiet Dürrenstein).

As the EU-Definition, which builds on the criteria for IUCN category 1, was adapted by the European Wilderness Society and their criteria for the EWQA were again worked out in cooperation with IUCN, it can be assumed that all of these areas have been certified by approximately the same criteria. However, the country-specific interpretation of the IUCN category 1 criteria leads to severe differences between IUCN 1 areas over Europe. The

European Wilderness Society on the other hand offers a uniform standard all over the continent. The arising differences due to the different certifications will be discussed in the course of this chapter.

First and foremost, it has to be mentioned that in general a direct comparison of protected areas is not possible, due to the differences and variations of ecosystems as well as due to the different aims of protection labels. Therefore, the presented categorisation framework should rather be considered as a supporting frame for the following analysis of the four chosen wilderness areas in chapter 3.3.
To build this framework, the categorisation concept of Primary and Secondary Wilderness was combined with the concept of Wilderness and Wild Areas to a new categorisation framework consisting of three categories: Primary Wilderness, Secondary Wilderness and Wild Areas. As mentioned in chapter 2.2.3.1., both concepts only cover two categories, which leads to an exclusion of various stages and versions of wilderness. Therefore, an expansion to three categories seems to be reasonable. The characteristics of these two concepts, as well as their areas of application have already been discussed in chapter 2.2.3.1. Their definitions are taken on here for the most part: Primary wilderness means no human intervention since the last glacial period. Secondary wilderness means areas with signs of past human interventions but no active restoring measures anymore. Wild Areas have clear signs of past human interventions and restoring measures are still happening.
Size is an important but not decisive factor in this categorisation, as a classification of wilderness focusing on the signs of human interventions seems to reveal more about the current "quality" of wilderness. However, if there would be a stronger focus on size, the framework could be extended with a fourth category - Wilderness-cell, presented in chapter 2.2.3.

The comparison framework is based on The EWQA by the European Wilderness Society, which is based on the EU definitions by the Wilderness Working Group, which again built on the IUCN definitions for category 1. Therefore, this framework is compliant with the most important definitions of wilderness in Europe. It focuses on the four aspects of wilderness and their quality, as well as on the management of the areas. Special emphasis lies on the extent of human influences as this is seen as the decisive argument of wilderness. The different aspects of the areas will be categorised according to this framework leading to an attempt of a final allocation to one of the three categories.
The presented framework in table 3 is structured in seven main criteria from which three are subdivided into more detail. All criteria interact with each other and should not be assessed separately, as, for example, the naturalness of an area cannot be evaluated without taking the size of the area or the extent of human interventions into account.

The criteria *"Natural features - flora and fauna"* deals with the naturalness of the area, hence with the intactness and nativeness of habitats and their natural processes and developments. The aspects undisturbedness and undevelopedness are expressed within the two criteria "*Human/artificial influences inside Wilderness"* and *"Human/artificial influences in Wilderness surroundings"* as they both deal with the direct and indirect role of humans inside and outside of wilderness areas. Time is a crucial factor when talking about human influences. Past interventions can affect areas over a long time even if we might think their influences are already gone. An example for that are the far-reaching aftermaths of game and forest management in Europe. Thousands of years of hunting did not only change the composition and distribution of animals in our forests but also the composition of plants. So even in near-natural habitats where past interventions are not visible anymore or never happened directly, the present composition of flora and fauna still shows the impact of such interventions. The documentation of interventions is therefore vital to detect and trace back deviations in habitats. Unfortunately, such documentations rarely exist for small-scale interventions that happened a long time ago. From the 16th century onwards in which a great amount of wood was needed for coal production, mainly big forest clear cuts are documented. However, it has to be assumed that even in remote areas, which were difficult to access some felling took place (LEDITZNIG, C., PEKNY, R., 2011). Therefore, no present signs of human interventions do not necessarily signify that interventions never took place there. The same goes for present interventions, which include restoring measures. Their long-term effects, as well as their extent are uncertain, which demands a detailed documentation.

The timeframe for human intervention starts with the end of the last glacial period, which can be set approximately to 11,000 to 10,000 years ago (STRAHLER, A.H. und STRAHLER, A.N. 2009). Human interventions prior to this date can be neglected due to their minimal invasiveness.

Therefore, all habitats which developed unhindered and without any human interventions since the last glacial period, can be labelled as primary habitats, such as the Rothwald in Austria (LEDITZNIG, C., PEKNY, R., 2011; LEDITZNIG, C. 2017). Habitats which developed unhindered after human interventions, for example clear cuts, consequently have to be labelled as secondary habitats.

The criterion *"management"* focuses on implemented management approaches and the presence and extent of restoring measures, as well as with the existence of a management plan and how human interventions are dealt with within it. Research and monitoring happening in the area are discussed here as well.

The criterion "*size and zoning*" deals with the zoning of wilderness and the differences between those zones. As already discussed in chapter 2. size is a crucial factor for ecosystems to function unhindered and freely. Territory sizes for animals such as wolves or

deer come into effect here too. However, size provides just indirect information of a wilderness area's quality. That is why, criteria such as human interventions inside and outside of the wilderness area should be rated higher as an area's size. Furthermore, small areas with a high quality of wilderness can be "enlarged" with surrounding buffer zones, even if these buffer zones do not show the same quality of wilderness they can still guaranty unhindered processes and exchange and protect the core zones of unwanted influences from the outside.

The point *"Time since introduction of non-intervention management"* simply mentions the starting points of the overall protection of an area, as well as the introduction of non-intervention management, which can be seen as the first and essential step to a wilderness management.

The criterion "*International protection equivalent*" deals with the embedding of the area in to international environmental protection legislations.

Table 3: Categorisation framework (Source: own design)

	Primary Wilderness	**Secondary Wilderness**	**Wild Areas**
Criteria	**Sub-Criteria**		
Habitat	Information on habitat		
Natural features-flora and fauna (naturalness)	Primeval, intact native habitats with unhindered natural processes	Intact native habitats (primary or secondary) with unhindered natural processes	Native habitats develop after human activities stopped - succession, more or less unhindered natural processes
Human/artificial influences inside Wilderness	No past human activities since last glacial period	Signs of past human activities since last glacial period	Signs of recent human activities
	No infrastructure, settlements, fences, power-plants etc (undevelopedness)	No infrastructure, settlements, fences, power-plants etc (undevelopedness)	No infrastructure, settlements, fences, power-plants etc, - plans to remove any disturbances (undevelopedness)
	no active tourism use, no economic interest (undisturbedness)	no active tourism use, just guided excursions with few people, no economic interest (undisturbedness)	Little active tourism use, no economic interest (undisturbedness)
Human/artificial influences in Wilderness surroundings	few influences/signs from human activities in the surrounding buffer areas	human activities in the surrounding areas can influence wilderness area to a certain extent, tourism use in surrounding areas	human activities in the surrounding areas influence wilderness area to a certain extent, tourism use in surrounding areas
Management	Non-intervention management	Non-intervention management in most parts of the area	Area is out of use, Non-intervention management is partly implemented
	No restoring measures	Restoring measures have taken place, still take place to a small extent with time limitation (e.g. forest rejuvenation)	Restoring measures take place
	Wilderness "management" plan, monitoring and research	Wilderness "management" plan, monitoring and research	Wilderness "management" plan in process, monitoring and research
	No human intervention in case of fire or diseases, no game management	Fire, disease and game management plan with non-intervention as a main objective	Fire, disease and game management plan
Size and zoning	Minimum size: 3,000ha	Minimum size: 3,000ha	Minimum size: 1,000ha
	Wilderness zone is surrounded by buffer zone with wilderness-like characteristics	Wilderness zone is surrounded by buffer zone with wilderness-like characteristics	Wilderness zone is surrounded by buffer zone
Time since introduction of protection and non-intervention management	Information on time		
International protection equivalent	IUCN 1a, EU wilderness upper end	IUCN 1a and 1b, EU wilderness	IUCN 1b, EU wild areas

3.3. Analysis of the wilderness areas

The presentation of the chosen wilderness areas focuses on wilderness relevant topics. Consequently, the following chapter does not offer a complete overview of the presented protected areas but rather an extract of their wilderness potential. Complete lists of the areas' habitats and species can be found in the underlying literature. Figure 4 shows the four selected areas. Three of them are already certified wilderness areas: Hohe Tauern Wilderness and Kalkalpen Wilderness have been certified by the European Wilderness Society and are embedded within National Parks of the same name, which are IUCN category 2. The Wilderness Dürrenstein consists of an IUCN 1a and 1b area. Königsbrücker Heide Nature Reserve on the other hand has not yet been officially certified by any organisation as a wilderness area but underwent a Quick Audit of the European Wilderness Society in 2014 that confirmed the wilderness potential of the area. Since this Quick Audit the Nature Reserve's management adapted their management measures in order to be officially certified as a Wilderness Area by the European Wilderness Society.

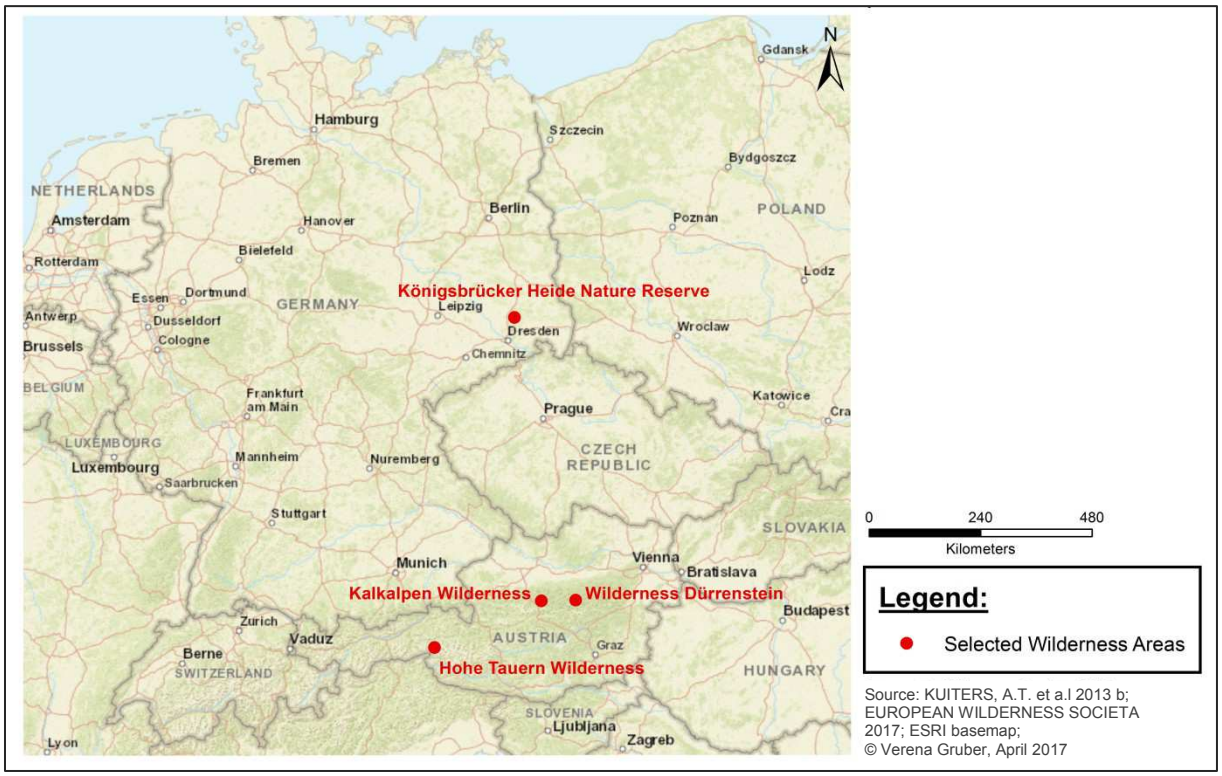

Figure 4: Overview of the selected wilderness areas in Central Europe; (Source: KUITERS, A.T. et al. 2013 b; EUROPEAN WILDERNESS SOCIETY 2017; own illustration with ArcGIS 10.5)

Furthermore, the wilderness quality of the three Austrian areas has been confirmed by the Wilderness Quality Index by PLUTZAR, C. et al. (2013) as well, which can be seen in figure 5. This index is based on the four different aspects of wilderness distinguished as in the approach of LESLIE et al. (1993):

1. "remoteness from settlement
2. remoteness from access
3. apparent naturalness (the degree to which the landscape is free from the presence of the permanent structures of modern technological society)
4. biophysical naturalness (the degree to which the natural environment is free from biophysical disturbance caused by the influence of modern technological society)"

The data expressing and presenting these four indicators were combined with a multi-criteria evaluation (MCE) framework in a Geographic Information System (GIS). Weighted distance decay models were calculated on a raster level with a spatial resolution of 100 metres. PLUTZAR, C. et al. (2013) state that their assessment misses several important factors, such as hunting or grazing, to extensively evaluate Austria's wilderness continuum. However, studies like this one are essential for the identification of wilderness-like areas in Europe and support national and international protection efforts that build on such findings.

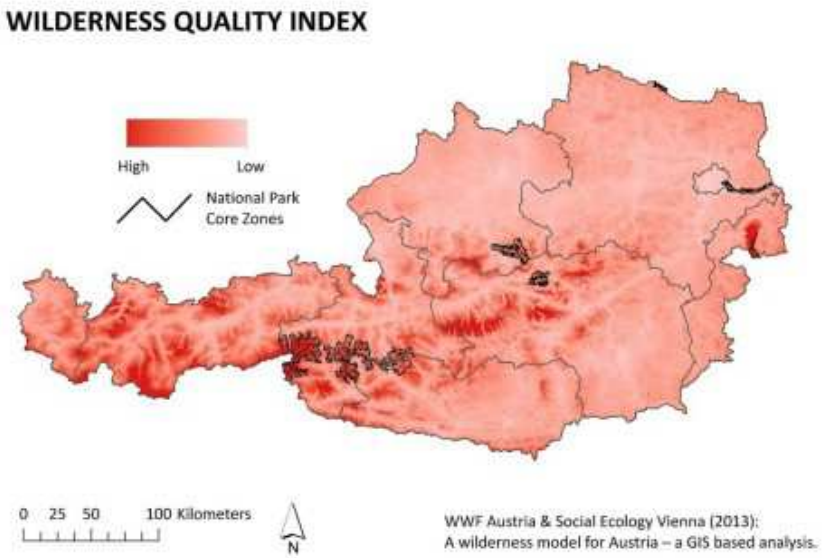

Figure 5: Wilderness Quality Index of Austria with the boundaries of the Austrian National Park core zones on top (Source: PLUTZAR, C. et al. 2013)

On the other hand, the wilderness quality of Königsbrücker Heide Nature Reserve is more difficult to identify with such an approach as the human interferences there happened more recently and there is still some infrastructure left, which impairs the identification. This proves that such GIS and remote sensing based approaches are important tools in the wilderness protection but cannot replace a repeated assessment on site.

3.3.1. Königsbrücker Heide Nature Reserve

The following statements to the Königsbrücker Heide Nature Reserve are based on the information from EUROPEAN WILDERNESS SOCIETY (2014 b), as well as on the homepage of the nature reserve, Staatsbetrieb Sachsenforst (2017). Open questions were answered during a phone call with Cornelia Schlegel from the Nature Reserve's management (SCHLEGEL, C. 2017).

Table 4: Categorisation of Königsbrücker Heide Nature Reserve; for criteria description see table 3; for further details see following paragraphs (Source: EUROPEAN WILDERNESS 2014; Staatsbetrieb Sachsenforst 2017; own design)

	Primary Wilderness	**Secondary Wilderness**	**Wild Areas**
Criteria	**Sub-Criteria**		
Habitat	Mosaic of dry and wet habitats resulting from the use as a military training area from 1907 - 1992, mixed deciduous forests, vegetation-less sandy areas, heather habitats		
Natural features-flora and fauna (naturalness)	–	–	Succession processes in whole area, in particular in Nature Development Zone; in most parts natural processes have priority over biodiversity protection; clearance of bushes in Natura 2000 site
Human/artificial influences inside Wilderness	–	–	Signs of former infrastructure and streets visible, removal has taken place and further removal is planned, soil compaction due to former use of tanks
	–	–	Removal of big parts of infrastructure, streets; further removal is planned
	–	Most parts are closed for tourism due to danger of ammunition, potential for tourism use due to historical background	–
Human/artificial influences in Wilderness surroundings	–	Transition zone acts as buffer between Nature Reserve and surrounding cultivated land; tourism is bundled in transition zone	–
Management	–	–	Non-intervention management in Nature Development Zone
	–	–	Restoration plan exists, various restoring measures take place with the long-term aim to enlarge the core zone: removal of big parts of infrastructure and streets; clearance of bushes in Natura 2000 site
	–	–	Wilderness developing plan partially exists and is obeyed; complete management plan is

			in process; non-intervention strategy is partially implemented; multiple wilderness developing projects inside the Reserve and the Natura 2000 intervention zones;
	–	–	No game management in Nature Development Zone; in general no intervention in fire, invasive species or disease control
Size and zoning	Total area of 6,931.47 ha; Current official zonation: – 79% (ca. 5,500 ha) Nature Development Zone with non-intervention management – 8% (ca. 550 ha) Zone of controlled Succession – 13% (ca. 900 ha) Maintenance Zone with cultivated habitats in border regions of the Nature Reserve		–
	–	–	Nature Development Zone is surrounded by Maintenance Zone; whole Nature Reserve is surrounded by transition zone
Time since introduction of non-intervention management	Out of use since 1992		
International protection equivalent	–	–	Intention to establish a wilderness area in the reserve stated by the state government of Saxony in a regulation of their state development plan of 2013; No protection as an official wilderness area yet

The 6,931.5 ha large Königsbrücker Heide Nature Reserve in Saxony, Germany has been quick-audited by the European Wilderness Society in 2014. The Full Audit mission is planned for 2017, according to ROSSBERG, M. (2017). The former military training ground has been out of use since 1992 and under protection since October 1996. The state government of Saxony formulated the intention to establish a wilderness area in the reserve in a regulation of their state development plan of 2013 (section Z 4.1.1.10) as following: "The Königsbrücker Heide Nature Reserve should be developed to an internationally recognised large-scale wilderness development area surrounded by a nature experiencing area (EUROPEAN WILDERNESS SOCIETY 2014 b, p. 3)." Parts of the reserve are protected under the Fauna-Flora-Habitat, as well as under the Birds directive of the Natura 2000 network.

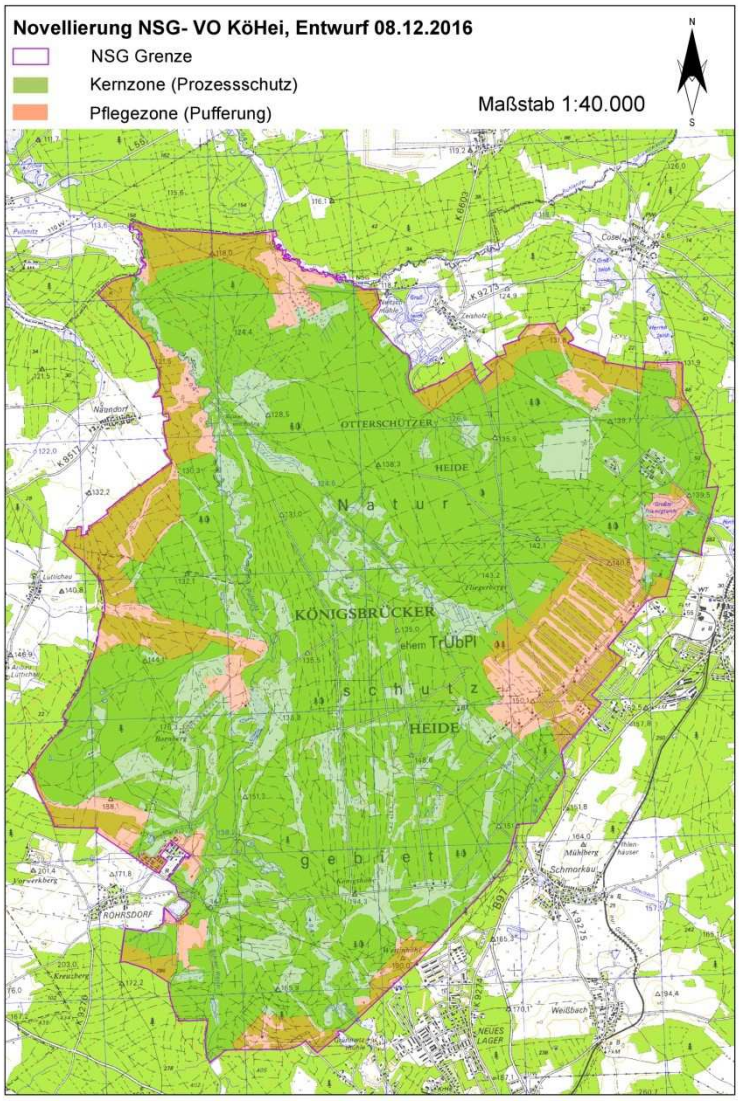

Figure 6: Zonation of Königsbrücker Heide Nature Reserve; green: Nature Development Zone with non-intervention management, red: Maintenance Zone (Source: unpublished map by NSG Verwaltung 2016 provided by SCHLEGEL, C.)

The Nature Reserve is still officially divided into three zones:

1. a Nature Development Zone with non-intervention management;
2. a Zone of Controlled Succession with securing of open land and heather areas and management measures for the Natura 2000 site;
3. a Maintenance Zone where precious cultivated habitats in the border regions of the Nature Reserve are maintained and which acts as a buffer zone to the surrounding areas.

This zonation system will be officially changed into a two-zone system, shown in figure 6, with the recognition of the new nature protection provision (NSG Verordnung) of the state Saxony in 2018. The reserve, however, is already working with the new two-zone system

which integrates most parts of the Zone of Controlled Succession into the Nature Development Zone. The Nature Development Zone now covers approx. 6,050 ha, 87% of the territory. The Natura 2000 site transfers to the Maintenance Zone (SCHLEGEL, C. 2017).

This shift of zones enables the reserve to manage the majority of its territory, the Nature Development Zone, according to non-intervention management so that wilderness can further develop here. All other management measures are bundled within the Maintenance Zone. An adjacent transition zone to the surrounding cultural landscape, not shown in figure 6, is not part of the Nature Reserve anymore but focuses on nature experience (Staatsbetrieb Sachsenforst 2017).

The area was used as a military training ground from 1907 to 1992 resulting in a mixture of dry and wet habitats with the dry habitats prevailing. These habitats are for example, mixed deciduous forests, natural dystrophic lakes and ponds, mire woodlands, vegetation-less sandy areas and open heather habitats. All habitats found in the Nature Reserve are in different succession stages making succession the main natural process for rewilding. The Nature Reserve is home to several internationally endangered species such as beaver, otter, wolf and sea eagle.

As already mentioned, the Nature Reserve hosts a Natura 2000 site. The Natura 2000 provisions demand the preservation of a "favourable protection status" in order to protect biodiversity. To maintain this status, the reserve's management is currently just clearing bushes within the Natura 2000 site. Any other maintenance measures have been stopped (SCHLEGEL, C. 2017).

The new zonation system clarifies one of the major conflicts the Königsbrücker Heide Nature Reserve had to deal with in the past. As interventions to maintain a specific state of habitats are conflicting with non-intervention management and wilderness development, which is the main aim of the Reserve, this was a pressing issue to solve.

According to EUROPEAN UNION 2013 it is not impossible to combine wilderness and Natura 2000. But this document also states that it depends on the conservation goal whether a specific habitat state ("favourable conservation status") wants to be maintained or not and that not all habitats are suitable for non-intervention management. This document by the European Commission further lists best-practice examples for most of the habitats of Königsbrücker Heide Nature Reserve in their appendix. Based on these European examples from different bio-geographical Regions it was concluded that 12 out of the 14 habitat types of the reserve could be managed according to a result-open non-intervention approach without any human interference. Local fluctuations as a result of natural processes within the protected area are permitted, according to this document, as long as the favourable conservation status is ensured on a national and bio-geographical level. As the two remaining habitats are not at risk on a bio-geographical level, they could also be managed

according to non-intervention management, in particular because the interventions in these just 8 ha small habitats would severely alter the habitats in the surrounding non-intervention zones. A full list of the habitat types of Königsbrücker Heide Nature Reserve can be found in EUROPEAN WILDERNESS SOCIETY (2014 b). So according to EUROPEAN UNION (2013), the Natura 2000 network allows explicit changes of the management to achieve wilderness.

The adaption of the zonation system, as well as the reduction of management measures within the Natura 2000 site prove the management's effort to enable wilderness development in the Nature Reserve. The next important step is the recognition of the new nature protection provision (NSG Verordnung) of the state Saxony in order to make the new zonation system official.

Königsbrücker Heide Nature Reserve shows that the combination of active Natura 2000 management and wilderness management is rather challenging for a protection area's management and requires not only expertise in every involved field but most of all a well elaborated management plan. This plan has to put an emphasis on monitoring and research, as the future developments resulting from this change of management measures demand regular surveillance. Furthermore, the contemporary application of two different management approaches offers a rare chance to detect and document differences as well as short- and long-term effects.

The area still shows clear signs of its former use in terms of infrastructure and streets. Parts of these remnants have already been removed and further removal is planned. There is a restoration plan, as part of the wilderness developing plan which is currently in process, dealing with various restoring measures taking place in different parts of the reserve. Passive natural restoration, however, is the main restoring measure in the reserve. The former use of tanks lead to soil compaction in parts of the reserve. These parts are partially managed under the Natura 2000 provisions as rare habitats developed due to this soil compaction but are left for natural succession now.

According to the European Wilderness Quick Audit (EUROPEAN WILDERNESS SOCIETY 2014 b) there is no grazing, forestry, fire, disease as well as invasive species control in the Nature Development Zone but these issues should be specified in the wilderness developing plan. There is also no game management in this zone leading to a considerable red deer population within the reserve. This big red deer population, however, is "managing" most of the heather habitats in the reserve with their grazing, according to SCHLEGEL C. (2017), making other management measures to secure these precious habitats obsolete. SCHLEGEL C. (2017) further stated that there are just 20ha of grassland in the Maintenance Zone grazed by German heaths. There is game management, forestry and grazing in the surrounding areas.

Though Königsbrücker Heide Nature Reserve has a high potential for tourism because of its historical background, though most parts are closed for tourism due to danger of ammunition. On the other hand, this high hazard potential was crucial for the implementation of non-intervention management as there is no economic interest in this area as well as no direct human intervention, except for the removal of ammunition. The only touristic activities currently happening in the area are concentrated in the transition zone where a strong focus lies on nature experience.
The management of Königsbrücker Heide Nature Reserve is currently expanding their partially existing wilderness developing plan, which is incorporated within their management plan. Among other things, this wilderness developing plan deals with multiple wilderness developing projects in the Nature Development Zone and in the Natura 2000 intervention zones. Besides that, a strong focus should be on the monitoring of succession processes and research in the reserve as it offers, as already mentioned before, unique possibilities to observe and understand succession stages, rewilding processes and the effects of different management approaches.

The European Wilderness Society Quick Audit of the Königsbrücker Heide Nature Reserve in 2014 clearly demonstrated the wilderness potential of the area. The allocation to the category "Wild Areas" of all criteria except of "size and zoning" in table 4 underlines this potential. The reserve is a prime example for wilderness establishing on a former heavily used area as well as for the conflict arising from contradictory conservation goals. Königsbrücker Heide Nature Reserves also proves that species related to wilderness, such as wolves, do not necessarily need "high quality wilderness" to establish in a region but simply the absence of humans. The area's management is aware of the area's potential and set a clear signal towards being internationally recognised as a wild area with the adaption of the zonation system.

3.3.2. Kalkalpen Wilderness

The following chapter is based on VANCURA, V. et al (2016 a). Further information was gathered on the homepage of the National Park and during an interview with the National Park's manager Erich Mayrhofer (MAYRHOFER, E. 2017; Nationalpark OÖ Kalkalpen Ges.m.b.H. 2011 a).

Table 5: Categorisation of Kalkalpen Wilderness; for criteria description see table 3; for further details see following paragraphs (Source: VANCURA, V. et al 2016 a; Nationalpark OÖ Kalkalpen Ges.m.b.H. 2011 a; own design)

	Primary Wilderness	**Secondary Wilderness**	**Wild Areas**
Criteria	**Sub-Criteria**		
Habitat	Large continuous piece of limestone Alps including several important habitats such as forest 81% (including old growth beech forest), mountainous pine forest 8%, alpine meadows 6% and rocks and scree 5%		
Natural features-flora and fauna (naturalness)	–	Undisturbed ecosystems such as old growth beech forest, rocky outcrops, mugo pine forests, etc; natural unhindered ecological processes such as succession, deadwood; habitat for native and endangered species such as lynx, birds of prey, etc	–
Human/artificial influences inside Wilderness	–	Wilderness area intensively used for the production of charcoal, mining, forestry and grazing; former utilisation can be traced back to medieval times, in highest part of the park no evidence of former use; change of tree species composition in favour of spruce due to its better drifting attributes;	–
	–	Network of roads, narrow gauge railways, tunnels, bridges in several valleys and impacts of construction are still visible; forest roads restoration through active or passive restoration or stopped in use; no fences in wilderness area, but in management and transition zone for cattle; trails and signs;	Shelter/bivouac, old forest houses, network of old gravel roads; permanent infrastructure also in restoration and transition zones;
	–	No extractive uses or commercial activities in the wilderness area;	Free access on foot; marked trails with signs in the wilderness zone, alpine ski touring, biking is allowed on trails;
Human/artificial influences in Wilderness surroundings	–	Some forests outside NP are intensively managed; culling programme (roe deer, red deer, chamois) in the management zone due to lack of large predators; transitional zone has domestic cattle grazing (alms);	–
Management	–	Wilderness area is free of management or restoration	–

		measures and is managed according to non-intervention management;	
	–	–	Natural processes are the main tool for restoration; management zone includes certain level of activities
	–	Management documents available; <u>Research:</u> forest dynamism, systematic research on parameters to measure the scale of naturalness such as site conditions, regeneration, tree species composition, utilisation, amount of deadwood, tree age and other indicators, mapping and inventory of habitats and various animals and plants <u>Monitoring:</u> burned areas, inventory control of various species, restoration and management measures, visitor control, meteorological monitoring; partner in several research projects;	–
	–	Austrian law requires suppression of forest fires; Austrian law requires control of threat of disease outbreak: regular disease control monitoring and measures, bark beetle control plan, active management measures focus to control bark beetle in the transitional zone and surrounding areas; invasive species are not a major issue at the moment;	–
Size and zoning	partially fragmented due to several small areas with restoration projects and old roads: total size of wilderness area 13,034 ha	–	–
			Wilderness area is not fully surrounded by buffer zones and reaches boarder of NP; management zone with alps, meadows, bark beetle management, wild animal management; Transitional zone with control of bark beetle population dynamics;
Time since	since 2003;		

introduction of non-intervention management			
International protection equivalent	–	IUCN 2, (site assessment of Austria protected area network in 1997 revealed that it meets the quality standard IUCN category Ib); EWS Platinum; pending application UNESCO World Heritage; „Europaschutzgebiet Nationalpark Kalkalpen“ - Natura 2000 (F-F-H and Birds directive); Europarc 2015; AlpPark 2013; Green Alps networks; Ramsar site; certified according ISO 9001 since 2008;	–

The 13,034 ha large Kalkalpen Wilderness is embedded in the Kalkalpen National Park in Upper Austria, Austria. The wilderness area covers 62% of the National Park's surface. The Kalkalpen National Park was established in 1997 and protects one of the largest connected forest areas in Austria (20,900ha). It is internationally acknowledged as IUCN category 2 since 1998 and as a European nature reserve in the Natura 2000 network under the Fauna-Flora-Habitat directive as well as under the bird directive since 2005.

The Kalkalpen Wilderness was fully audited by the European Wilderness Society in July 2015 and certified as a Platinum Wilderness Area. The National Park stretches over the mountain ridges of Sengsengebirge and Reichramiger Hintergebirge from 385m up to its highest peak, Hohe Nock, at 1,963 m. These two mountain ridges are mainly build by Wetterstein limestone and dolomite rock.

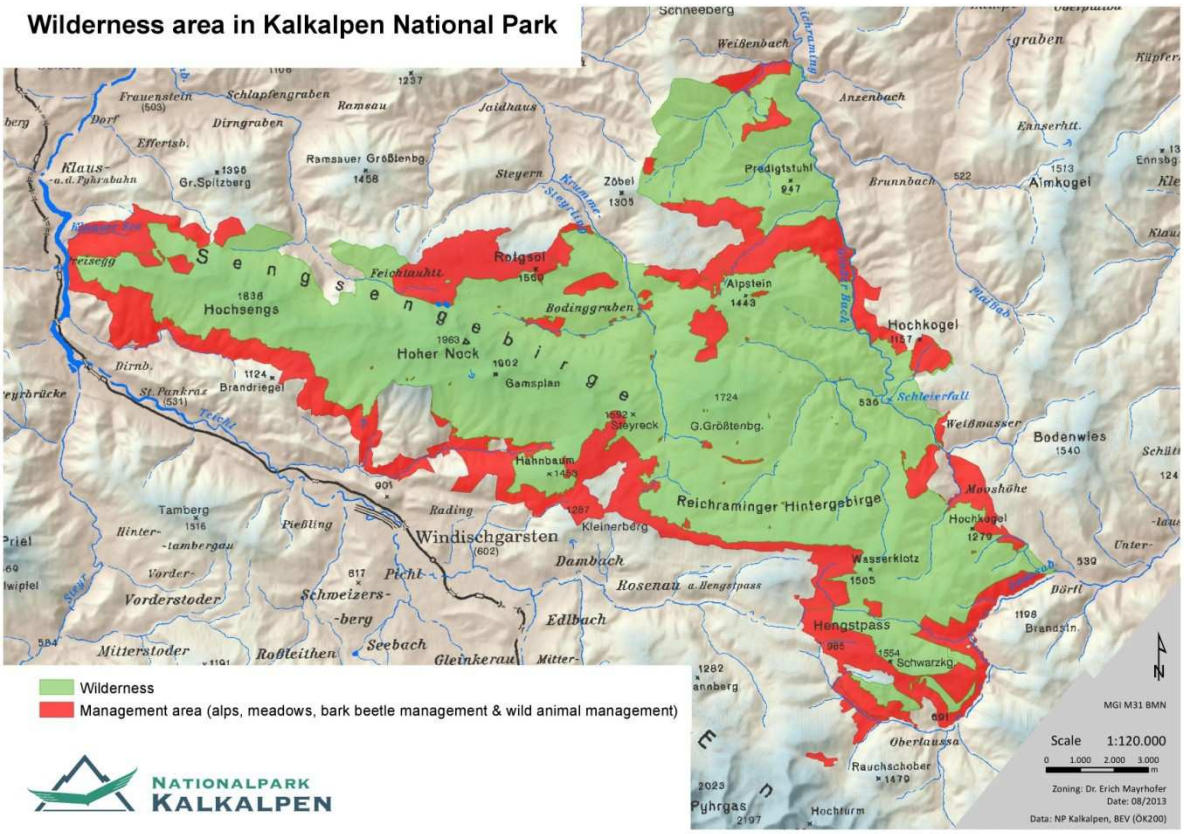

Figure 7: Overview of the Kalkalpen National Park wilderness and management areas (Source: Nationalpark Kalkalpen progress report 1998 - 2012, in: VANCURA, V. et al 2016 a, p. 74)

Figure 7 shows that the wilderness area is fragmented due to small areas with restoration projects and old roads. It is congruent with the Nature Zone (Naturzone) of the National Park's zoning system where no management measures are in place. It is mostly surrounded by the Preservation Zone (Bewahrungszone), which consists of the temporary managed parts of the National Park Kalkalpen. The Preservation Zone covers approximately 25% of the park. Ecological pasture management, bark beetle and herbivore control take place here due to the land ownership structures. It acts as a buffer and restoration zone for the wilderness area, whereas the wilderness area reaches the boarder of the National Park in some parts. The surroundings of the National Park partially meet the Wilderness Quality Standard by the EWS but are intensively managed in other parts in the form of meadows and alps, game and bark beetle management as well as forestry.

According to Nationalpark OÖ Kalkalpen Ges.m.b.H. (2011 a), in 2011 81% of the park's territory were covered by forest, whereas approximately 75% of these forests are managed according to non-intervention management. A biotope mapping, conducted by vegetation experts in the course of the Park's application process as UNESCO world heritage, revealed that based on vegetation indicators approximately 2% of the total area of the National Park

(438 ha) are primary forests without any significant past or present human interventions. Historical records of forestry activities and forest fires verify this. According to this biotope mapping, another 73% of the Park's territory consist of old growth forests which are at least 140 years old. Another 8% of the National Park is covered by mugo pines, 6% by alpine pastures and meadows and 5% by rock and scree areas.

The wilderness area hosts various types of undisturbed and dynamic habitats in different ecological stages such as old growth beech forests, rocky outcrops and mugo pine forests. These habitats contribute to the conservation of various threatened wilderness flagship species such as lynxes, various birds of prey, red deer and badgers and moreover provides potential refuge areas for wolves and bears in case of their returns. Kalkalpen Wilderness is governed by natural processes such as succession and spontaneous natural events like windfall, snow pressure and avalanches, rock fall or bark beetle outbreaks which constantly shape the landscape. These disturbances are an important part of the dynamic development of the National Parks ecosystems. In particular, deadwood plays a significant role for the ecological development of the area and hosts various endangered native species.

The areas above the tree line recovered from former grazing, which was stopped 60 years ago, and are now covered by mugo pine.

Next to grazing in the lower parts, the wilderness area was also intensively used for the production of charcoal, mining and forestry. The area also hosted a large road network, of which parts still exist, and a narrow-gauged railway. These former usages of large parts of the park, in particular some valleys in the Reichraminger Hintergebirge, leads back to the Middle Ages. The first timber logging in the Hintergebirge and the Sengsengebirge dates back 500 years ago. Visible signs of this time of intensive forest exploitation of the narrow karst valleys are numerous logging dams and racks, drifting tracks and about 100 charcoal sites as well as roads, tunnels and bridges. The early mining was a crucial factor for this first increased demand for timber in the area. Apart from the felling of trees, the high demand of timber also changed the species composition of the forests in favour of spruce because of its better drifting attributes. The intensity of these utilisations strongly varies within the area as some parts were used intensively, such as the eastern parts, whereas others were only used once. Due to the inaccessibility of some parts of the present National Park, it can be assumed that some parts of the forests have never been felled. The remotest parts of the Sengsengebirge, for example, show no evidence of past forestry use at all.

This former utilisation led to a high amount of infrastructure, such as roads, bridges and buildings, in the area. When the National Park was founded in 1997 the management decided that the majority of this old infrastructure was economically not necessary for the Park. So big parts where removed, sold or simply left to decay. The conveyance of infrastructure consequently led to a gradual retreat of humans and subsequently to a

repossession of nature. Most parts of the park have been left to nature since then. In some areas forest conversion of spruce monocultures was carried out in the first 10 years after the establishment of the park whereas in particular in the border regions bark beetle control took and still takes place to protect the adjacent commercially managed forests. Since 2007 the only management measure in the Nature Zone is non-intervention management.

The only permanent infrastructure left in the wilderness area are old forest houses, only used by the management, some bivouac shelters, as well as a network of old gravel roads, trails and signs. These roads are only used by the management in cases of emergency or to transport visitors, as well as by land owners as due to the roughness of the terrain some of these roads are the only passageways to remote valleys inside and outside the National Park. The majority of the former forest roads have already undergone active or passive restoration, so that at the moment 170 km of roads are left in the National Park. The management plans to reduce this network by another 50 km. The dismantling of the road network mostly happens through natural restoration after the closing of the streets. The main restoration tools in the whole National Park are spontaneous natural processes, passive restoration and most of the wilderness area has been left for this passive restoration for decades.

There are no present extractive or commercial activities in the wilderness area. It is only accessible by foot whereas biking is allowed on the trails as well.

5% of the previously mentioned 75% of forests with non-intervention management host a culling programme experiment to manage the populations of roe deer, red deer and chamois due to the lack of large predators in the area. The hunting is performed in a qualified area without cars by the park staff. The preservation zone still hosts domestic cattle grazing and consequently fences. There is just minimal light and noise pollution in the wilderness area due to its remote location.

As in the other two Austrian wilderness areas, the Austrian law requires fire control measures in the case of forest fires. But as the last two forest fires in the National Park (12 and 50 years ago) happened in such extreme ecological conditions, no active post-fire restoration measures were taken in the burned areas. The Austrian law also requires the control of disease outbreaks. This is why there is a regular disease control monitoring in place. Active measures to control bark beetle are only installed in the preservation zone as well as in the surrounding areas of the National Park. Disease control, in particular against bark beetle infestations, is a complex issue in the park as the non-intervention management of the majority of the park's territory is in conflict with the economic interest of the surrounding areas. Therefore the arrangement to only control bark beetle outbreaks in the preservation zone in the border region of the park is a safe way of handling this issue. Invasive species are currently not a pressing issue in the National Park.

The National Park is an attractive hiking area and has a tourism development plan in place which includes the wilderness area. There are touristic activities provided focusing on wilderness, as well as wilderness education such as training programmes, a wilderness academy and a "wilderness rangers in school" programme, which are important to raise the support of the locals and visitors. Like in the Hohe Tauern Wilderness there are no restrictions for tourists in the Wilderness Area. On the one hand the wilderness area should be accessible for people to experience the deep impressions wilderness can have to someone's body and soul and to observe the development of nature without human interference. On the other hand this unrestricted accessibility, even if it is just by a small amount of experienced people, influences wilderness in several ways. In particular, shy animals and fragile plants are disturbed by the presence of humans and as there is no rule to stay on the paths, an unguided excursion through the forests might have severe effects on the ecosystems. This problem to make wilderness accessible but at the same time to protect it is difficult to handle. A first step is a thought-through visitor guidance system as people tend to stay on paths even if they don't have to. Consequently if there are no paths in specific areas of the wilderness zone people simply will not go there as it is too difficult and dangerous to find a way out again.
According to VANCURA, V. et al (2016 a) there are several management documents dealing with the long-term conservation strategy of the National Park. Wilderness conservation is seen as a main objective in the park. The focus lies on the creation of a large and contiguous wilderness area, as well as on its connectivity with other near-by protected areas. There is also a research and monitoring plan available with a focus on wilderness and wilderness restoration. Research projects deal with dynamism in the forest ecosystems, parameters to measure the scale of naturalness based on site conditions, regeneration, tree species composition, utilisation, the amount of deadwood or tree age. There are regular mappings and inventories of the parks habitats, animals and plants, as well as of the old growth beech forests. Monitoring projects deal, for example, with the reintroduction of lynx and the impact of bark beetle, as well as with burned areas, visitor control, restoration, management measures and meteorological parameters. The National Park Kalkalpen is also contributing to external research projects.

Most criteria can be found in the category of "Secondary Wilderness", shown in table 5, whereas some criteria, in particular the sub-criteria of *"Human/artificial influences inside Wilderness"* dealing with the infrastructure and the surrounding of the wilderness area fulfil the requirements for the category of "Wild Areas". The time span is a crucial factor here as all infrastructure inside the Wilderness Area is relatively old and was built before the establishment of the National Park. On the other hand, other parts of the wilderness area, such as the primary forests, can be categorised as "Primary Wilderness" when it comes to

their naturalness. The National Park was and is directly or indirectly altered and influenced by the past interventions. Nature took over most of the former infrastructures, though as some of them are still in use, such as the gravel roads, the quality of the wilderness area is diminished. Even though the use of these roads is reasonably justified in such a large area, in order to minimise disturbance factors for the wilderness area, its use should be further reduced.

The habitats of the Kalkalpen Wilderness show a high diversity and dynamic and do not only host endangered and native species but could also serve as refuge areas in case of the return of former inhabitants of these areas such as wolves and bears. The return of big predators would significantly contribute to the life cycles in the ecosystems of the area and would also diminish the need of game management. To get the tolerance and acceptance of the locals for these big predators, however, is a tough process.

Overall, it can be said that the high diversity and dynamism of the habitats in Kalkalpen Wilderness allows its rating as "Secondary Wilderness" despite of the former use of the area.

3.3.3. Wilderness Dürrenstein:

The following subchapter is based on information gathered from Schutzgebietsverwaltung Wildnisgebiet Dürrenstein (2017), LEDITZNIG, C., PEKNY, R., (2011), an interview with Mr. Leditznig, the reserve's manager (LEDITZNIG,C. 2017), as well as from internal management documents provided by Mr. Leditznig.

Table 6:Categorisation of Wilderness Dürrenstein; for criteria description see table 3; for further details see following paragraphs whole reserve, 1a area, 1b area; (Source: LEDITZNIG, C., PEKNY, R., 2011; Schutzgebietsverwaltung Wildnisgebiet Dürrenstein 2017; own design)

	Primary Wilderness	**Secondary Wilderness**	**Wild Areas**
Criteria	**Sub-Criteria**		
Habitat	Primeval spruce-pine-beech forest (Rothwald); 200 years old near-natural mixed forests, alpine meadows and pastures, alpine rock landscapes; dead wood is important habitat for xylobionten species		
Natural features-flora and fauna (naturalness)	Primeval spruce-pine-beech forest Rothwald	200 years old near-natural forests developed after iron production without human intervention - various succession stages; various rare habitats and species; due to high naturalness of habitats various wilderness depending/prefering species (bats, lynx, birds (woodpecker) etc)	
Human/artificial influences inside		Except Rothwald all forests have been used for the iron	

Wilderness		production, but developed freely since then; Pastures are under extensive management	
	Hiking trails		
		Game management in specific zones; extensively used pasture with grazing for conservation purpose;; visitor area: "experience path", excursions to Natural Zone	
Human/artificial influences in Wilderness surroundings	All surrounding forests have been used in former times; game management in surroundings		
Management		Non-intervention management in majority of the reserve	
		Forest restoring/renewing measures in spruce monoculture (1% of area), reintroduction Ural owl	
	Research and monitoring concept 2013 with guidelines on research and monitoring; Monitoring: game populations and their influences, continuous inventory of flora, fauna and habitats long-term monitoring of indicator species (fungus, lichens, xylobiont beetles, bats, woodpecker), management measures, forest development and conversion measure, abiotic location factors (2 meteorological stations since 2009/2010), non-indigenous species and visitors; Research: is mandatory in IUCN 1, projects concerning process dynamic, ecological disturbances and dynamics in the primeval forest, ecosystemic performance of the protected ecosystems, in cooperation with BOKU Wien, ÖBF		
		Control of human caused fires as far as the law allows it. No intervention in natural fires as long as no danger to humans and area is	

		manageable; Bark beetle: no control in wilderness area. Bark beetle monitoring and in case control in the eastern part of the reserve;	
Size and zoning	Whole area: 3,450 ha; 1a (1,160ha); 1b (2,290ha)		
		Natural zone: 88% of territory, game regulation in ca. 20% of area (includes IUCN 1a area) Nature Zone with Silvicultural Management: less than 5% of territory, convention of secondary spruce monocultures into mixed forests until 2020 on 1% of area - natural regeneration; Alpine/wooded Pasture Management Zones: ca. 7% of territory, extensive used pasture with grazing for conservation purpose, Zone for Visitor Management: less than 1% of territory; Ecological Game Management Zone: 25% of territory, ecological game management due to lack of predators	
Time since introduction of non-intervention management	IUCN recognition since 2003; non-intervention management in most areas in place since last use of the forests decades and centuries ago;		
International protection equivalent	IUCN 1a and 1b, part of the Natura 2000 area "Ötscher-Dürrenstein"		

The Wilderness Dürrenstein lies in the south-western border region of Lower Austria and Styria, Austria, and was established between 1997 and 2001. The reserve was recognised as an IUCN category 1 area in 2003. Since then it was enlarged twice and now covers 3,450 ha. The Wilderness Dürrenstein consists of a 1,160 ha large IUCN 1a area and a 2,290 ha large IUCN 1b area around the name giving peak Dürrenstein (1,878 m). The whole area is part of the Natura 2000 region "Ötscher-Dürrenstein".

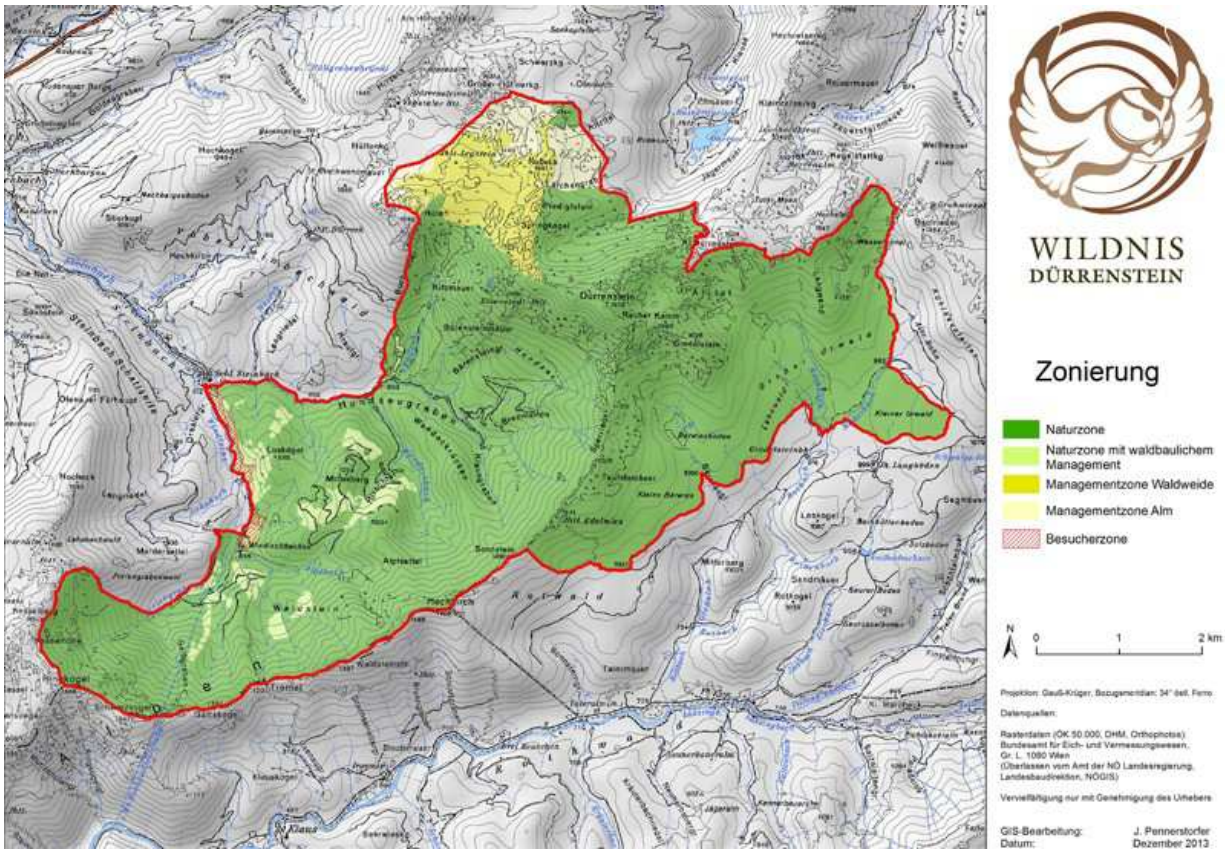

Figure 8: Zonation of the Wilderness Dürrenstein: green: Natural Zone; light green: Nature Zone with Silvicultural Management; yellow: Wooded Pasture Management Zone; light yellow: Alpine Pasture Management Zone; plaid: Zone for Visitor Management (Source: unpublished map by PENNERSTORFER, J. 2013 provided by: LEDITZNIG. C.; data basis: Bundesamt für Eich- und Vermessungswesen, NÖGIS)

The reserve is divided into five zones shown in figure 8. The Natural Zone covers 88% of the reserve and except for game regulation of red and roe deer, as well as chamois on 20% of it, no management measures are implemented here. This zone includes the whole IUCN 1a area. The zone with game management is called Ecological Game Management Zone. Due to the lack of predators ecological game management is necessary here to secure the natural forest-game-structure and to diminish conflicts with the surrounding commercial forests; In the Nature Zone with Silvicultural Management, which covers less than 5% of the reserve's territory, convention of secondary spruce monocultures into mixed forests and interventions for natural forest regeneration take place till 2020; in the Alpine/Wooded Pasture Management Zones extensive pasture management with grazing for conservation purposes still takes place. This management measures secure the habitats of many rare species. Managed limestone grasslands are also part of these zones which cover approximately 7% of the reserve; the Zone for Visitor Management covers less than 1% of the Wilderness Dürrenstein and hosts a wilderness experience path; (Schutzgebietsverwaltung Wildnisgebiet Dürrenstein 2017). The 1a area is located in the

eastern part of the reserve. The border between the 1a and 1b area runs through the valley head of the Seetal and along the eastern and southern ridge of the Dürrenstein to the Sonnstein.

The Wilderness Dürrenstein hosts one of the last primeval spruce-pine-beech forests of Europe, the so-called Rothwald. Albert Rothschild, name-giving to this primeval forest, saved this area in 1875 from forestry to preserve it for future generations. The continuous forestation of the area since the last glacial period has been proven by pollen analysis by KRAL, F., MAYER, H. (1969). This analysis, however, just proves the continuous forestation, not that no interventions ever happened there. If or how the locals used this area, for example for hunting or small scale timber production, before it was put under protection cannot be determined anymore. Therefore the adjective primary only indicates that the forest has never been cut down and therefore exists since the last glacial area but not that it has never been used or influenced in any way. Today this remnant of primary forest covers approximately 400 ha and is surrounded by various forms and stages of old-growth near-natural mixed forests, which are up to 200 years old, secondary spruce forests, alpine meadows and pastures, as well as mugo pines, alpine rock and scree landscapes (LEDITZNIG, C., PEKNY, R., 2011; LEDITZNIG, C. 2017). The reserve hosts a variety of rare and dynamic habitats and species. In particular, the high percentage of dead wood in the old growth forests is an important habitat for xylobiont species and fungus. Other species depending on these kinds of natural habitats in the area are for example bats, woodpeckers or lynxes.

Most secondary forests of the area developed after they have been cut down for the iron production approximately 200 years ago. Since then they developed freely and mostly without any interventions by humans. The few secondary spruce forests only cover 3% of the territory and are currently dissolving due to the bark beetle. Except for the tree composition of some small parts of the areas, the wilderness reserve shows no longer any sign of the former use of the area. The areas with active management are of course an exception. Active forest restoring measures just take place in the spruce monocultures, which are included in the Nature Zone with Silvicultural Management. There is also a reintroduction project for the Ural owl in place.

The surrounding forests of the Wilderness Dürrenstein have been used for iron production as well. Interactions between the reserve and the surroundings are limited to game and bark beetle as the game management of the surroundings influence the reserve and the other way around. Apart from that, no direct influences from the surrounding areas can be detected, according to LEDITZNIG, C. (2017).

There are a limited number of hiking trails in the reserve and there is a rule to stay on these trails. Apart from these trails, the Wilderness Dürrenstein is accessible only during guided

excursions. The whole reserve is visited by 1,500 to 2,000 persons per year, so tourism is not a big issue here.

As already mentioned, there are zones where game management is necessary due to the lack of natural predators, such as lynxes or wolves. Large game populations can lead to conflicts with the surroundings, as they can cause damage to agriculture and forests. Another reason for the implementation of this game management, according to PEKNY, R., LEDITZNIG, C. (2009), is that large game populations can alter the natural forest rejuvenation. Wilderness areas are able to handle larger game populations than commercial forests, according to PEKNY, R., LEDITZNIG, C. (2009), because other time periods are in place for the forest restoration. But as the reserve still wants to guarantee the rejuvenation of native tree species, this is seen as another reason to justify the management of game in the reserve. This management measures are corresponding with the IUCN category 1 requirements as they allow setting control measures for animals threatening the natural forest-game structure of an area (PEKNY, R., LEDITZNIG, C. 2009).

However, a counterargument is that forest rejuvenation, diseases, as well as population sizes underlie, as any other natural process, natural fluctuations that reach critical peaks or collapses. These factors are essential for the natural development and self-regulation of an area. Consequently, human intervention not only delays and stops these natural developments but also the evolution of species. Furthermore, population sizes just have to be limited at one place where they have been artificially "enlarged", due to medication or feeding during winter, at another place. To some extent, such measures are included in the Austrian game laws, which justify them with regard to the use of renewable resources by game management in cultivated landscapes (PEKNY, R., LEDITZNIG, C. 2009). But as game populations migrate and hunting is an economic and in some areas to some extent necessary measure because of the interests of commercial forestry, protected areas in general are under a lot of pressure to continue with some sort of game management within their territory.

Wild boars are not native to the area and are a threat to ground-nesting birds, therefore they are not tolerated in the reserve. Apart from them, there are no invasive species documented in the reserve (PEKNY, R., LEDITZNIG, C. 2009).

The reserve's management is acting according to a management plan, developed in cooperation with the institute for wildlife biology and game management of the University of Natural Resources and Life Sciences Vienna in 2013. This management plan includes a research and monitoring concept, which is mandatory in IUCN category 1 areas. An integral part of the park's research and monitoring is the continual inventory of flora, fauna and habitats. Research is done in the fields of ecological disturbances and dynamics in the primeval forests and the other ecosystems of the reserve. Monitoring focuses on indicator

species (fungus, lichens, xylobiont beetles, bats, woodpeckers, etc.), management measures, game populations and their influences on the ecosystems, forest development and conversion measures, as well as on non-indigenous species and visitor management. A lot of these research and monitoring projects are in cooperation with the University of Natural Resources and Life Sciences Vienna as well as the ÖBF.

This management plan also deals with the control of fire and bark beetle. The fire control is, as in Kalkalpen and Hohe Tauern Wilderness, based on national laws. In Dürrenstein Wilderness, in general, human caused fires are fought whereas natural fires, for example because of lightning strikes, are allowed to burn as long as no man-made infrastructure is in danger.

Bark beetle outbreaks are generally not controlled within the wilderness area. The conversion of forest stands in the last spruce monocultures act as a prevention measure. The forest administration Lugau installed a buffer zone between the wilderness area and their managed territory, as well as various measures to monitor and if necessary to control bark beetle outbreaks in cooperation with the reserve's management, in particular in the eastern part of the reserve, to protect the adjacent forests of the forest administration Lugau (DOPPLER, J., LEDITZNIG, C. 2012).

The IUCN 1a area hosts the primeval forest "Rothwald", as well as surrounding old-growth and secondary forests. The only management measure in the IUCN 1a area is a game management programme on approximately 23% of its area. All other current management measures take place in the IUCN 1b area.

The majority of the reserve's habitats are secondary habitats where natural processes can happen freely and undisturbed as the few management measures in place do not significantly interfere with them. The naturalness of the reserve would be categorised in between "Primary" and "Secondary Wilderness". The management plans to further reduce all current management measures, except for the visitor management, in the future. The installation of the zone for visitor management bundles the majority of visitors in one area leaving the rest of the area almost unimpaired to these influences. This is why the whole reserve would be categorised as "Secondary Wilderness", which also corresponds with the allocation with the majority of the criteria in table 6.

The Wilderness Dürrenstein offers a unique compilation of primary and undisturbed secondary forest habitats, which were able to survive unimpaired due to the sustainable long-term thinking of Albert Rothschild. As the former use did not leave any permanent structures behind most of the secondary habitats developed without any interference and are therefore probably one of the finest examples for secondary forest habitats and secondary wilderness in Europe. Thought it has to be mentioned that the reserve profits a lot from the absence of heavy influences from the surroundings and the absence of traditional use of the

area. After the end of the iron production the forests have never been used again and have been protected soon after that. In other words, as no forestry or agricultural use was established there it never became necessary to dissolve it at one point. This is a major advantage to other areas.

The proximity to Kalkalpen Wilderness Area, which hosts similar and same habitats and species, enables species to migrate and evolution to go on. Connecting these wilderness areas with other adjacent protected areas is an important future task for the areas' managements.

3.3.4. Hohe Tauern Wilderness

The following subchapter is based on VANCURA, V. et al. (2016 b) as well as Ferienregion Nationalpark Hohe Tauern GmbH (2017).

Table 7: Categorisation of Hohe Tauern Wilderness; for criteria description see table 3; for further details see following paragraphs (Source: VANCURA, V. et al 2016 b; own design)

	Primary Wilderness	**Secondary Wilderness**	**Wild Areas**
Criteria	**Sub-Criteria**		
Habitat	Subalpine, alpine, nival habitats: areas of rocks, boulders and scree, glaciers, areas with temporal and permanent snowfields and permafrost, alpine grasslands, subalpine coniferous forests, habitats of the timberline, sparsely vegetated areas		
Natural features- flora and fauna	Newly emerging areas due to dynamic high alpine processes: glacier forefield, deposition areas of rock falls, etc .	Intact native, mostly primary, subalpine, alpine and nival habitats; high dynamism due to retreating glaciers, thawing permafrost, fluctuation of mountain creeks; high percentage of biodiversity and high rate of endemism in whole National Park; wilderness zone is dominated by natural dynamics	–
Human/artificial influences inside Wilderness	–	Impacts of previous commercial activities, such as forestry and are still visible	–
	No permanent infrastructure; no trails in "Special Protected Area" but in other parts of wilderness area, no roads, accessible only by foot; no fences; no light or noise pollution	–	–
	–	No extractive or commercial uses; collecting of minerals is not permitted	Less than 5,000 visitors per year in wilderness area

Human/artificial influences in Wilderness surroundings	–	Heavy touristic use and growing interest in outdoor activities in surrounding areas; two alpine huts with supply cable cars; game management in surrounding areas compatible with wilderness (EWS); gravel roads in transition zones	–
Management	Non-intervention management is well-established in the wilderness area	–	–
	–	Passive restoration with positive outcomes	–
	–	Wilderness Management Plan still under development as part of the management documents; <u>Research</u>: (National Park): focus on alpine environment, permafrost thawing, glacier retreat, flora and fauna and biodiversity conservation, key-species and habitats, landscape level-processes, relevant management issues, ibex, eagles, chamois; <u>Monitoring:</u> disease outbreaks, management of herbivores, wilderness and biodiversity, dynamics of previously glaciated areas, wilderness and the impact of tourism activities; European wide projects: protection of vulture, ibex, eagle	–
	–	Hunting and game management are not permitted in the wilderness area, ibex are managed by park administration; <u>Disease:</u> national legislation inhibits let-it-fly policy but no active disease control in the wilderness; park policy states that invasive species are not tolerated within the wilderness zone but are currently not a problem	–
Size and zoning	8,465ha along the main ridge of the Hohe Tauern range	–	–
	Wilderness area is one	–	–

	large compact piece of land divided in wilderness area and transition zone;		
Time since introduction of non-intervention management	NP was established in 1984		
International protection equivalent	–	Embedded in NP IUCN 2; Natura 2000 under the Birds, Flora and Fauna, and Habitats Directives; part of Austria's protected area network; Europarc (2015); AlpPark (2013); Member of Green Alps networks	–

The 8,465 ha large Hohe Tauern Wilderness is embedded in the Hohe Tauern Nationalpark Salzburg, Austria, which was established in 1984. The National Park was acknowledged as IUCN category 2 in 2006 and is also part of the Natura 2000 network under the Birds, Flora and Fauna, as well as under the Habitats Directives in all three provinces (Carinthia, Salzburg, East-Tyrol).

The wilderness area was fully audited and certified by the European Wilderness Society in 2015 with the Gold Standard. The compact piece of land, shown in figure 9, stretches from 1,654 m up to the peak of Großvenediger at 3,660 m and consists of the highest parts and valley heads of the Obersulzbachtal, the Untersulzbachtal and the Krimmler Achental. The wilderness area consists of the National Park core zone and the "Special Protected Area" in the Untersulzbachtal. It is surrounded by the National Park core and buffer zones which act as a transition zone to the wilderness area.

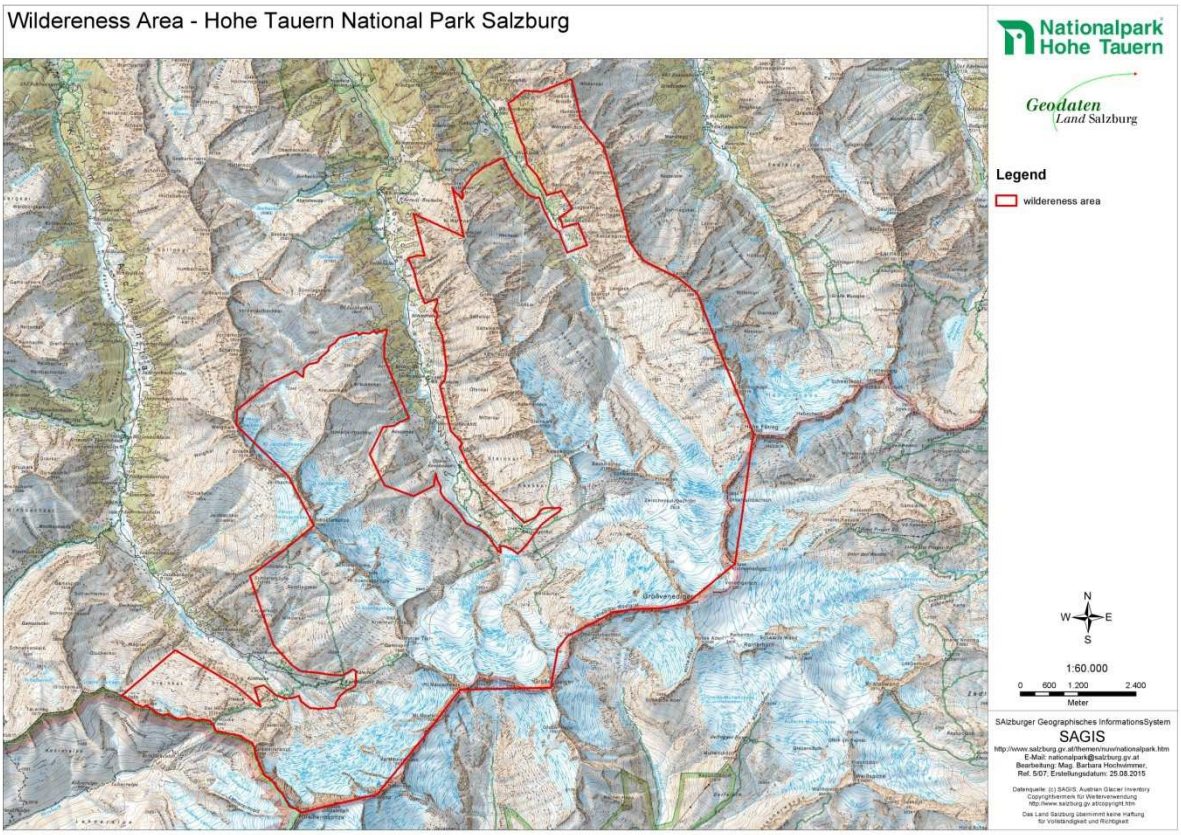

Figure 9: Boarders of the Hohe Tauern Wilderness (Source: unpublished map by HOCHWIMMER, B. 2015 provided by VANCURA, V.; data basis: SAGIS (http://www.salzburg.gv.at/copyright.htm))

The wilderness area includes various characteristic subalpine, alpine and nival habitats, such as: areas of rocks, boulders and scree, which cover ca. 40% of the area. Glaciers, temporal and permanent snowfields cover more than a third of the area. Alpine grasslands, subalpine coniferous forests, the habitats of the timberline and sparsely vegetated areas make up the rest. All of these habitats show a high rate of dynamism due to the retreating glaciers, the thawing permafrost, other peri- and paraglacial processes, as well as the yearly fluctuations of mountain creeks. The subalpine forests are dominated by Pinus cembra and Larix decidua and in the lower parts by Picea abies. In the wilderness zone all of these natural processes happen freely and unhindered as non-intervention management is well-established there.

The flora and fauna composition can be called natural, whereas the ibex was reintroduced to the area by a reintroduction project and is still managed by the park administration. Further reintroduction projects for eagles and vultures are still taking place. The whole Hohe Tauern National Park shows a high percentage of biodiversity and a high rate of endemism.

Some patches in the lower parts of the wilderness area were used for grazing, as well as for forestry in the past, in particular the northern part, and even though none of these activities currently take place, their signs are still visible. Not all of these formerly used forests will self-recover without active intervention by the management, which makes small-scale

interventions necessary to get back to a near-natural state. However, most parts of these formerly used areas have successfully been left for passive restoration for decades and according to the management plan it should continue this way.

Therefore, the category *"Natural features - flora and fauna"* would be categorised in between "Primary" and "Secondary Wilderness" as, due to the high dynamic of the area, new areas develop all the time, for example glacier forefields due to the glacier retreat or deposition areas of rock falls. These small new emerging areas can definitely be rated as "Primary Wilderness" but do not represent the whole wilderness area. Further, most of the nival and alpine areas have never been used, except for alpinism, and consequently have not been severely altered by humans. On the other hand, signs of past human activities can be found in the lower regions and small-scale rewilding and restoring measures, which do not focus just on the wilderness area but on the National Park core zone, are still in place. So an allocation at "Secondary Wilderness" is reasonably justified here.

There are neither permanent infrastructure nor roads, fences or any extractive uses in the whole wilderness area and the area is only accessible by foot. But as the National Park is a very popular hiking area, there are hiking trails in most parts of the wilderness area except for the Untersulzbachtal, which is a "Special Protected Area" and free from any trails. The wilderness area is situated in the highest parts of the National Park and is therefore mostly visited by experienced hikers, climbers, skiers or educational excursions which make up less than 5,000 visitors per year, according to the park authority. These activities do not alter the area significantly as these people move on old paths which have been there for decades. Consequently, the disturbance of vegetation because of footsteps is rather minimal, but as these are fragile habitats it still has to be taken in account. The same applies for the disturbance of animals living there.

During the site assessment of the European Wilderness Society no light or noise pollution from the nearest permanent settlements, which are 10km away from the wilderness border, were identified. Though the two alpine huts and their supply cable cars in the surrounding area are visible from parts of the wilderness area, they are just a minor visual disturbance. But as they are rather popular touristic destinations, in particular the Kürsingerhütte in the Obersulzbachtal, as this cabin is a popular starting point to reach various high peaks, among them Salzburg's highest peak Großvenediger, and glaciers (Obersulzbachkees), their impacts on the nearby wilderness area cannot be denied. Without those huts, a significantly smaller amount of people would visit this remote area.

Supply flights with helicopters have already been minimised to two flights per year by the park management. Other permanent or temporary infrastructures in the transition zone, such as information signs, do not influence the wilderness area. The only exceptions are the gravel roads in the valley floors, which are highly frequented in the summer time by taxi

services and authorised persons, such as resident farmers and hosts. So, even if they do not alter the wilderness area directly, the high number of tourists in the transition zone during the summer months might have far-reaching influences, for example for the wildlife of the wilderness area.

There is neither hunting nor game management inside the Wilderness Area. The game management of the surrounding areas of the wilderness area is, according to the European Wilderness, compatible with wilderness. Due to conflicts with the national legislation the park administration cannot implement any sort of let-it-fly policy when it comes to disease control but is not actively controlling diseases in the wilderness area. The collection of minerals is not permitted within the wilderness area but currently there are conflicts arising related to that topic, which might influence the quality of the wilderness area in the future.

The Hohe Tauern Wilderness is managed according to a wilderness management plan, which is part of the overall management documents of the National Park. These documents are still in development. This wilderness management plan includes research and monitoring projects, as well as research partners. Research projects focus for example on the dynamism or on the high grade of biodiversity of the area. The National Park Hohe Tauern cooperates with several other National Parks in the Alps when it comes to research and monitoring, such as the Hohe Tauern National Park Carinthia and Tyrol, the Swiss National Park, the National Park Berchtesgaden and the Stilfserjoch/Stelvio National Park, as well as with various Austrian universities.

Table 7 shows that most criteria can be found in the category of "Secondary Wilderness" whereas some lie in the category of "Primary Wilderness". Hohe Tauern Wilderness clearly shows that not only the quality of the wilderness area per se is decisive for its categorisation. Even though some aspects match with "Primary Wilderness" the touristic use of the surrounding transition area has influences on some parts of the wilderness area, in particular in the Obersulzbachtal and the Krimmler Achental. The biggest, but indirect, influencing factor is the seasonal presence of a great number of people in the two of the three valleys. This conflict between touristic use and nature protection, in particular wilderness protection, can be observed all over the world and is a complex issue. As Austria is a state driven by tourism where, if one might say so, alpinism is part of the countries' culture this conflict is especially present. Not all interactions between the Wilderness Zone and the surrounding areas can be measured or retraced which makes it difficult to understand them and moreover to prevent the "unwanted" ones. Therefore, precise monitoring and research are indispensable to guarantee the continuation of the wilderness quality of the Hohe Tauern Wildernes Area. The National Park management already implemented monitoring and research projects related to wilderness but a future focus on it would be desirable. So overall

the categorisation as "Secondary Wilderness", which also matches with the majority of criteria, is justified here.

3.4. Comparative Analysis of the wilderness areas

This chapter clearly demonstrates the versatility of what is called wilderness in a nature protection context. All organisations active in this field work with the same basis – to conserve areas without significant human traces and/or to protect them from further interferences. The actual characteristics of wilderness protection, however, are rather complex as the four examples showed.

The presented framework and the categorisations of the four areas underpin the dynamism of wilderness, or better, the dynamism of nature without human interferences. However, none of the selected areas is strictly allocated to one category but rather split up across the three categories depending on the respective criteria. In table 7, individual parts of the four wilderness areas are assigned to their most suitable category to serve as examples for the three categories. Consequently, a clear allocation to one of the three categorisations cannot be achieved. The borders of the three criteria are more like fluent transitions and are not based on "hard criteria" with precise figures. The presence or absence of traces are more decisive and the factor time plays a crucial role in their weighting.

Table 8: Example areas for each category of the categorisation framework (Source: own design)

Primary Wilderness	Secondary Wilderness	Wild Areas
Rothwald, old-growth forests in Kalkalpen Wilderness, glacier forfields in Hohe Tauern Wilderness	Majority of Wilderness Dürrenstein, Kalkalpen Wilderness, Hohe Tauern Wilderness	Königsbrücker Heide Nature Reserve

It also has to be mentioned that this valuation is based on the present state of the areas. It just presents a snapshot of the current processes resulting from past developments. This, however, would be in contradiction to the whole system of wilderness being a dynamic process rather than a specific state of nature. This reflects the previously mentioned discussion of the problematic of missing baselines in the concept of the wilderness continuum. Nature cannot be put in a strict frame with baselines or numbers differentiating it in wilderness, or any category of it, and non-wilderness. Therefore, a categorisation as the one in this thesis is actually void. However, it is in our nature to categorise the world as this makes it easier to understand it. And as we are speaking of slow developments in comparison with the human lifespan, a categorisation of wilderness for protecting reasons based on the current state of an area makes sense.

Table 8 shows that the majority of the analysed wilderness areas can be labelled as secondary wilderness. This is due to the presence and influences of past activities on their territory, as well as because of the influences from the surrounding areas, as it is the case in Hohe Tauern Wilderness. The larger extent of past activities rates Königsbrücker Heide Nature Reserve as Wild Area. All four areas installed non-intervention management on the majority of their territory. However, every area faces different challenges arising from that. The main conflicts detected consist of game and invasive species management, for Kalkalpen Wilderness and Wilderness Dürrenstein, tourism, for Hohe Tauern Wilderness, presence of former infrastructure, for Kalkalpen Wilderness and Königsbrücker Heide Nature Reserve, and overlapping with a Natura 2000 site, for Königsbrücker Heide Nature Reserve. Some, as in Königsbrücker Heide Nature Reserve, could be solved by a change of zonation, others need time and the understanding, as well as acceptance for the implemented management measure from the local residents and stakeholders. Besides that clear provisions and their precise implementation have to be set by the management or governments to reduce the potential of conflicts.

It is wishful thinking, however, to assume that wilderness can coexist with cultivated or industrial landscapes without any conflicts arising from their different management approaches. On the positive side, such challenges force managements, stakeholders and society to think outside their boxes, which opens up new opportunities for all involved sides. The natural conditions of the areas are, even though mostly not pristine, still in a natural state and underlie natural processes and developments, such as succession. The influences from any activities inside or outside the wilderness areas are, for the moment, manageable whereas their future impact cannot be predicted.

4. Discussion

The following chapter will take up the topics addressed in the research questions, which were formulated in the first chapter of this thesis.

- How is wilderness defined in global and European contexts?
- Which categories and phases of wilderness can be distinguished in Europe? What are the differences between them and does it make sense to differentiate between them?
- Which categories and phases can be found in Europe and how do these wilderness areas differ from each other? Which aspects do they have in common?

This thesis addresses numerous uncertainties and challenges in the field of wilderness protection. Most of them can be summarised under the issue of applicability and interpretation of wilderness definitions. The theoretically most applicable definitions for a European context were presented in chapter 2. Their advantages and disadvantages when put into practise have been discussed in the course of this thesis as well.

The reasons why the European Wilderness Society and the IUCN, as well as to some extent the Natura 2000 network, protect wilderness are actually rather similar, as explained in chapter 2, simply their weighting varies: IUCN protects biodiversity and natural features in intact ecosystems with limited and controlled human visitation, use and impact within their category 1a (IUCN 2017 a). Large unmodified areas that retained their natural character and have no permanent human habitation are protected within category 1b (IUCN 2017 b). The European wilderness society's mission is to "identify, designate, manage and promote Europe's last old growth forests, wild-rivers, wild areas and wilderness" (EUROPEAN WILDERNESS SOCIETY 2014 a) on the basis of the definitions of wilderness and wild areas by the WILDERNESS WORKING GROUP in AYKROYD, T. (2013). The Natura 2000 network includes wilderness within their network with the background of biodiversity conservation (KUITERS, A.T. et al. 2013 a).

All of these definitions address a high rate of intactness and naturalness of ecosystems, as well as low or no forms of human modifications. Some integrate a high rate of biodiversity, such as the Natura 2000 network, others not. This results from the discussion if wilderness actually benefits biodiversity in the short or long-term. Authors such as LUPP, G. et al. (2011) state that in comparison to previous land uses, in particular in the case of extensively used cultivated land, wilderness might lead to a biodiversity loss at the species level. The developments at a landscape level are more complex as new types of spontaneous vegetation composition arising on areas that have been put out of use are often dominated by non-native species. Such non-native species can severely alter and even decrease the

habitats of native species. But mostly these habitats of native species have already been severely influenced by human activities before they were put out of use.

LUPP et al. (2011) further give the example of species depending on replacement habitats, such as military areas with certain disturbance patterns, because their original habitats, for example open dune landscapes, have been extinct in Europe. These places would evolve to rather homogenous forests in the short or medium term with a wilderness management approach and consequently just provide habitats for a few species. The factor time is crucial here though, as in the long-term and with sufficient space for natural dynamics habitat types similar to the original ones might occur again. These habitats would provide space for fauna and flora depending on such dynamic patterns. With this in mind, it can be said that wilderness protection does not exclude biodiversity protection in the long term. However, the words "long-term" are decisive here as the main problems arising between biodiversity and wilderness protection are due to a short-term perspective of biodiversity protection. MAYRHOFER, E. (2017) assumes that with a better implementation of habitat protection, for example by wilderness management, it would be possible to reduce species protection, which is a main focus of biodiversity protection, as this would be a "side effect" of habitat protection anyway.

One main difference between the definitions of the IUCN and the definitions of the Wilderness Working Group is the context they were developed for. The IUCN categories and criteria were developed for a global applicability, whereas the Wilderness Working Group developed their definitions specifically for Europe.

Apart from the different contexts of the definitions, their applicability and in particular the approaches of certifying them, varies significantly. Furthermore, IUCN is certifying protected areas as a whole, or rather according to their primary objective which corresponds to a category's criteria on more than 75% of the territory, and not just zones of it (VANCURA, V. 2017). A good example for this is Hohe Tauern National Park, which hosts the "Special Protected Area" in Untersulzbachtal, which would probably fulfil the criteria for IUCN category 1a or 1b. According to KUITERS, A.T. et al. (2013 a), the application of the IUCN category system allows a "nesting" of one category within another one. However, this nesting area would need to be "identified separately for accounting and reporting purpose" (KUITERS, A.T. et al. 2013 a). This, of course, means a lot more expenses for the National Park management and, as the area is already protected under a stricter, however just nationally applied, category compared to the rest of the National Park, it is understandable to avoid putting another label on it. If the Austrian Federal Ministry for Agriculture, Forestry, Environment and Water management, which is responsible for the application of the IUCN categories in Austria, would even rate this area as IUCN 1 is another question. The

European Wilderness Society, on the other hand, is simply certifying those parts or zones of protected areas that fulfil their criteria.

The IUCN, as already mentioned, does not certify areas on their own but has representatives in every country to undertake this task by their own interpretation of the category's criteria. The Wilderness Working Group or the European Union, which commissioned the development of the definitions of wilderness and wild areas, are not certifying wilderness themselves. But their definitions are in use at the European Wilderness Society, which built up their Wilderness Preservation Network of actively certified wilderness areas on these definitions.

In the end, these different types of definition applications are decisive if it is actually wilderness that is protected or not. So even though the IUCN is certifying unmodified or only slightly modified nature in Europe since decades and the European Wilderness Society has just been doing so since 2014, the latter is certifying areas with a uniform standard all over the continent (EUROPEAN WILDERNESS SOCIETY 2014 a). This uniform standard plays a crucial role if an area can actually be called wilderness or not.

Chapter 3.3. shows that the Austrian interpretation of the IUCN 1 criteria corresponds with the EWQA of the European Wilderness Society. However, the Wilderness Dürrenstein currently does not show any interest to be part of the European Wilderness Network as, according to LEDITZNIG, C. (2017), the IUCN certification is sufficient for them and the protective purpose of the reserve.

The main conditions for the European Wilderness Society to assess an area's wilderness potential are the interest, willingness and commitment of an area's management to implement wilderness management. Other crucial factors are of course financing, time, availability of trained employees and most of all that the natural conditions meet the EWQA (ROSSBERG, M. 2017; VANCURA, V. 2017). Apart from that, wilderness protection in general strongly hinges on national legislations, depending on the weight a country grants it and tolerates non-intervention management, national organisations promoting wilderness protection and the regional social acceptance of the topic (ROSSBERG, M. 2017).

To sum up, the definitions used by the IUCN and the European Wilderness Society are both classifying nature according to its modifications, naturalness and size. The former builds upon the concept of primary and secondary wilderness, whereas the latter leans on the classification of wilderness and wild areas. The categorisation framework presented in chapter 3. combines those two concepts but especially builds upon the concept of the wilderness continuum. This is justified with the problems arising from categorising a dynamic state. Furthermore, the basis of the concept of the wilderness continuum is neutral in its evaluation of nature and acknowledges room to cultivated landscape, as well as to "self-willed" land, as the figures 2 and 10 show.

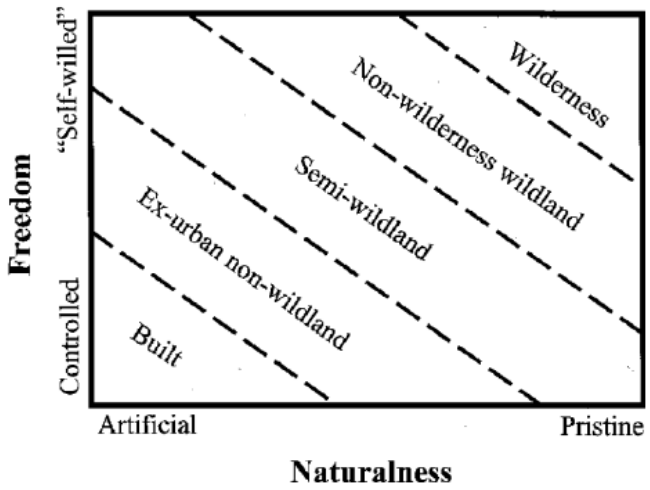

Figure 10: Increasing wilderness as a function of naturalness and freedom from human control (Source: APLET, G. et al. 2000)

The concept of primary and secondary wilderness on the other hand evaluates nature by means of the factors time and modification. From a nature's point of view, this makes sense as primary and secondary habitats differ in many ways. But when it comes to wilderness this evaluation has to be broken down to just the factor of time as not even primary wilderness is unmodified from a holistic viewpoint.

The wilderness continuum grants more space and freedom to nature's dynamics and shows which conditions might occur when areas are put out of use and undisturbed developments are allowed. If these developments will ever lead to a state that can be called wilderness is uncertain and mostly depends on the definition of it. How one wants to call or classify such a state or any state in areas put out of use and develop undisturbed and freely might not be that important in the end anyway. The main point is to recognise that such areas and developments are worth protecting and that they are granted their value by leaving them unimpaired in the future.

Emotions arising from wild nature are not paid close attention in any of the European definitions, even though the ICUN category 1a and 1b at least mention cultural and spiritual value of natural features and the possibility to experience solitude as a characteristic of their areas (IUCN 2017 a; IUCN 2017 b). The problem of including such emotions arises from the difficulties to measure them. It can be assumed though, that areas fulfilling the natural criteria for wilderness are able to evoke such emotions. But as already mentioned, emotions like solitude are not bound to wilderness but simply to nature, making their status as wilderness criteria void.

So even though wilderness in Europe knows two thought-through and applicable definitions for protecting reasons, based mainly on natural conditions, it has to be kept in mind that not just wilderness protection but nature protection in general is, as VINCENZOTTI, V., TREPL,

I. (2009) called it, a "mental construct". We protect parts of nature we regard as worth protecting due to their rareness, a high rate of biodiversity or the presence of endangered species. Most nature protection categories protect cultivated land – a nature how we imagine and want it to be, a place of desire. Hardly any categories focus on actual "natural" nature and let nature happen freely, unrestricted and open-ended. Of course, the discussion what actually is "natural" comes into play here again. But as previously stated this would go beyond the scope of this thesis. However, this is where wilderness protection comes into play, at least its ideal. The challenges and problems of protecting freely, unrestricted and open-ended nature have already been demonstrated in chapter 2 and 3 of this thesis.

The economical interest in the European natural environment makes putting large areas out of use nearly impossible. And even if there is no economical interest left within areas that have been put out of use, the interests of the surrounding areas will still be pursued. This consequently influences the areas within again. To secure such interests measures might be necessary within the areas to reduce the influences from the management measures taken there. Examples for that, such as tourism, hunting, fire, disease and invasive species management, are presented in chapter 3.
Another issue with putting areas out of use is the tradition and history related with them. Old path networks, and access possibilities in general, traditional grazing of alpine pastures or historic hunting rights are deeply rooted in society and therefore can hardly be set aside or put out of use within a couple of years. It takes the understanding of the majority of society to do so and it is common knowledge that masses are slow. The awareness of the extents and consequences of such "traditional and established" measures is mostly non-existent as entrenched pictures and imaginations of how nature should look like are mostly shaped by cultivated and not natural landscapes. Of course, such cultivated lands have a right to exist as well but these views are rooted in the historic need to control the unpredictable processes of nature for survival, which has been mentioned in chapter 2.1. However, as stated in chapter 2, wilderness offers various short and long-term benefits for society. The public awareness of these benefits is key to society's participation in the development and designation of wilderness areas. Consequently, the raising of this awareness should be a main focus of all existing wilderness areas.

Today this need to control nature can often be outdated but still transports a feeling of security. In contrast, the ways humans used to control and use nature can even exacerbate natural processes. For example, invasive species outbreaks or wind throws have higher rates of damage in industrial monocultures than in natural or near-natural forests as monocultures are known to be less resilient than natural forests. However, this cannot be assumed for all measures for controlling and using nature.

An important tool to manage those challenges is zonation. Boundaries for management measures are essential to control their consequences on both sides of a border. Buffer zones, for example, can soften influences from both sides.
In particular, tourism can also be managed with the choice of the appropriate categorisation category. Categories like IUCN 1a and 1b are not meant for a touristic use, other than national parks, category 2, and might even host no-go zones. The installation of zones that bundle tourism and raise the awareness for the importance to respect this zonation system and possible no-go zones can reduce the pressure on the rest of the area. In most cases such wilderness-like areas bundling tourism satisfy the desire to see wilderness anyway because they serve the imagination people have about it.

Chapter 2 and 3 demonstrate that some sort of categorisation underlies all definitions applicable in a European context and that, consequently, all wilderness areas can be allocated to one category of wilderness. In the end, however, it does not make a big difference if this categorisation is subdividing in primary and secondary or wilderness and wild areas. The US Wilderness Act proves that a categorisation is not necessary to protect wilderness. The only distinction necessary is the one between wilderness and not-wilderness and as all of the questioned experts agreed to, this line can be drawn at the decision to put an area out of use and stop any interferences (MAYRHOFER, E. 2017; LEIDITZNIG, C. 2017; JUNGMEIER, M. 2017; ROSSBERG, M. 2017; VANCURA, V. 2017). All developments after that point can already be called wild, making the territory where they happen to wilderness.
Furthermore, the conflicts arising by trying to guarantee that these areas can develop freely in the future are not limited to any specific category of wilderness, but simply to areas out of use and without any economic interest.
The decisive factor is again time, as any sign of past activities will be covered with or integrated in natural processes eventually and their influences will decrease over time. Our role in this development is to step back and observe how nature is mastering itself. In the end, this is the main point of wilderness protection - to let nature be nature. Doing that, however, does not mean that we should exclude ourselves from it but that we see ourselves as part of the bigger picture as we are a part of nature.

5. Conclusion

The objective of this thesis was primarily to answer questions such as "What is wilderness and why do we protect it?". In order to do so, it was necessary to ask "How is wilderness defined and according to this definition, is there wilderness in Europe?" This thesis offers an attempt to answer these questions and the research questions building up on them in a scientific way.

As this thesis focuses on Central Europe it consequently only provides an overview of the worldwide discussion about wilderness and its protection. Wilderness knows a lot of definitions and differentiations and as a result just as many conflicts and "threats". Taking up the fundamental discussion if nature is still untouched, uninfluenced or unmodified anywhere in this world would have gone beyond the scope of this thesis. However, this discussion is not decisive for protecting reasons anyway because even with an extensive scientific background, we cannot grasp the whole extent of human influences on nature. This was demonstrated by the four examples presented in chapter 3.3. We build our definitions for terms such as natural, native or wilderness on this scientific background but ultimately, we can only assume what they are based on our own point of view.

The analysis of the four selected wilderness areas points out that the main challenge wilderness areas in Central Europe are facing is the handling of their past usages. Only little areas have been left untouched so the main focus of organisations dealing with, protecting and actively certifying wilderness has to be the confrontation with this issue. Choosing the appropriate form of management, and if necessary restoration measures, finding ways to keep influences from surrounding areas as little as possible and sensitise the society for non-intervention management and its monitoring are therefore the main tasks of managements of wilderness areas. Planning and installing connection corridors between protected areas to ensure species exchange and migration is another essential task for the future of wilderness protection in Europe. The present trend or momentum of wilderness is advocated by developments such as the positions paper of the National Parks Austria, which suggests the establishment of wilderness in all Austrian National Park core zones.

To sum up, wilderness protection has a right to exist even on a densely populated continent such as Europe. The four analysed areas definitely show that there are still unmodified or only slightly modified areas left within Central Europe deserving to be called wilderness or wild areas. However, this thesis also demonstrates that wilderness in Europe needs a more flexible and future-oriented approach due to the historic and current extent of utilisation of the continent. How wilderness can look like and what characteristics it can show in Europe is demonstrated by this thesis.

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