Conservation Management Practices In Three Different European Protected Areas

With a focus on hydrology and grazing

Alfred Toepfer Natural Heritage Scholarship 2023

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Introduction

I have been captivated by nature for as long as I can remember. It is vital for the health, both mental and physical, of us all, yet still the degradation of natural areas, biodiversity loss and climate change are consistantly deprioritised as societal issues. Globally, populations of wildlife declined an average of 69% between 1970 and 2018[(1)] (with further declines before monitoring began in 1970 which should not be ignored). A vast amount of irreparable damage has already been done, and it is likely to get significantly worse at an accelerating pace, even with immediate action. A radical transition away from a growth/consumption based societal system is urgently needed.

If managed correctly, protected areas are a vital resource in this struggle, preserving areas of particular importance to nature. Nature conservation in non-protected areas should equally not be overlooked, as protected areas cover far too small an area to maintain resilient populations alone.

My aspiration for this study is to learn from the management practices in different protected areas and consider how they could be utilized to maximize their effectiveness in protecting nature.

Growing up in Western Europe, where nature is increasingly compressed into ever smaller and more degraded forms, I was particularly excited to visit these areas. Intensive forms of agriculture and large-scale industrial development began more recently here than in Western Europe, therefore the effects are more limited thus providing a glimpse into how nature could have looked in the past. However, undoubtedly such intensification is leading to declines even in areas which have (or had until recently) relatively intact biodiversity.

For the past two years I have worked at the Bird Observatory in Ottenby Nature Reserve, on the island of Öland in southeast Sweden. The reserve encompasses a wide variety of habitats for its relatively small size. However, it also faces some significant challenges when it comes to conservation, these include: hydrology, overgrazing, small area, fragmentation, isolated populations and predation. I was interested in visiting other protected areas to study a) if they suffer from some of these same issues, and b) how they are managed to promote resilient nature, and what parts of this could be implemented in other protected areas in Western Europe.

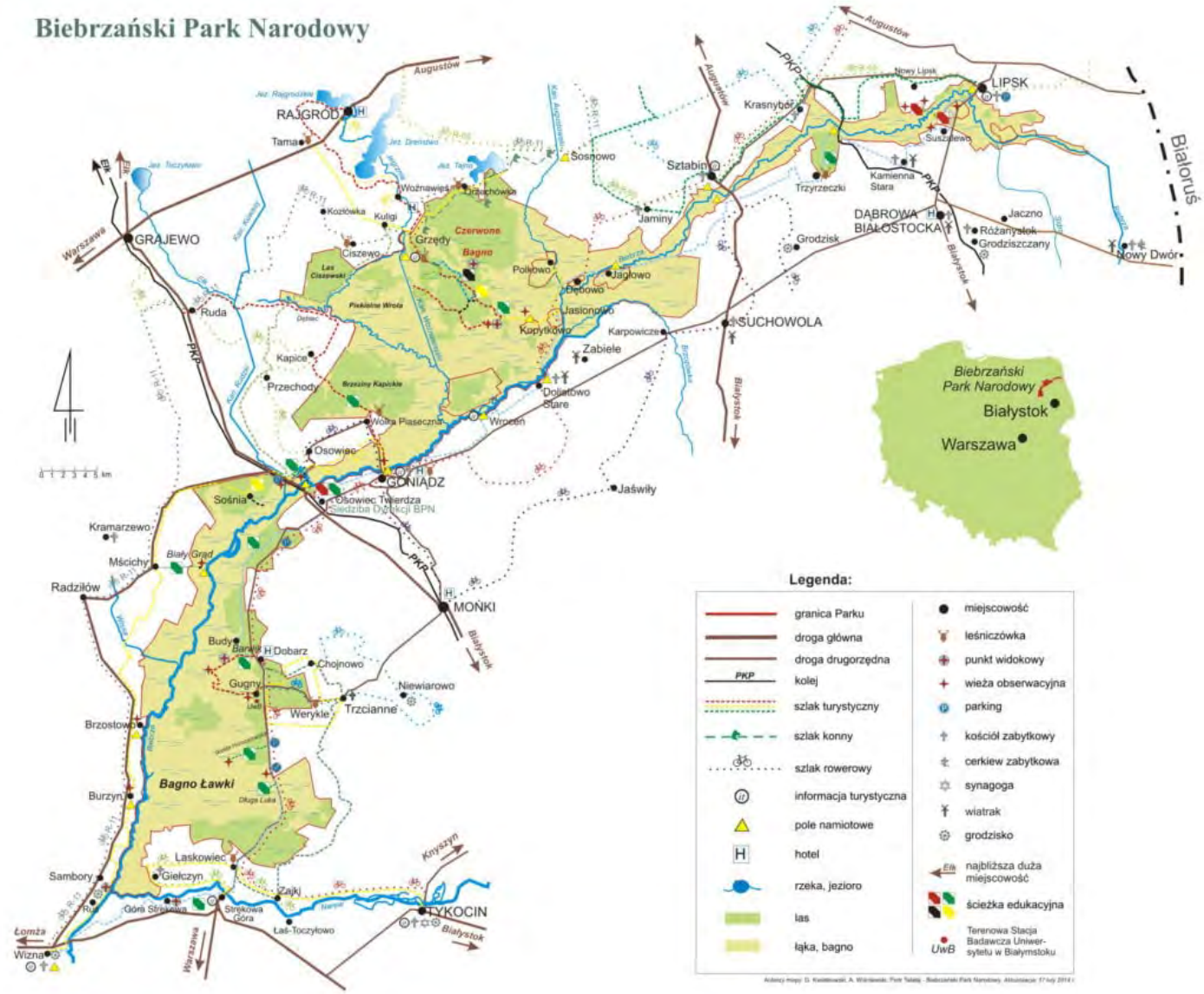
Overview of Protected Areas

I selected my three protected areas to represent broadly different habitat types (even if the habitat varies within the area):

Extensive freshwater marshes (Biebrza National Park, Poland), ancient, unmanaged forest (Białowieża National Park, Poland) and meadows (Maramureș Natural Park, Romania). These are all habitats which have been significantly impacted by changes in land use over the past centuries, and their extent in Europe is now probably lower than at any other point in history. This means that protected areas are of vital importance to these habitats and the life they support. The management practices required to protect and maintain these different habitat types vary drastically, and this is often reflected in the management practices adopted within protected areas.

Biebrza National Park, Poland

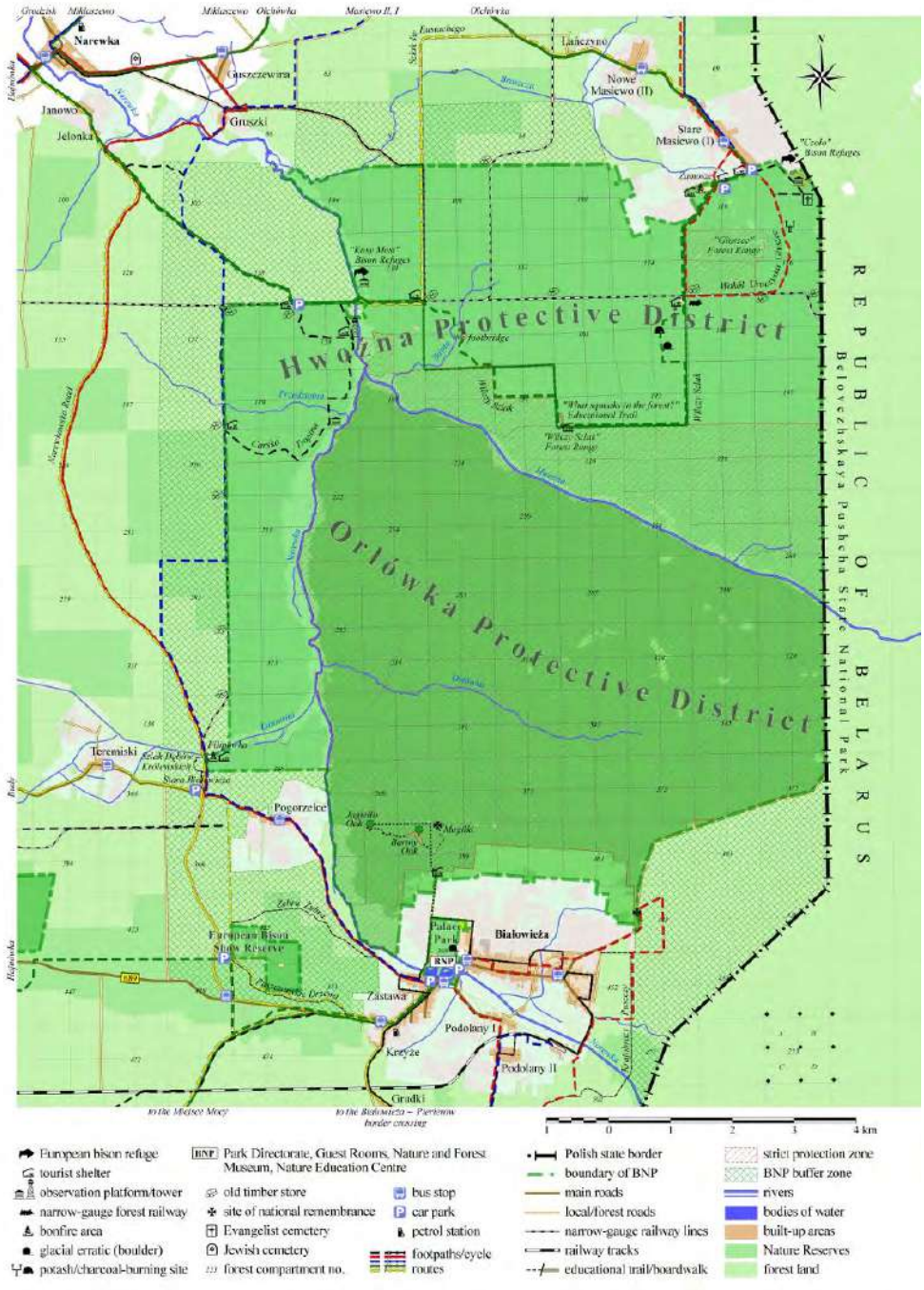
Biebrza National Park lies in Podlasie province in northeast Poland. The park protects the Biebrza river basin and the largest complex of peat bogs in Poland. It is the largest of Poland's 23 National Parks with an area of 592.23 km^2 and was created in 1993. About 60% of land in the park is owned by the park itself, with the rest being owned by a large number of (mostly small) private owners. The management in the park is mostly concentrated on maintaining the wetland habitats in their current state and thus trying to prevent succession (which would lead first to scrub and eventually to woodland). This means a lot of the parks resources are spent on a) cutting meadows/clearing scrub to prevent succession, b) buying pockets of land which are no longer under active use by private persons, to allow coherent management. Much of the privately held land is in small and fragmented patches and is no longer in use, meaning it is in danger of becoming overgrown by scrub and thus becoming unsuitable for wetland species.



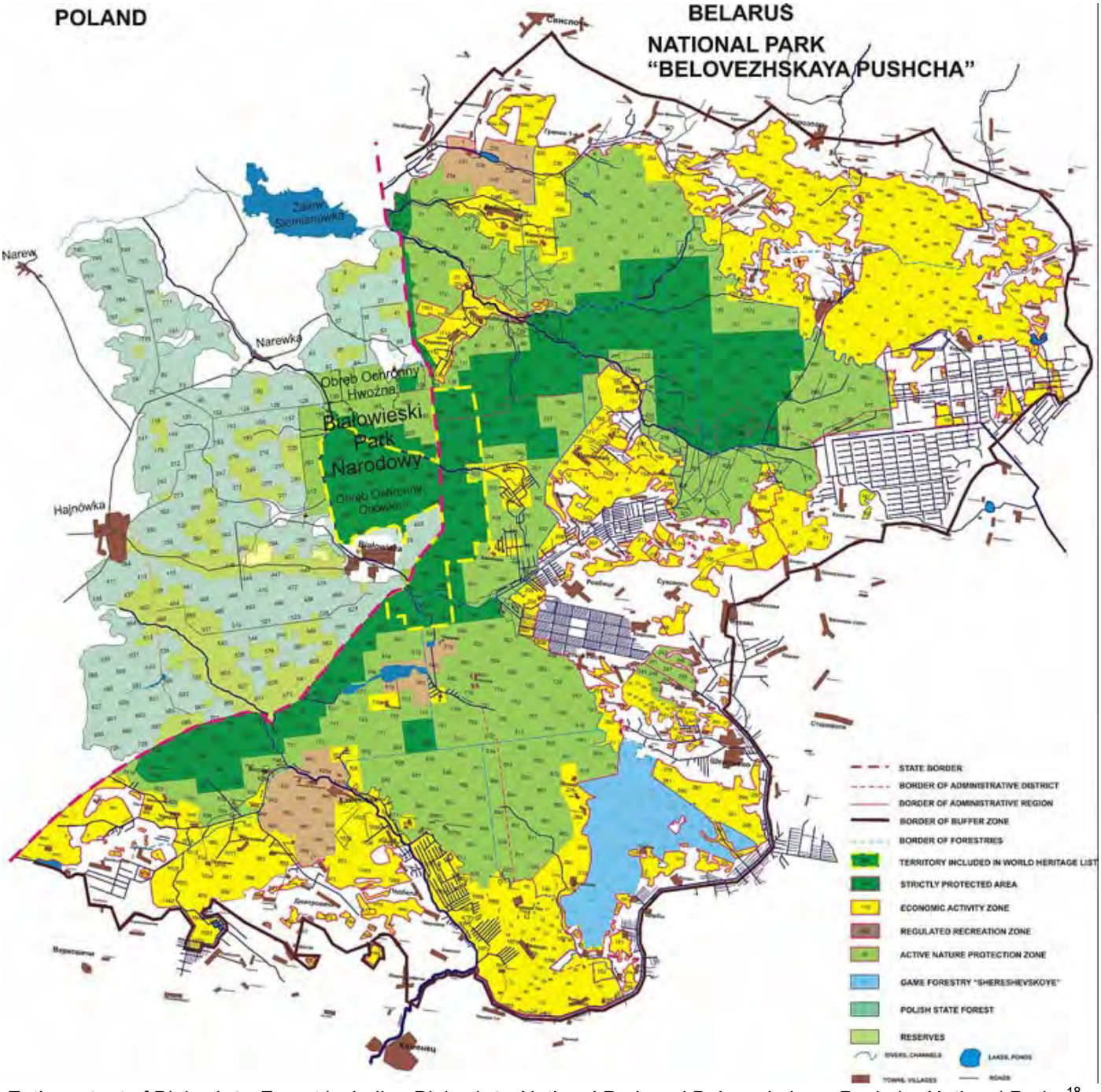
Biebrza National Park [16]

Białowieża National Park, Poland

Białowieża National Park is located about 100km to the southeast of Biebrza, on the Belarussian border. The park protects the Białowieża forest which is the largest remaining fragment of low-land primeval forest in Europe. The forest straddles the border between Poland and Belarus and is protected by the 105 km^2 Białowieża National Park on the Polish side and the 1771 km^2 Belavezhskaya Pushcha National Park in Belarus. The land is owned entirely by the national park. Most of the work here focuses on allowing the natural development of the forest through protection, rather than active management. The park is a stronghold for the European bison (*Bison bonasus*) which is now recovering its population thanks to reintroduction projects and conservation work. Unlike with other species, the park is responsible for the management of the bison population. One of the strategies to ensure that they have enough winter fodder is a special subsidy for landowners to cut hay and leave it in-situ for the bison to access when required. This helps not only the bison, but a host of species associated with traditional hay meadows which would suffer without this management.



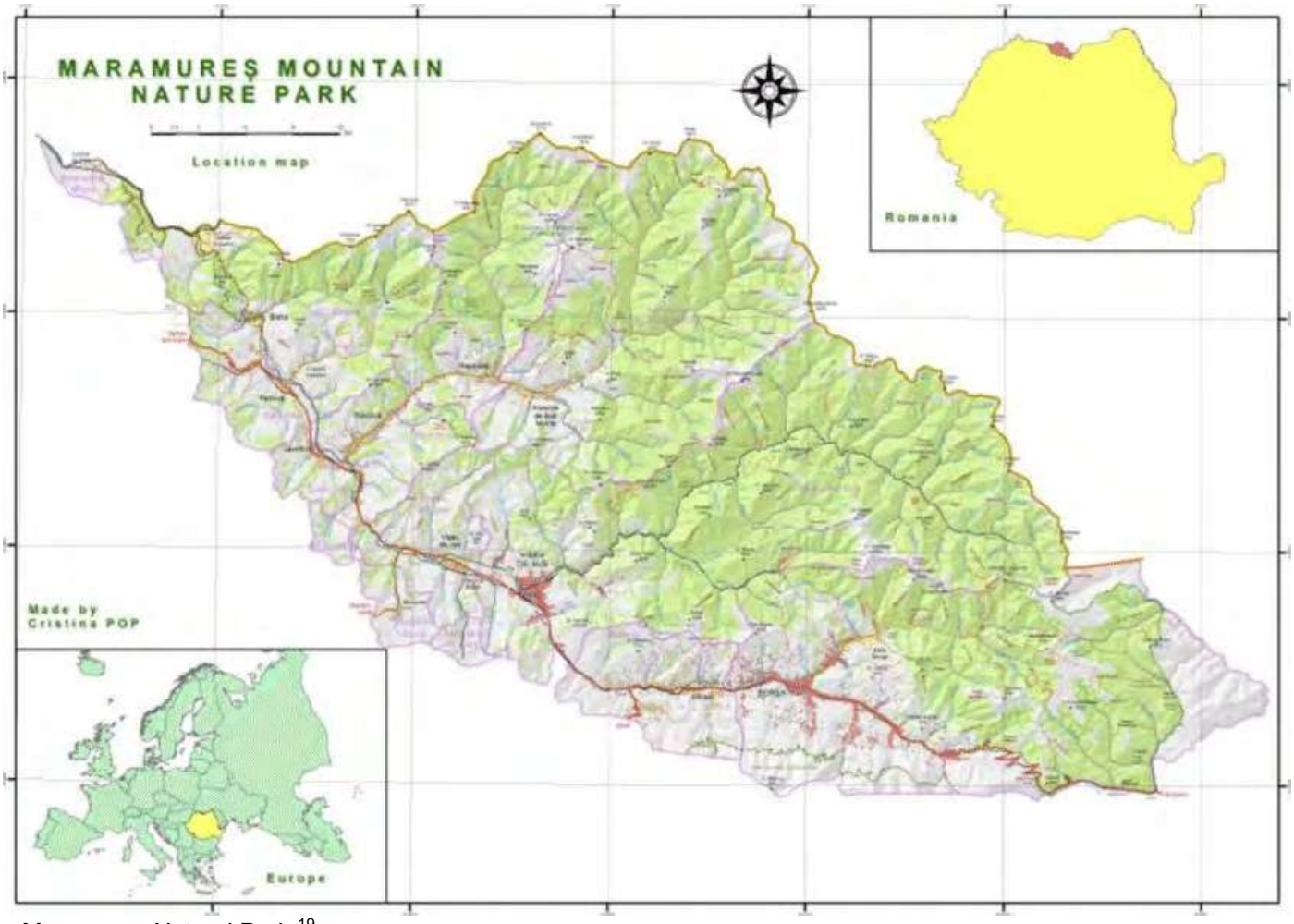
Białowieża National Park [17]



Entire extent of Białowieża Forest including Białowieża National Park and Belavezhskaya Pushcha National Park. [18]

Maramureș Natural Park, Romania

Maramureș Natural Park is located in northern Romania, on the Ukrainian border. It protects the Maramureș mountains. The key habitats are forest and meadows with a large altitudinal range. It is the largest Natural Park in Romania with an area of 1488.5 km^2. The park doesn't own any land, but rather is responsible for the protection and management of land owned privately or by the community or state. Much of the work of the natural park focuses on protection rather than active management, but also involves encouraging landowners to continue traditional land use practices (such as traditional hay production) by providing help with receiving EU environmental subsidies. The park is also responsible for checking that development in the 'sustainable development zone' of the park is not in opposition to the park's aims.



Maramureș Natural Park [19]

General introduction to the topic

Nature conservation is a broad topic, with many different ideas and practices, some of which are well accepted, others more controversial. It is a topic which evokes strong and passionate opinions from many different sides. It is these conflicts of interest which can create difficulties when it comes to the implementation of conservation management strategies. Since humans are a specie which, as any other, use its environment to support its existence, it is vital that conservation management is not exclusive to all human activity. On the other hand, human activities can be both destructive and beneficial to the environment, so it is one of the challenges of conservation to try to balance human with non-human interests.

One of the largest obstacles that many conservation projects face is the conflict of interest between the aims of the project and other land users, as well as the bureaucracy faced in trying to implement larger scale actions. This is a real problem which can delay and prevent vitally important works from being completed.

Different strategies are often adopted based on the specific habitat and the scale of the area to be managed as well as established practice. These can vary greatly, and I believe that there is much that we can learn from how conservation is conducted in different geographical areas.

Objective of visits

One of the main objectives of my study visits was to collect information on the management practices in different kinds of protected areas, how successful they are at maintaining resilient biodiversity, and how that differs from comparable areas outside of the protected area. Another objective was to investigate the challenges to conservation in different protected areas, and how these are overcome. I selected protected areas in Eastern Europe as I believed that they would contribute a different context and different viewpoints on conservation than those that I am familiar with in Western Europe; as well as a different starting point when it comes to protecting certain declining species.

Overview of the trip

My trip started with my arrival in Biebrza National Park on 14th May, I joined staff from the national park in the field on a couple of occasions and conducted some interviews back at the office. On 20th I continued to Białowieża National Park, here I joined two trips into the strict reserve, and also a trip to the northern part of the park with staff to celebrate the European National Parks Day. I stayed here until 27th when I began my journey to Maramureș Natural Park, where I arrived on 29th. I only stayed here for a few days and during this time I joined one field trip into the national park. On 2nd June I began my journey home, to Sweden. My entire trip was undertaken by train; four years ago I decided to stop flying, due to its negative environmental impact. This meant that my time in the protected areas had to be limited due to time-constraints, but I believe it was worth it, and the long train journeys allowed me to contemplate my experiences in each of the parks.

Analysis

In this section I analyse the different protected areas I visited. The particular ecosystems will be discussed along with threats and conservation within these protected areas, as well as comparison to non-protected areas where possible. In order to achieve this, I talked with a range of biologists and researchers working in the protected areas. Post-trip I have read a number of relevant scientific articles which were either sent to me by my contacts in the protected areas or that I have found by searching the internet. Both of these sources, as well as publicly available information from the protected areas websites have been a source of information for my analysis. I acknowledge the fact that the time I spent in the areas was too short to get to know them well (particularly my last visit in Maramureș where I was only able to stay for a few days), and that I only scratched the surface of the conservation issues they face in these vast areas. Despite this, I feel that I got a good introduction to the key issues and will discuss what I have learnt below.

First, I will give an introduction to some of the designations that the protected areas have which give various levels of protection to an area. It is good to have an understanding of the differences between these designations as they have a significant impact on how well protected an area is.

- **Natura 2000**—solely in the EU, covers 18% of land and 8% of marine territory in EU. Natura 2000 is a network made up of Special Areas of Conservation (SAC) and Special Protection Areas (SPA) according to the EUs Habitats directive and birds directive, respectively. SPAs are designated primarily for the protection of birds, and SACs for other species groups and habitat types. The aim of the network is to provide long-term protection to Europe's most valuable and threatened species and ecosystems.[(2)] Natura 2000 does not convey any protection intrinsically, but instead the member state must ensure that the areas are managed in a sustainable way. Due to this there is much room for interpretation and potential mismanagement, so the level of protection in Natura 2000 areas varies greatly and cannot be assumed to be high.

- **Ramsar**—an international network of important wetland areas. As of May 2023, there are 2,491 Ramsar sites around the world, protecting 256,759,538 hectares (634,466,640 acres), and 171 national governments are participating. Responsibility for the management of Ramsar Sites is at the national level, by the officially appointed Administrative Authority of the Contracting Party. The Ramsar Convention encourages Parties to create National Ramsar Committees to act as the appropriate Administrative Authority. In some cases, Ramsar sites are transboundary in which case more than one Contracting Party is responsible for their conservation and management.[(3)]The protection conveyed by a Ramsar site is often higher than that conveyed by Natura 2000 sites.

- **Nature Reserve**— usually designated because of the presence of well-preserved or threatened ecosystems or species. They often convey a high level of protection, but often cover smaller areas than the other designations. They usually restrict or forbid land use which is incompatible with the preservation of the area for biodiversity, but this also varies.

- **UNESCO Biosphere Reserve**—the UNESCO World Network of Biosphere Reserves (WNBR) covers internationally designated protected areas, known as biosphere reserves, which are meant to demonstrate a balanced relationship between people and nature (e.g. encourage sustainable development). They are created under the Man and the Biosphere Programme (MAB). It should encompass a mosaic of ecological systems representative of major biogeographic regions, including a gradation of human interventions.[(4)] Due to zoning (core, buffer or outer transition zone), biosphere reserves often have different levels of protection depending on the zone, in this way they are rather similar to the system used in many National and Natural Parks.

- **National Park** — usually designated for conservation purposes (but can also focus more on landscape value), created and protected by national governments. They often have a strong level of protection, but this varies. The International Union for the Conservation of Nature (IUCN) has defined the National Park as its category 2 type of protected area.[(5)]
- **Natural Park**– like a National Park, but instead of being managed by a national authority is instead run by a regional authority. As with National Parks the level of protection varies, but is usually lower than that of National Parks. Usually falls between IUCN category 3-4.[(5)]

Biebrza National Park

Encompassing a huge area (592.23 km^2), the habitat in Biebrza National Park is rich and varied, from woodlands to marshes. It can be divided into three different geomorphological zones, all of which have a different character depending on their formation during the last Ice Age. The Northern Zone covering the valley east of Sztabin, the Middle Zone - from Sztabin to Osowiec, and the Southern Zone - from Osowiec to the mouth of the Biebrza river to the Narew river. The Northern Basin, also called the Upper Basin, covers a 40-kilometre section of the valley with a width of 1-3 km. Peat deposits here are 3-6 m thick and in some places are underlaid by gyttja (mud formed from the partial decay of peat). The Middle Basin has a shape similar to a trapezoid with dimensions of 20 x 40 km. It is a complex of peat bogs with an area of approx. 45,000 ha. and peat thickness of 1-3 m. In its northern part, sand and gravel lie under the peat deposits, and in the southern part, clay. The Middle Basin is distinguished by vast sandy dunes surrounded by peat bogs, shaped as a result of aeolian processes. The Augustowski, Woźnawiejski and Rudzki Canals (built in the first half of the 19th century) significantly changed the hydrological system of this part of the valley, causing a permanent lowering of the groundwater level and drying of the peat bogs. The Southern Basin, the most natural in the Biebrza Valley, also known as the Lower Basin, has the shape of a gutter, 30 km long and 12-15 km wide. Peat bogs with a peat thickness of 1-2 m cover an area of about 21,000 ha. It is characterized by the presence of a belt of dunes in the north-eastern part and small mineral elevations (dunes, sand dunes). Along the riverbed, there is a mud zone 1-2 km wide with numerous oxbow lakes and meanders.[(6)]

There is a buffer zone around the core zone of the national park, the aim of this is to minimize impacts of development and industry on the National Park, but it does not lend any specific protection, rather it is up to the National Park to object to unsuitable developments. Outside of the national park, areas with particularly high biodiversity are designated Natura 2000, but this lends a lower level of protection than the National Park.

The National Park is designated as a Ramsar site, and the whole area of the park as well as some of the surroundings are designated as Natura 2000 areas.

Within the National Park, there are no specific regulations on agriculture, but the Common Agricultural Policy (CAP) of the EU stipulates that agricultural land has to be ‘maintained’, which can be negative for biodiversity when it involves inputs of agrochemicals. There is no dedicated program to encourage farmers to farm in a ‘nature friendly’ way, except for the subsidies provided by agri-environmental schemes by the EU. Land owned by the park is often leased out and mown in order to maintain the natural value of the marshes.

There are a number of species for which the Biebrza basin is of particular importance. Among birds it is an important site for waterfowl, marsh terns, crakes and greater and lesser-spotted eagle (*Clanga clanga* and *Clanga pomerania*), however the species which Biebrza is perhaps most famous for is the aquatic warbler (*Acrocephalus paludicola*), an internationally threatened species and Europe’s most threatened passerine. Biebrza is the most important breeding area in Poland for the species, with Poland hosting some 25% of the world breeding population (the majority of the rest of the population breeds in Belarus and Ukraine). Mammals found within the park include Eurasian wolf (*Canis lupus*), Eurasian lynx (*Lynx lynx*) and elk (*Alces alces*). In addition, the area is important for flora - particularly plants restricted to wetland ecosystems, and invertebrates - with several species endemic to the basin.

Below I will outline some of the key threats and the conservation actions being employed against them.

Succession of wetland ecosystems: the marshes in the Biebrza basin are made up of a range of anthropogenically influenced wetland habitats which rely on extensive agriculture to prevent succession to other habitats such as scrub and woodland (which can be valuable in their own right for another suite of species, but are not nearly as threatened as those tied to the wetland habitats). One of the challenges faced in the management of the national park is the land ownership situation. When the national park was created, it included an area with a significant rural population. Much of the land was owned by a large number of small-scale private owners which managed the land extensively and generally in a way that was beneficial to biodiversity (grazing with small herds of traditional breeds of cattle over large areas and mowing the meadows, thus preventing succession). When it came to inheritance, land was often split into increasingly narrow, long strips (some areas are covered by hundreds of thin strips of land - some barely a metre wide - belonging to many different owners). More recently, with an increase of younger people moving away and/or leaving traditional agricultural practices, much land is now being abandoned.

This is an issue because it is almost impossible to manage an area that is split into so many small fragments with different owners in a coherent way for conservation, and much land is now transitioning to scrubland due to this. To combat this issue, the park puts a lot of resources into buying areas of abandoned land to allow for active conservation.

Extensive grazing on the marshes is now a dying sight, one area where it still occurred until recently was around the town of Brzostowo. Local farmers grazed traditional breeds of cattle (in particular the Polish red cattle, a breed with a lower milk yield than more modern breeds, but more suited to the local conditions) on the marshes around the village and on the other bank of the river (meaning the cows would cross the river twice a day). This practice kept the marshes in a good condition for breeding waders; their selective grazing action kept the vegetation short and varied, and their trampling introduced variety to the surface layer of soil and bare patches for seeds to germinate. This practice has been dying out in this area (despite collaboration efforts from the World Wildlife Fund and the National Park at the turn of the century) due to the unprofitability of these breeds of cattle compared to modern breeds. Where there were previously several hundred cows grazing, there are now only a few tens left at most. The effect of this reduction in grazing has shown directly in the strong decrease in breeding waders in recent years.

In April 2020, during a drought period, a fire broke out in Biebrza and burned about 5500ha of land, it was the largest fire in recorded history in this area. An article ‘Large fire initially reduces bird diversity in Poland’s largest wetland biodiversity hotspot’[(7)]analysed the short-term (first 3 months after fire) effect of the fire on the community of breeding marshland birds. The article discusses how certain species benefitted in the short term while others suffered, compared to different effects in the medium to long term. Fire is and has always been a natural process with some important environmental benefits which cannot be achieved by other means. However, with increasingly dry conditions caused by climate change, and degraded hydrological systems, wildfires are becoming larger and more damaging, with the intervals between fires getting shorter. In the case of Biebrza, more regular and intense fires can bring about permanent changes to the marshes, by changing the vegetation structure and in the worst case damaging the peat layer beneath; with severe consequences for the same species that may benefit from less intense and smaller scale burning.

The article concludes ‘Climate change, along with water management, often leads to further drying of water-dependent ecosystems and can cause severe droughts and synchronized fires over large areas. The simultaneous burning of large areas can wipe out large metapopulation fragments and significantly reduce connectivity between patches, with dramatic consequences for rare marsh species. It is therefore critical to prevent further drainage of marshes, while restoring previous water levels and dynamics to increase their resilience to fire.‘

One of the causes of increased vulnerability to extreme climatic conditions such as wildfire and drought is land drainage. Throughout the preceding centuries, land has been drained at an unprecedented rate, contributing to a wetland loss of 64% worldwide[(8)]. This has had a profound impact on species tied to these habitats, and the ability of wetlands to sequester carbon dioxide (when drained, wetlands can become a source of greenhouse gases rather than a sink). A study by the Swedish Environmental Protection Agency in 2017 showed that drained wetlands cause about 20% of the Swedish emission of greenhouse gases[(9)].

A report ‘Restoration of the hydrological system in the Middle Basin of the Biebrza Valley. Phase I’[(10)] gives the following explanation of past drainage works in Biebrza and the current work being done to reverse the damage done. I think it is a good explanation of the importance of wetland preservation and restoration:

‘In the second half of the 19th century, the Russian Tsar administration carried out extensive drainage works in the Biebrza Valley in order to remove water from the area. The idea was to convert wet meadows into farmland in order to improve the economic situation of the local people and reduce poverty.’

‘Several canals were created in the Middle Basin of the Biebrza Valley at that time. The key ones were: Woznawiejski Canal, which collected a part of water from the Jegrznia river in the area of Kuligi village, and Rudzki Canal, which collected water from the Ełk river in Modzelowka village. As a result, the remaining sections of those rivers became practically dead. The effect of digging Woznawiejski Canal was the formation of a so-called “triangle”, i.e. the area between the canal, the Jegrznia river and the “dead” Ełk river.’

‘Digging of the canals led to a faster outflow of surface water, a decline of groundwater levels and, finally, the degradation of peatlands. Negative habitat changes such as the cessation of peat formation processes and, in many places, the degradation of organic soil (which is completely dependent on water) are also reflected by decreased biodiversity of unique wetland flora and fauna. What makes the environmental protection of these areas even more difficult is the decline of traditional extensive farming. Wet meadows which are no longer mowed overgrow with willow, birch or alder. These changes affect especially the birds which prefer wetland habitats such as the Ruff, the Northern Lapwing, the Great Snipe, the Common Snipe, the Black-tailed Godwit, the Common Redshank or the Aquatic Warbler, which is a globally threatened species.’

‘Today, we can also observe the negative effects of drainage on the agriculture. In particular, due to the draining effect of Rudzki Canal in many places the conditions for agricultural production have worsened so drastically that the land surrounding the canal needs to be irrigated.’

‘In 2010, to prevent further degradation and improve the condition of habitats, the Biebrza National Park launched a project entitled: “Restoration of the hydrological system in the middle basin of the Biebrza Valley. Phase I.” Which is co-financed by: the European Union via LIFE+ Financial Instrument, the National Fund for Environmental Protection and Water Management in Warsaw and Biebrza National Park.’

‘It is one of the first large scale restoration projects in Poland and one of the most important ones in Europe. The schedule of works which are now being implemented was prepared in 2001 by the Live Architecture Workshop Association and Biebrza National Park in cooperation with the Provincial Land Reclamation and Water Units Board in Białystok.’

Phase one targeted the Woznawiejski Canal: ‘The most important task was to distribute the water between the old Woznawiejski Canal so that 75% of the water flowing through the Jerzgnia river could be directed to the old river bed rather than into the canal. To achieve that, a weir was built on Woznawiejski Canal together with a fish ladder and 6 check dams to stabilize the water level in the canal below the weir. Also some fragments of the old Jegrznia river bed in the area of Kuligi village were cleared to make sure that more water is collected at an early stage and avoid local flooding of farmland.’

This phase of the project is now complete, and much of the results will be seen in the longer term (bird and water table monitoring is ongoing). Preliminary results of monitoring water levels concluded: ‘The time of the weir’s operation has been too short and specific in terms of hydrology and meteorology to assess clearly the impact of water elevation in Woznawiejski Canal on the surface and groundwater levels in the surveyed area. However, based on the assessment of water table fluctuations, we can say that after introducing water elevation in the Woznawiejski Canal, the canal’s impact on groundwater levels in the adjacent wetlands has changed from drainage to supply.’

The initiation of phase II of the project is planned to begin soon. It is a larger and more expensive project than stage I, with more physical and bureaucratic hoops to jump through. This includes clearing out the whole of the ‘dead’ section of the Ełk river so that redirected water from the canal will flow in the old river bed rather than flooding the surrounding area.

During my stay at Biebrza, I joined the project manager of stage II of the project, Adam Bernatowicz, along with Magdalena Marczakiewicz in the field to look at the sites of planned restoration as well as some of the areas that have already been altered by phase I.

On the last full day of my stay I joined a field trip to Bagno Ławki, a vast area of sedge meadow famous for being one of the most important breeding areas of aquatic warbler in Biebrza. The aim was to assess scrub encroachment on the marshes in order to plan scrub removal work (to prevent succession of the sedge meadows). Up until this point in my stay I had not visited any significant areas of this habitat type, so it was fascinating to see the core breeding area of the aquatic warbler and to experience some of the planning work behind the conservation of this area.

Rudzki Canal, the main drainage canal for the Ełk river.

The Kapicki Canal after the installation of a weir and check dams to slow water flow.

The Rudzki Canal dam which will be used to redirect water to the Ełk in the next stage of the project.

The row of reeds below the treeline follows the course of the ‘dead’ Ełk river, but dries completely during the summer.

Cattle grazing the marshes in Biebrza National Park.

Whiskered tern (*Chlidonias hybrida*), a classic marshland bird species.

Aquatic warbler in typical sedge-meadow habitat, Bagno Ławki.

Aquatic warbler, Bagno Ławki.

Białowieża National Park

The main biotype within Białowieża National Park is forest and it is this that it is most famous for. This forest is however very varied in character, both in age and in species composition. The park itself covers the oldest and best preserved parts of the Polish side of the Białowieża Forest (about 1/6). The forest that falls outside of the boundaries of the park is designated as Natura 2000 and some of it is also protected by nature reserves. The national park itself has three zones: 6059,27 ha is under strict protection, 4104,63 ha is under active protection, and landscape protection covers the area of 353,37 ha, an additional 3224,26 ha constitutes a buffer zone around the national park.(11)

The forest's extensive nature and age means it is home to a host of threatened and relict species which have become rare or even extinct elsewhere in this part of Poland. The area is famous for supporting all of the European woodpecker species, a testament to the high quality of the habitat (some woodpeckers, particularly the White-backed (Dendrocopos leucotos), have a very high demand for old and extensive areas of forest with high continuity, and they disappear as soon as this is removed). The forest is also home to Eurasian wolf, Eurasian lynx, elk and most notably, the European bison (the largest land mammal in Europe). This species once existed across Europe and Western Asia but went extinct in the wild in 1919 when the last individual died out in Białowieża. A small population existed in zoos, and from this a captive breeding programme was started, with the first animals released in a breeding reserve in Białowieża as early as 1929. By 1952, the first bison left the reserve into the 'wild'. In 2009, the wild population numbered 456 in the Polish part of the Białowieża forest, and the population is relatively stable with about 800 individuals in the whole forest (in both Poland and Belarus). The bison are an important addition to the megafauna, grazing less selectively than the other ungulates and therefore having a different effect on the development of the vegetation, promoting variation in the habitat and therefore increased biodiversity.(11) One of the strategies to ensure that they have enough winter fodder is a special subsidy for landowners to cut hay and leave it in-situ for the bison to access when required, this helps not only the bison but a host of species associated with traditional hay meadows, which would suffer without this management.

The age and extent of the Białowieża Forest create perfect conditions for a diverse breeding bird fauna, they also effect the behavioural and population dynamics of these species compared to other forests. During my stay at Białowieża, I joined Dorota Czeszczewik, an ornithologist who has been monitoring breeding birds in the National Park for several decades, on a nest survey of collared flycatcher (*Ficedula albicollis*) in the strictly protected area. The collared flycatcher is particularly numerous in the NP, in much higher densities than I have ever seen elsewhere. The effect of the high continuity in tree age, natural quantities of dead wood as well as the large extent of the area becomes particularly obvious on entering the old parts of the Białowieża Forest. The effects of these features on bird population and behavioural dynamics are discussed in a paper based on the long-term monitoring work in Białowieża: 'Ecology and biology of birds in the Białowieża Forest: a 40-year perspective'.(12) Here I will include some excerpts from this paper, which demonstrates the importance of this kind of forest for maintaining a high diversity of breeding bird species and stable populations in the long term.

'The avifauna of the Białowieża Forest is characterized by features associated with primeval habitats such as the stability of communities over time, high species richness, relatively low densities, high proportion of hole-nesting birds, very high predation pressure and weak, insignificant competition interactions. This emphasizes the importance of predation, excess of nesting sites for cavity nesting birds, high abundance of food, especially for insectivorous species and fluctuation of bird population size due to rodent outbreaks (pulsed resources).

‘The most severe threats for the avifauna of the Białowieża Forest are: rejuvenation of tree stands, removal of dead wood, fragmentation of old-growth stands, change of tree stand composition (reducing the proportion of some tree species). In order to expand our ecological knowledge about birds, we should keep the Białowieża Forest fully protected for years to come. The main priority should be the maintenance of natural processes changing the forest’s species composition.’

‘The BF was protected as hunting area until the beginning of the 20th century. In the 20th century, new legal forms of protection of the BF were developed (national park, reserve, Natura 2000, UNESCO, etc.). This allowed for preserving very old forest stands, which are unique on a global scale.’

‘Significant differences were found between abundance, diversity and species richness indices, between the BNP breeding avifauna and managed stands.’

‘Low density of majority of species (Tomiałojć et al. 1984; Tomiałojć, Wesołowski 2004) results from large territories and social behaviour of birds (Wesołowski 1981, 1983; Wesołowski et al. 1987). The habitat is not filled with birds, despite food richness and nest sites, and low productivity could be a result of strong predation pressure (Tomiałojć, Wesołowski 2005). For instance, the density of great tit (Parus major), pied flycatcher (Ficedula hypoleuca), common blackbird (Turdus merula) and dunnock (Prunella modularis) in the BF is several times lower than that in the forests of western Europe. Some species, however, rare in other places, in the BF in some years may reach very high density. A collared flycatcher (Ficedula albicollis) can be an example of that – it breeds in density up to 22 pairs / 10 ha (Walankiewicz 2002b).’

‘The avifauna of the BNP, despite certain changes in bird’s density, over the past 40 years was characterised by high stability unlike in other parts of Europe that are highly transformed by human. The majority of species regularly nesting in the BNP showed long-term growth trends what was related probably with global factors (Wesołowski et al. 2010). Stability of the communities results from long-term stability of forest habitats of the BNP (despite certain changes on the local scale) what creates favourable conditions for reproduction for many years (Wesołowski et al. 2015).’

‘Birds in the BF often nest in places that are unusual for them in other forests. It is caused by large variety of places suitable for nesting in the BF. Over 80% of wren’s (Troglodytes troglodytes) nests in the BF are located in the disks of uprooted trees (Wesołowski 1983). Beside this species, couple more species (dunnock, blackcap (Sylvia atricapilla), blackbird, robin (Erithacus rubecula), song thrush (Turdus philomelos)) sometimes use this structure as their nesting places. Blackbirds build nests in decaying or foraging black woodpecker cavities of spruce snags (Tomiałojć 1993). Swifts (Apus apus), known mostly as urban birds and nesting on the buildings, nest in the cavities of old tall trees in the BF.’

‘Those elements are especially common in the BNP and much less likely to occur in managed forests (Tomiałojć et al. 1984).’

‘Competition for cavities in the BNP is, therefore, not an important issue for secondary cavity-nesters (Wesołowski 1989, 2003, 2007a; Walankiewicz 1991; Walankiewicz et al. 1997; Czeszczewik et al. 2012), unlike it was showed in forests transformed by humans (Newton 1998).’

‘Woodpeckers as cavities ‘producers’ are known as a keystone or engineering species (Paine 1969; Jones et al. 1994). However, they do not play that role in the BF, despite their species richness and high density. Large number of cavities available in forests of various tree species composition did not come into existence as a result of excavating. These are, for instance, fissures, cracks in trunks or boughs, holes created as a result of a branch or trunk top’s fracture and then their decay (Wesołowski 2007a).’

‘Nest boxes are being mounted in forests strongly transformed by humans where only few cavities exist. Those artificial nesting places are often considered to be better than cavities (safe nesting places). However, that is not always the case as the results of the research conducted in the BF has shown. In tree cavities, very few nest parasites can be found, unlike in case of nest boxes (Wesołowski, Stańska 2001; Hebda, Wesołowski 2012). That results probably from the fact that in nest boxes, an old nest material can be found. In the cavities, on the other hand, this material is very rarely preserved till the next season (Wesołowski 2000; Hebda et al. 2013). Moreover, in managed forests stands of the BF, the nest boxes turned out to be an ecological trap because they also attracted predators that destroyed large part of birds’ broods (Czeszczewik et al. 1999).’

‘Most of the cavities were found on hornbeam (Carpinus betulus), and majority of them were found in the BNP in older, living trees with trunk diameter of 30–60 cm. Most of the cavity-nesters usually choose hornbeam as nesting place (Walankiewicz, Czeszczewik 2006), and this tree is the most common species in the BNP. Unfortunately, thicker hornbeams are less often seen in the managed part of the BF because of its cutting for fire wood.’

‘Recently, after last outbreak of bark-beetle, the number of dead spruces has increased in the whole area of the BF what is very beneficial for the three-toed woodpecker (this species forages mostly on freshly killed or dying spruces) and, in the future, for white-backed woodpecker that feeds on decomposed trees, quite often on spruces (Czeszczewik 2009a).’

The paper includes several more examples of species for which the Białowieża Forest provides the conditions for long-term population stability, which have a much more precarious status in managed forests. I found several other scientific papers drawing similar conclusions. This proves how important it is to have forests like Białowieża - that are both well preserved and extensive enough to provide refuges for species when local conditions change from year-to-year. I believe that this is a big problem in highly fragmented habitats (for example in Western Europe), where there is nowhere for species to take refuge when local conditions become unsuitable.

Between July 2015 and June 2018 an increase in logging took place in the Polish section of the Białowieża Forest lying outside the national park. This increase was aimed at reducing the severity of a particularly strong outbreak of Spruce Bark Beetle. The Spruce Bark Beetle is a naturally occurring species in this area and its impact on biodiversity is usually positive—it creates habitats for a whole host of species reliant on dead and dying wood. The beetle attacks weakened trees (including spruce, larch, pine and fir) by burrowing through the bark to build tunnels where they mate and lay eggs. Their effects are usually limited by the number of dead and weakened trees available to attack (since the defences of healthy trees are enough to ward off the beetles).

Huge outbreaks can occur in conjunction with severe environmental conditions such as drought and storms or fungal infections which can damage large numbers of trees. It was during a particularly dry period that the aforementioned outbreak in Białowieża occurred. These conditions which are conductive to large beetle outbreaks are increasing with climate change and are likely to get more severe in the future. Historically, the composition of the forest included a higher proportion of coniferous trees compared to deciduous, this composition has changed and the opposite is now true. This is a dynamic ecosystem, and although the strict level of protection aims to preserve the forest, it does not aim to prevent it from changing—nor is this possible. While the Spruce Bark Beetle is of course a threat to spruce forests and related biodiversity in the context of increasingly extreme climatic conditions, the stance of the National Park is that this can and should not be prevented (as this causes more harm than the beetles alone).

A study 'Is the impact of loggings in the last primeval lowland forest in Europe underestimated? The conservation issues of Białowieża Forest'[13] investigated the impact of these loggings on biodiversity in Białowieża Forest. I believe it gives a very good summary of the reasons why this 'salvage logging' is the wrong solution to increased Spruce Bark Beetle outbreaks, and why clear cutting (particularly in old-growth forests) completely opposes any reasonable conservation objectives and must be ended immediately.

Here are some excerpts from this study: 'The State Forests Holding that manages the BF outside of the Białowieża National Park (BNP), decided to remove dead and dying trees by means of modern technology (harvesters, forwarders), hence creating sizable clear-cuts. Based on analyses of high-resolution satellite images, our study is the objective estimate of the extent of logging (since 2015) in zones with different UNESCO protective status, and a quantification of the potential landscape-scale impact beyond the spatial extent of the actual loggings. We discuss the possible direct and indirect ecological effects of the recent salvage logging in this unique area, and provide recommendations for future management of Białowieża Forest to mitigate these human-induced impacts.'

'The salvage logging, defined as removal of trees and other biological material from sites after natural disturbance events, is an extreme case of clear-cutting appearing to be particularly damaging to the forest ecosystems. It reduces biological legacies, affect rare post-disturbance habitats, alter community composition, impair natural vegetation recovery, facilitate the colonization of invasive species, alter soil properties, increase erosion, modify hydrology, and alter patterns of landscape heterogeneity (Lindenmayer and Noss, 2006).'

'The impact of clear-cutting goes beyond the time and space of logged areas by directly affecting the neighbouring stands both in the short and long-term. The logging activities resulted in a 26% increase in fragmentation in the entire Natura 2000 area'

'For lynx Lynx lynx, a species with high conservation value, salvage logging will lower habitat suitability since it has been shown that it selects sites in the BF that are characterized by high complexity (linked to fallen logs) and dense undergrowth useful for stalking their prey species (Podgórski et al., 2008). Research from other temperate forests in Europe clearly indicates that salvage logging leads to structural and compositional homogenization of stands and delays regeneration processes (Michalová et al., 2017; Thorn et al., 2017b).'

‘The presence of tree logs promotes natural regeneration of trees by providing physical protection against ungulate browsing (Smit et al., 2015). Recent studies from the BF show yet another mechanism of how tree logs can promote natural tree regeneration by creating places with higher perceived predation risk. Red deer, as the main browser in this system, avoid foraging close to tree logs (Kuijper et al., 2015; van Ginkel et al., 2018) resulting in lower browsing pressure on trees and higher regeneration success (Kuijper et al., 2013).’

‘Predation pressure on ungulate prey species may thus be altered resulting from changes in habitat structure. This shows the complexity of the trophic interactions that are likely strongly affected via changed landscape structure and which are difficult to predict (Kuijper et al., 2016). But the fact that salvage logging disrupts natural trophic interactions, which are one of the main conservation goals for this unique forest complex, is highly worrying for the natural functioning of this ecosystem.‘

The authors conclude:

‘Firstly, the logged areas should be left for natural regeneration. The State Forests Holding proposes that the logged areas will be cultivated, prepared for replanting and later thinned, which will continue the process of using machinery and affecting the adjacent forest stands for decades. When this approach is followed, the replanted gaps will form unnaturally regenerated patches influencing the long-term stand development and all its associated dynamic processes, including changes in trophic chain relationships (Broadbent et al., 2008). Hence, we strongly support allowing natural regeneration as occurs in the neighbouring Białowieża National Park (see Kuijper et al., 2010) to create natural tree stands that are better adapted to the current climatic conditions (see also Żmihorski et al., 2018). Secondly, we strongly recommend extending the national park to the whole BF. Currently, the area is partly managed by three districts of the State Forests Holding, partly by the Regional Directorate for Environmental Protection and partly by the BNP. In addition to securing natural functioning of this valuable ecosystem, enlarging the national park would allow for much better coordination of BF's management including development of ecotourism in the area. This would also be a sensible step towards achieving target 11 of the Aichi Biodiversity Targets in Poland (CBD, 2010). The Białowieża Forest, that represents the last-remaining large complex of lowland temperate forest with a primeval character, would then serve as a source of invaluable knowledge concerning the interplay of natural processes and biodiversity. This knowledge could be in turn applied in other areas where restoration of naturally dynamic forest is necessary.’

Here are some photos I took during my study visit documenting the incredible and dynamic forest ecosystem at Białowieża.

European bison, Teremiski.

On the left side of the path is a meadow which gets cut, the right side an abandoned meadow with scrub succession.

White-backed woodpecker.

The entrance to the strictly protected area at Białowieża National Park.

A typical view in the strictly protected area—diverse forest with a lot of dead wood.

A natural glade in the strictly protected area of the park, in the background is a stand of predominantly coniferous trees.

Two large, dead spruce (*Picea abies*) trees, vital habitat for a rich diversity of species.

Norway maple (Acer platanoides)

Fresh wolf (Canis lupus) tracks, it was magical to know that these enigmatic creatures could be hiding any-

Red deer (*Cervus elaphus*) and European bison footprints.

Maramureș Natural Park

This protected area, unlike the other two I visited, is located in a mountainous region with a high altitudinal range. Habitat types in this area are quite varied, with different types of woodland and meadow ecosystems, depending on the nature of their anthropogenic use and their location. Similarly to the other two parks, Maramureș has three zones with differing levels of protection.

- Integral protection area - 18,769 ha, this zone has the highest level of protection and prohibits all commercial activities that threaten the biodiversity.
- Sustainable management area - 79,585 ha, some commercial activities are allowed (such as forestry), in accordance with management plan.
- Sustainable development of human activities area - 35,000 ha, allows most development but has some restrictions on damaging industries and developments.

The park does not own any land, it is owned by either private owners, the community, or the state. The park takes care of protection and management planning.

Private owners within the integral protection area are compensated by the state (since they are restricted in their economic use of the land).

Threatened species and species with important populations here include: huchen, otherwise known as the Danube salmon (*Hucho hucho*), classified endangered by IUCN, several large mammal species including Eurasian lynx, Eurasian wolf, European wildcat (*Felis silvestris*), elk and a large population of brown bear (*Ursus arctos*). Breeding birds include black stork (ciconia nigra), lesser-spotted eagle, golden eagle (*Aquila chrysaetos*), Ural owl (*Strix uralensis*), Eurasian eagle owl (*Bubo bubo*), pygmy owl (*Glaucidium passerinum*), capercaillie (*Tetrao urogallus*), hazel grouse (*Tetrastes bonasia*), black grouse (*Lyrurus tetrix*), three-toed woodpecker (*Picoides tridactylus*)and white-backed woodpecker. 58 of the 126 butterfly species existing in the NP are classed as threatened on the National Red List (EX - one specie, CR - 4 species, EN - 13 species, VU - 30 species).

A large part of the management work at the park consists of protecting habitat from illegal activities as well as reviewing the suitability of planned development in the sustainable development area.

Another aspect of the work involves aiding local landowners in receiving EU subsidies to protect traditional agricultural practices (which are often positive for certain habitat types, particularly hay-meadows and pastures). These practices are threatened by modern intensive agricultural practices, often by large landowners, which the small-scale farmers cannot compete with. The traditional types of agriculture are better preserved in this region of Romania than in many other parts of Europe, some of the reasons for this are the terrain and land ownership traditions, as well as the economic situation in general, meaning intensive agriculture would be less profitable here. Ironically, EU agricultural subsidies are actually one of the key reasons for the decline in traditional agricultural practices, as they directly encourage intensive, high productivity types of agriculture which are negative for biodiversity. This means that the two types of subsidies (those encouraging environmentally friendly/ traditional agriculture vs those encouraging a high output) directly contradict each other. Despite this contradictory system, it is important to encourage the use of the environmental subsidies as it helps at least some traditional agricultural practices to cling on.

Another issue in Maramureș Natural Park is invasive species. Japanese knotweed (*Reynoutria japonica*) for example is very invasive in the lower elevations of the park, particularly close to water, and threatens native flora.

As I mentioned previously, the duration of my stay here was very brief due to time restraints, which only allowed me to join Daniel Pop (ranger at MMNP) in the field on only one occasion. This means my experience of the different areas of the park is therefore even more limited than the other two I visited, and I gained less insight into the problems the park faces and the conservation measures used in response.

Below are some photos documenting the park and the traditional agriculture in the area:

Meadows, with invasive Japanese knotweed growing close to the river.

Traditionally managed haymeadows have an incredible floral diversity.

Traditional way of drying hay (with Japanese knotweed visible on the left).

A typical view of the mosaic of woodland and meadow habitats in Maramureș Natural Park.

Haymeadows are rich not only in plants, but in insect species, such as this sooty copper (*Lycaena tityrus*).

Alpine meadow.

A meadow showing the beginnings of succession from small spruce trees.

At the end of this section, I have included a brief introduction to Ottenby Nature Reserve and the specific issues here, to give some context to the discussions in the next section.

Ottenby is a coastal nature reserve in southern Sweden, covering the southernmost tip of the island of Öland. With an area of about 10 km^2 , it is one of the largest in Kalmar county, but is nonetheless tiny in comparison to the other protected areas I visited. This small size brings with it the issues related to small, fragmented populations which can struggle to survive changing conditions in the long term.

One example of this is the southern subspecies of dunlin (*Calidris alpina schinzii*), which has declined significantly in Sweden, due to a combination of factors including changes in precipitation and hydrology, grazing and predation pressure. A new 'head starter' project was started during 2023, in which eggs are collected from nests of wild birds, hatched, and released when they are large enough to fly, and have a better chance of avoiding predators. Along with this, control of predators (such as Eurasian badger (*Meles meles*) and the invasive American mink (*Neogale vison*)) was also stepped up in the area. This was considered as a necessary conservation measure in response to the high mortality of juveniles, and is undoubtedly successful in artificially supporting numbers in the short term. Measures to improve environmental conditions and therefore breeding success in the wild are obviously important in order to ensure long-term survival. This is important not only within Ottenby but on a larger landscape scale, to ensure that the population as a whole can survive localised fluctuations.

A long term monitoring project has been conducted on Öland's coastal meadows since 1988, involving a large scale breeding bird survey every 10 years (1988, 1998 and 2008), with yearly surveys of some areas between 2003-2008.[(14)]

Unfortunately, the 10 year interval is rather broad, as variation in breeding numbers between years can be large and unrepresentative of long-term trends. Despite this it is possible to see some rough trends, and combined with the data collected on grazing pressure it is possible to see some relationship between these. It seems that the correlation between grazing pressure and number of breeding pairs is weakly positive up to a certain point for many species (such as waders). A very high, or very low grazing pressure can have negative effects for some species, but since the trend is relatively weak—it is important to also pay attention to other factors, such as agricultural practices (including the use of agrochemicals), hydrology and predation pressure. Hydrology seems to be of particular importance—many areas on Öland have become increasingly dry, both due to drainage and decreased rainfall —having a negative effect on breeding bird populations.

Below is a map of Öland showing wetland areas (black) after drainage operations of the late 1800s and early 1900s (left) compared to before the drainage (right). The difference is stark, and it is no surprise that this has had serious effects on the ecosystems on the island. There are some plans for wetland restoration on Öland (including in Ottenby, as a part of the Dunlin project), however the largest obstacle to these is resistance from local landowners and farmers. Even though the effects of well-planned wetland restoration are only positive (especially for farmers who will suffer much more from increased dryness and yet will benefit so much from a healthy local hydrology). I believe that one of the largest problems is the lack of knowledge of this history, and the threat of increased dryness in the future.

Map of Öland showing wetland areas (black) after drainage operations of the late 1800s and early 1900s (left) compared to before the drainage (right).[15]

Ottenby Nature Reserve, viewed from the lighthouse ‘Långe Jan’ on the southern tip of Öland.

Conclusions

When I began planning for this project, I had a pretty clear idea of the areas I would like to focus on, based on the key conservation issues I have experienced on Öland and those I have experienced elsewhere. I wanted to link what I learned back to Ottenby, and the specific issues here, but I also felt that it could have a meaning for many other protected areas as the issues encountered are often the same—even if local conditions can be very different. The two topics that I was most interested to tackle were the effects of grazing and hydrology on biodiversity. Despite the vast differences between each of the protected areas I visited, these issues were always relevant, and often some of the most significant.

To conclude, I would like to discuss the wider relevance of the conservation measures taken in these different areas.

The conservation issues within Biebrza National Park are quite similar to those at Ottenby, the same threat of succession of wetland ecosystems exists in both areas. However in Ottenby this is dealt with through fairly intensive grazing (by cows, sheep and deer), whereas in the large area of Biebrza it is mostly dealt with by mowing. Grazing pressure on the marshes in Biebrza has declined significantly, due to changes in agriculture meaning small scale and extensive agriculture has become increasingly unprofitable, having negative effects on the populations of many wetland bird species. The effects of increasing dryness and depleted groundwater are also a threat in both areas, with hydrological restoration works already underway in Biebrza and planned in Ottenby. These works will have a significant impact and be particularly vital for the survival of resilient ecosystems in the future with the increasing threats of drought, wildfire and unpredictable precipitation patterns brought by climate change.

In Białowieża National Park, the same issues are still relevant, but in a very different way, and the different ecosystems require a different, passive rather than active form of management. This can work in some larger areas where the ecosystems under protection are 'climax communities' meaning that succession has come as far as it can however, this does not mean that the ecosystems are not still constant evolving. Climatic conditions, both long term and extreme events, mean that this is always the case—and large healthy ecosystems can usually adapt to these changes without any 'help'. However, in the case of areas where the ecosystems we are trying to protect are at an earlier successional stage, they require constant management to prevent succession and loss of the particular species found at that stage (since we have altered conditions so much that those ecosystems are no longer self-sustaining). This also applies to smaller areas, as smaller, isolated populations are more at risk than large and well-connected ones. At Ottenby, there is an area of blended broadleaf woodland (consisting predominantly of pedunculate oak (*Quercus robur*) and Silver birch (*Betula pendula*) with smaller numbers of other tree species). It has been forested for at least several hundred years but has also been managed, with some of the larger trees being removed for timber, meaning that the continuity in some parts of the forest is incomplete. To counter this the management in the forest includes ringbarking some smaller trees to allow others to grow larger, and also some measures to artificially give some younger trees characteristics of older trees (such as cutting grooves in the bark). This can make the trees suitable for colonisation by species which would normally require much older trees. Dead wood is also left in place due to its importance to many species.

In Maramureș Natural Park, the same issues come up: changing agricultural practices either causing problems from intensive agriculture, or succession of valuable ecosystems because of abandonment of agricultural land. Unlike many other areas, the traditional agricultural practices here are still alive, and the meadows created by this traditional agriculture are very rich and important for a host of species.

My study trips allowed me to get a ‘behind the scenes’ view on areas that I have long dreamt of visiting due to their high biodiversity and gave me an insight into the management realities in these areas. The trips were absolutely not all-encompassing, these are large areas with complex conservation issues and the specifics of their management require expert knowledge of the local conditions and history. However, there are several issues which are almost universal in the conservation of terrestrial (and sometimes aquatic) ecosystems. These issues require tailor made conservation strategies, sometimes active and sometimes passive, which are flexible to changing climatic conditions. It is also essential that conservation measures are not restricted to protected areas but also extended to the wider environment. Natural ecosystems have never been more fragile and fragmented and the necessity for more careful agriculture, forestry and a reduction in development and extractive industries has never been greater. The consequences of continued ‘business as usual’ are dire, not only for nature but for us too.

I hope that this study will provide some interesting insights from the protected areas I visited and be useful for conservation planning in different areas.

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Assessing scrub succession with staff from Biebrza National Park.

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