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Assessing the Rewilding Scores of German National Parks

Biological diversity and ecology (B.SC.)

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Abstract: Assessing the Rewilding Scores of German National Parks

The current UN Decade on Ecosystem Restoration supports and has called for ambitious actions to not just halt biodiversity loss but to restore the ecosystems that have been lost until 2030. Rewilding is a highly appropriate approach to apply to this challenge. With minimal human interventions, natural processes and dynamics at its core, it drives the recovery of self-sustaining ecosystems in the long term.

In order to scale up rewilding across Europe, it is crucial to have a solid, science-based methodology to monitor the progress at site-level.

In the present work, the rewilding scores of five national parks in Germany have been quantified following an expert-based rewilding progress assessment proposed by Torres et al. (2018) and calibrated by Segar et al. (2021). As expected, all National Parks showed a positive increase in their rewilding scores after the initial interventions upon designation.

This work has shown that even with strict limitations to time and human resources, as is often the reality in rewilding areas, the practicality and cost-effectiveness of this monitoring method holds true.

While the five national parks struggle to increase some of the indicators quantifying for the ecological integrity of their area, due to the reality of the regional contexts, the legal framework has shown considerable effects on the reduction of human forcing to the systems across all sites. This is a powerful opportunity for national parks to build upon and become reference points for rewilding in Germany and Europe.

1. Introduction

The biodiversity crisis and its recent magnitude of species extinctions especially of vertebrates, range contractions, and population declines on a global level have been referred to as a “biological annihilation” and has been dubbed the “sixth major mass extinction” event in earth’s history (1). Between the years 1970 and 2016, WWF’s Living Planet Index from 2020 shows a 68% decline in monitored vertebrate species populations globally (2). This loss impoverishes biodiversity and destabilises the self-sustainability of ecosystems and their services on which human civilization ultimately depends.

Looking further at declines from a non-vertebrate standpoint, we find that in protected areas in Germany the total flying insect biomass, despite increased global and national efforts to halt biodiversity loss since the last century, has decreased substantially by more than 75% over a 27 year period between 1989 and 2016 (3). The fact that even within protected areas in Germany species extinctions and population declines are ongoing, is a compelling warning and should motivate nature protection and restoration actions to become more ambitious. Looking at these trends, it is worth reconsidering and questioning the effectiveness of a protectionist approach of nature conservation alone, that is rooted in the latter half of the past century (4&5).

The preservation of fixed states of nature, often on small, local scales has been the go-to method of nature conservation in Europe (5). However, a very influential notion that has influenced the conservation community, is the so-called “shifting baseline syndrome”. It addresses the problem of conserving a state of nature, that is based on the perception of what “the normal” state of nature is, should be, or was like in recent memory. The perception of normality shifts from one generation to the next as the state of nature changes with ever-increasing human interventions (6). This acceptance of a highly degraded state of nature as normal, which needs to be cared for by the public, continuously lowers the standard of nature. “Rewilding” tries to break this mould by bringing the topic of discussion away from a species and habitat focus and towards restarting the dynamic natural processes to act as the main managing and driving force of an area.

Looking at the different strategies that have been implemented on a global, regional, and national scale in the past to halt biodiversity degradation and loss, we find that none have been successful. These include the EU’s 2010 Biodiversity Action Plan (7), the UN’s decade on Biodiversity (2011-2020) and all of the Aichi targets (8). In Germany, the 2% wilderness objective of the National Strategy on Biological diversity target has also been missed (9). And with the demand for resources and pressure from various industries on every acquirable piece of land increasing, the challenge of reaching these targets in the future is likely to grow ever more difficult and continued failure of newly set goals seems unavoidable.

The newly launched UN Decade on Ecosystem Restoration supports and has called for ambitious actions to not just halt biodiversity loss but to restore the ecosystems that have been lost until 2030 (10). Rewilding is a highly appropriate tool to apply to this challenge, as contrary to the more conservative nature protection approach, it has at its core the natural processes and dynamics that drive the recovery of ecosystems in the long term, without human intervention (11).

While it is still a young development that is continuously becoming more popular among the public, conservation practitioners and scientific communities (5), its practical application still faces a number of challenges. One of the issues today is the lack of a landscape-scale application of a standardised monitoring method of a site’s progress over time following rewilding interventions (12). Such monitoring can serve the multiple needs of reflecting on past interventions and their effectiveness by the practitioners, identify challenges and opportunities for specific areas and allow for learning in the rewilding community by exchanging results. This work addresses this challenge by applying a tested, expert-based rewilding progres assessment to quantify the rewilding progress over time across five national parks in Germany.

2. Rewilding and National Parks

As defined in category II of the protected area categories by the International Union for Conservation of Nature (IUCN), national parks are *“large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities“ (13).* Their primary objective is “to protect natural biodiversity along with its underlying ecological structure and supporting environmental processes, and to promote education and recreation”. This hands-off approach towards unimpaired ecological processes and the human inclusiveness aspect of an area, sets them apart from other categories and is congruent with rewilding principles (14).

As stated above, rewilding aims to go beyond the classical conservation approach, of halting biodiversity loss by reaching a specified end-point through high costs and human management, but aims to reverse the trends of the biodiversity crisis by letting nature lead and manage itself instead. Rewilding is a relatively new word with various approaches, defined and used differently, such as the “three C’s approach”, “Pleistocene Rewilding”, “Active/Passive Rewilding” or “Trophic Rewilding” (Jepson & Blythe 2020). However, it has already been practised in the past, without the direct use of the term or these classifications. For instance, the first German national park, the Bavarian National Park founded in 1970, followed a progressive philosophy of *“Letting nature be nature”* when facing contentious decisions in the early stages of the park's development. With this now well-known guiding principle at their core, 15 other national parks have been designated in Germany since then, covering 1.050.442 ha of Germany's land and sea territory to date (15) (see figure 1). The youngest of these, Hunsrück-Hochwald National Park, was officially designated in 2015.

Following the international and national standards, a German national park should designate at least 75% of its total area, after 30 years since their designation, to their primary objective and be of sufficient size, which is defined at a minimum of 10.000 ha (16 & 17), to allow for long term persistence of native species and communities (13). Only one of these sites, the Kellerwald-Edersee National Park in Hessen, has fulfilled the criteria of a national park and has subsequently received an IUCN certificate in 2010. The remaining 15, therefore, do not fulfil all the criteria yet, and are thus referred to as “development parks” (14). Despite this, all 16 German National Parks hold a promising potential, due to their legally binding management principles, for rewilding and the necessary reversal of the biodiversity crisis in Germany and Europe (16,18,19).

Figure 1: Map showing the locations of all 16 National Parks in Germany with their respective size in hectares (20)

3. Assessment of rewilding progress

As rewilding is still a young concept in Europe, it is not surprising that there is a lack of rewilding monitoring at site level world wide. With only nine sites that have been scored thus far in Europe, following the method described below, only one of these is a National park and only one of these is a site in Germany, namely the Swiss National Park and the Oder Delta Rewilding Area respectively (12, 21). This lack of monitoring, especially for National Parks, goes hand in hand with a lack of a generally accepted concept of how "natural processes" or "near natural processes" are defined and thus how the goals of a national park, to allow for and enhance these processes, can be achieved. This problem was addressed in the recent, large-scale evaluation of the Management Effectiveness of German National parks from 2020: "The central objective of national parks is to enable natural dynamic processes without human interference in at least 75% of their area ("Let nature be nature"). The operationalization of this goal requires an understanding of what "natural processes" or "near-naturalness" means in a concrete case and how these desired states can be achieved." (22).

While there are many ecological monitoring systems already in place, there has not been one that embodies the rewilding vision and principles for self-sustaining ecosystems, while at the same time being cost and time effective. For this reason, Torres et al() based their rewilding progress measurement on the rewilding framework presented by Perino et al. (2019) to account for and quantify the various indicators that more specifically assess rewilding progress at site-level, compared to more traditional ecosystem monitoring that focus more strongly on certain ecological factors with a very static and fixed nature status.

The 19 Indicators that form the backbone of the Rewilding Score, as identified by Torres et al. (2018) and have been further standardised through a consensus iteration process with rewilding experts and practitioners by Segar et al. (2021), address this problem. Nine of the 19 indicators are based on the rewilding framework proposed by Perino et al (2019). This theoretical framework defines the ecological integrity of an area by looking at three crucial components, namely stochastic disturbances, natural dispersal/connectivity and trophic complexity (Figure 2). These interacting components describe the self-sustainability of an area.

Going beyond the ecological integrity component, the Rewilding Score additionally offers a way of quantifying human management and interactions with a system and linking it to ecological integrity.

Natural processes and human influence, or "human forcing", on the system are an inherent concept in this score's framework. Thus, these indicators offer a concrete way of assessing the components of the site's natural processes and to monitor these over the time. This provides insights on how practitioners have been allowing and can enhance these natural processes for a site in the future, to reach the national parks objective of "letting nature be nature".

Looking at the progress of rewilding in these sites to date since their foundation, by looking at the relative Rewilding Score change over time, can further identify or give insights into management challenges and opportunities across sites. In the present work, the Rewilding Scores of five German national parks have been quantified by local experts, professionally linked to the respective park administrations. This work is based on the milestone studies on monitoring rewilding progress by Torres et al. (2018) and Segar et al. (2021) and is the first of its kind assessing multiple National Parks in Germany. The method and the results of these scores are presented and discussed below.

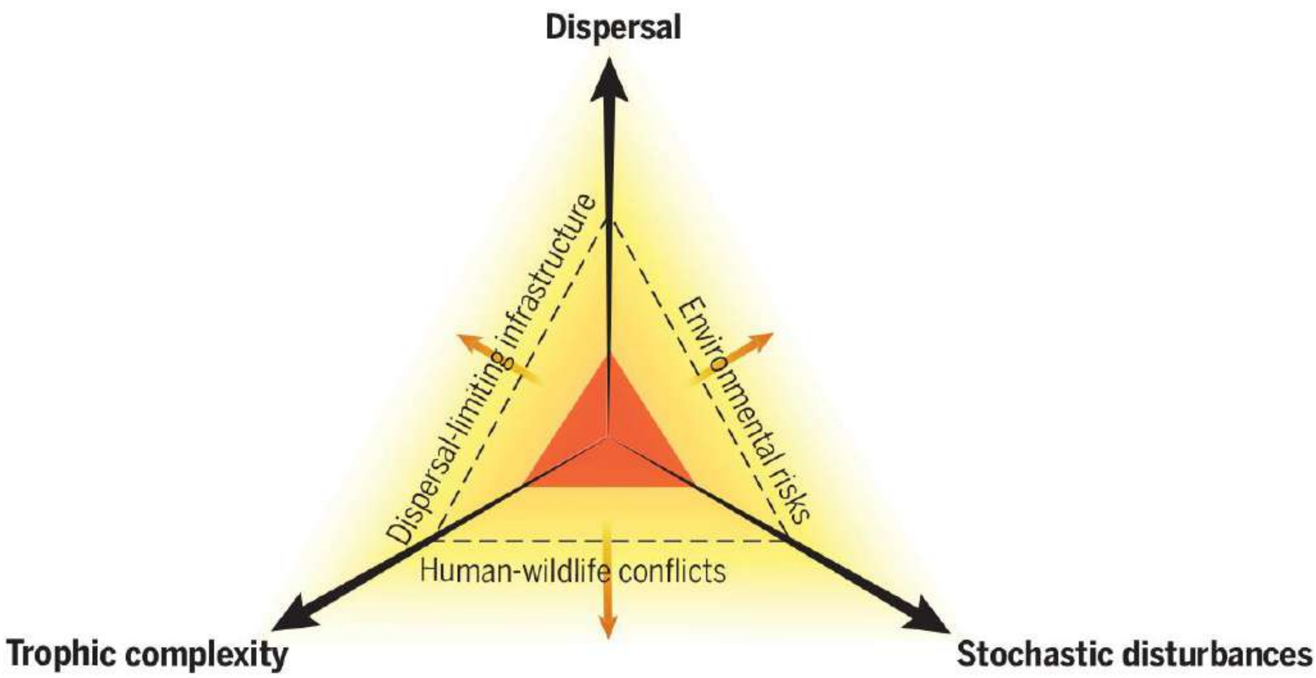


Figure 2: The framework offered as a guideline for rewilding, including three components that determine the ecological integrity of a site as identified by Perino et al. (2019), upon which 9 of the 19 indicators of the Rewilding Score are derived. The components lead to an increase in the self-sustainability of ecosystems (23).

4. Methods

Nationalpark	Year of designation/ fusion	Age (years)	Size (ha)
Jasmund	1990	31	3070
Müritz	1990	31	23200
Harz	2006	15	24732
Schwarzwald	2014	7	10062
Hunsrück-Hochwald	2015	6	10230

Figure 3: The assessed national parks are ordered by age with their respective age/year of designation and size in hectare (15,24).

In total, five German national parks were assessed with differing ecological, geographic and historic contexts: Jasmund, Müritz, Harz, Schwarzwald and Hunsrück Hochwald national parks (Figure 1, Figure 3). To quantify the rewilding progress since the designation of the parks and their current state we defined two periods to be scored. The “baseline” period marks the foundation of the national park and start of rewilding interventions, while the “current" period was set to November/December 2021. For each site, one local expert, who is professionally connected to the national parks administration, ideally within the research department, was contacted. At the end of November a questionnaire was handed to each local expert with guidelines for the practitioner on how to score each indicator for their site using the calibrated indicators by Segar et. (2021) and the supplementary material provided with further references. While some indicators are data driven, others are scored based on the best available data at the time and the knowledge of the local expert. While one expert per site functioned as the person quantifying the scores for each indicator, colleagues from the department of research and other members of the national parks were also consulted by the experts. This, in combination with using the consensus indicator list derived by the iterative Delphi-exercise by Segar et al. (2021), is an attempt to minimise subjectivity and bias from the local experts during the scoring process. The adapted list of indicators from Segar et al. (2021) has been compiled through an elicitation process of expert-based data by 18 experts across seven rewilding sites in Europe, in an effort to minimise the potential for misunderstandings and to standardise this time and cost-effective method of monitoring rewilding progress in Europe. A more accurate approach of using remote sensing data was not done due to the limited framework of this study.

The Rewilding Score encompasses key ecological processes that are characteristic for complex and natural dynamic systems, as described by the primary objective of national parks. These are expanded into 19 indicators that further cover the broad range of indicators necessary to monitor rewilding progress for a site, including human influences. Of these, nine indicators distinguish for the ecological integrity (E) of a site and are classified based on the three components of the rewilding framework proposed by Perino et al. (2019), namely natural disturbance (S_d), connectivity (S_c) and trophic complexity (S_t). While the other ten indicators, fall under the "human forcing" (H) component and address the human inputs and outputs (S_{io}) into a system, through various management and exploitative activities (figure 4).

For each indicator a score on a continuous scale between 0 and 1 is given by the local expert following Torres et al. (2018). A high score for human forcing indicators result in an unfavourably low Rewilding Score, while a high score for the indicators of the ecological integrity of a site result in a high overall Rewilding Score (R). The overall Rewilding Score was calculated by the author, after receiving the scores for all 19 indicators by the local experts of the sites. For each component of the score's framework (S_d, S_c, S_t, S_{io}) the arithmetic average was calculated. To quantify for the interactive quality of the three ecological integrity components, the geometric mean of these scores is calculated. The Rewilding Score of a site for a particular time period lies in a bidimensional space created by E forming the Abscissa and H the Ordinate. Its precise position in this space is determined by the values of E and H and are calculated as follows:

$$E \cdot (1 - H) = \left(\sqrt[3]{\overline{S_\mathrm{d}} \cdot \overline{S_\mathrm{c}} \cdot \overline{S_\mathrm{t}}} \right) \cdot \left(1 - \overline{S_\mathrm{io}} \right)$$

Figure 4: Calculation of the overall Rewilding Score (R) of a site for a particular time (baseline/current), following Torres et al. (2018).

Score changes over time were calculated as the relative percentage of difference between the baseline and current Rewilding Score, following Segar et al (2021). The data analysis and visualisation was done using R-Studio (Version 2021.09.2+382, "Ghost Orchid", Release 2022-01-04).

Since the indicators are standardised and can be scored by local experts across different rewilding sites, a comparison between these is possible. Thus no further site-specific indicators were defined and used in this work, to allow for a wide application of comparisons between the various national parks and rewilding areas. However, it is worth noting that each site is subject to a complex interaction of history and culture, socio-economic and ecological contexts that are highly site specific. For this reason, detailed comparisons between sites have not been attempted in this study. Instead, common indicator changes across sites and more general trends with regards to rewilding progress of the national parks were identified and discussed.

5. Results

a. Rewilding Intervention summary and Context

Following the official designation as a national park (NLP) by the respective federal states as outlined by the guidelines for protected area management by the IUCN and §24 of the German Federal Nature Conservation Act (BNatSchG), all sites show a clear increase in the overall Rewilding Score (R) over time (figure 5).
The period over which the rewilding progress was quantified varies between sites according to the NLP's definition of baseline. While three NLPs chose the designation of their national park as the baseline (figure 3), the Harz NLP administration, defined it as the time of fusion (January 2006) between the two federally adjoining national parks, Nationalpark Hochharz (1990) and Nationalpark Harz (1994). Thus the rewilding progress for the Harz NLP was quantified over the course of 15 years, albeit rewilding interventions had already started in 1990 and 1994 upon their designation. The rewilding progress for Schwarzwald NLP was scored over a total of 7 years following its designation and the youngest German National Park, Hunsrück-Hochwald NLP, spanned 6 years. Jasmund NLP and Müritz NLP both covered a time period of 31 years each. Owing to these different assessment periods, a detailed comparison between sites and their indicators was not attempted. Rather, site specific trends and common patterns of the national parks with regards to their rewilding progress were analysed.

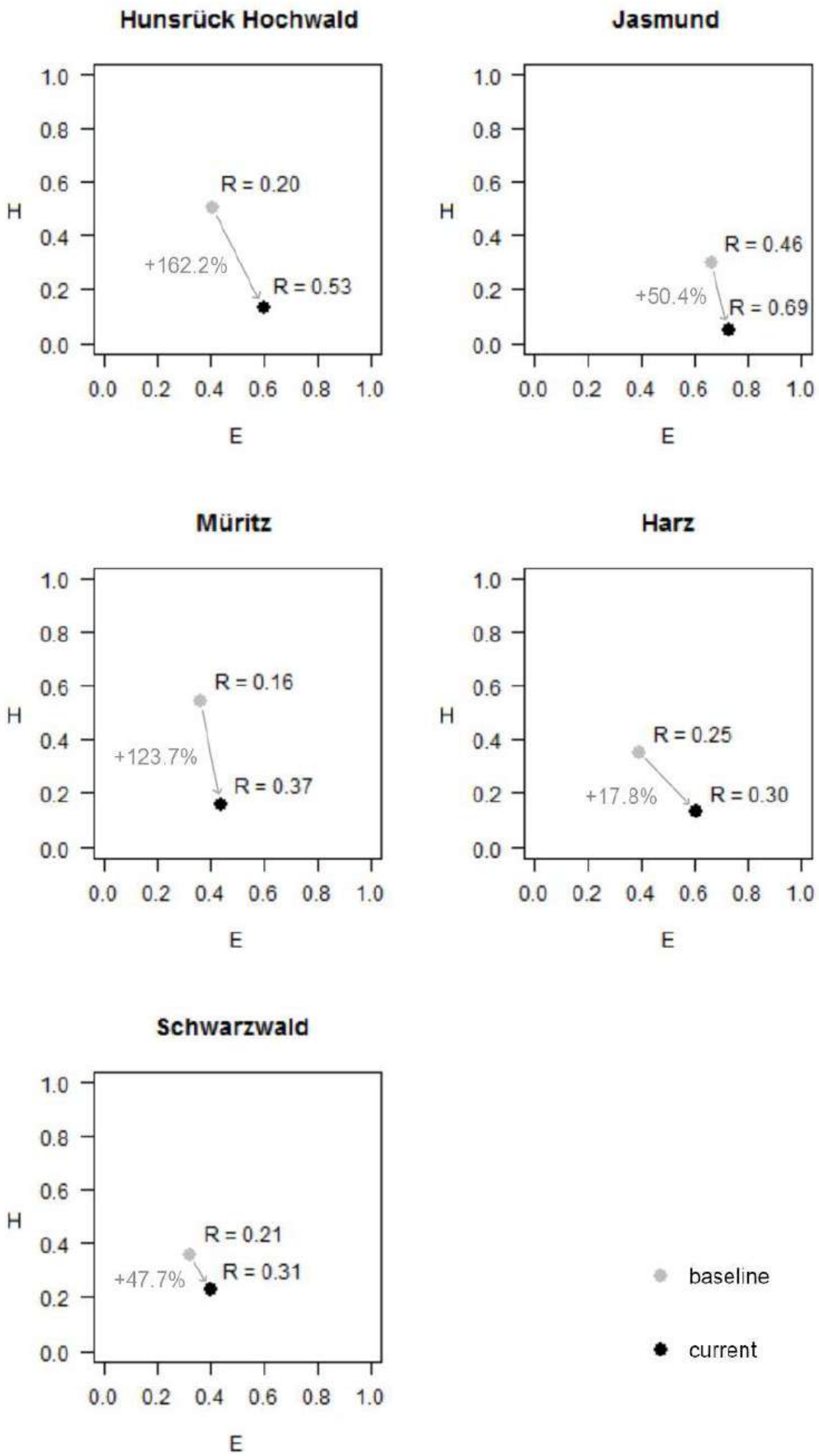


Figure 5: Panel showing the Rewilding Scores (R) for each time period (baseline, current) and their rewilding progress (%) over time in the bi-dimensional space created by the two main components of R, namely Human forcing (H) and Ecological Integrity (E), for each site.

b. Changes in Rewilding Scores and Rewilding Progress over time (%)

Rewilding Scores (R) for both time periods across all sites range between 0.16 and 0.69 with a mean score of 0.35. R Baseline scores ranged between 0.16 and 0.46 with a mean score of 0.26. While current Rewilding Scores range between 0.30 and 0.69 with a mean of 0.44 (figure 6).
This results in a rewilding progress (%) over the period in time assessed across sites, ranging from +17.8% in Harz NLP to +162.2% in Hunsrück Hochwald NLP. In between these lie Schwarzwald NLP with +47.7%, Jasmund NLP with +50.4% and Müritz NLP with +123.7%. The mean rewilding progress for all National Parks following their designation/fusion is +80.7% (figure 5).

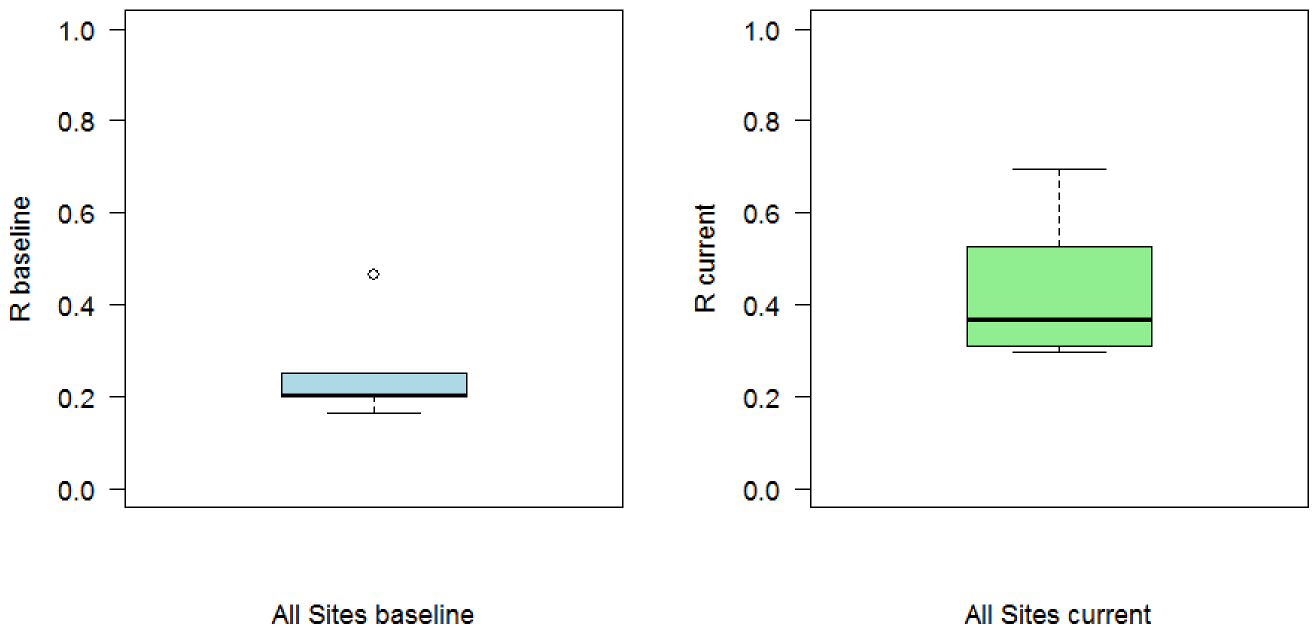


Figure 6: Boxplots of all Rewilding Scores for baseline (blue) and current (green).

c. Changes in H and E across sites and over time

Most sites show favourable changes in all four components of the score (S_d, S_c, S_t, S_{io}) over time. Among the common measures influencing the Rewilding Score positively upon designation of the sites across the range was an overall reduction in human forcing (H) (average of -54.8% across the sites). The progress in developing the ecological integrity (E) of the areas showed more moderate improvements in comparison (average of +23.5%) (figure 6).

All sites report considerable decreases of human forcing (H) to the system with changes ranging from -9.8% in the Harz NLP to -83.3% in the Jasmund NLP. In between these lie the Schwarzwald NLP with -36.1%, Müritz NLP with -70.4% and Hunsrück Hochwald NLP with -74.2%. The mean progress over time for H across all

sites is -54.8%.
Disregarding the Harz NLP, which saw rewilding interventions starting up to 16 years before the baseline period set in this assessment, the mean progress of H for the remaining four sites is -66.0%.
Four sites reported an increase in ecological integrity (E), ranging between +10.1% in the Jasmund NLP to +49.3% in Hunsrück Hochwald NLP. In between these sites lie the Harz NLP with 11.8%, Müritz NLP with 21.5% and the Schwarzwald NLP with +25.0%. The mean progress over time for E across all sites is +23.5% (figure 7).

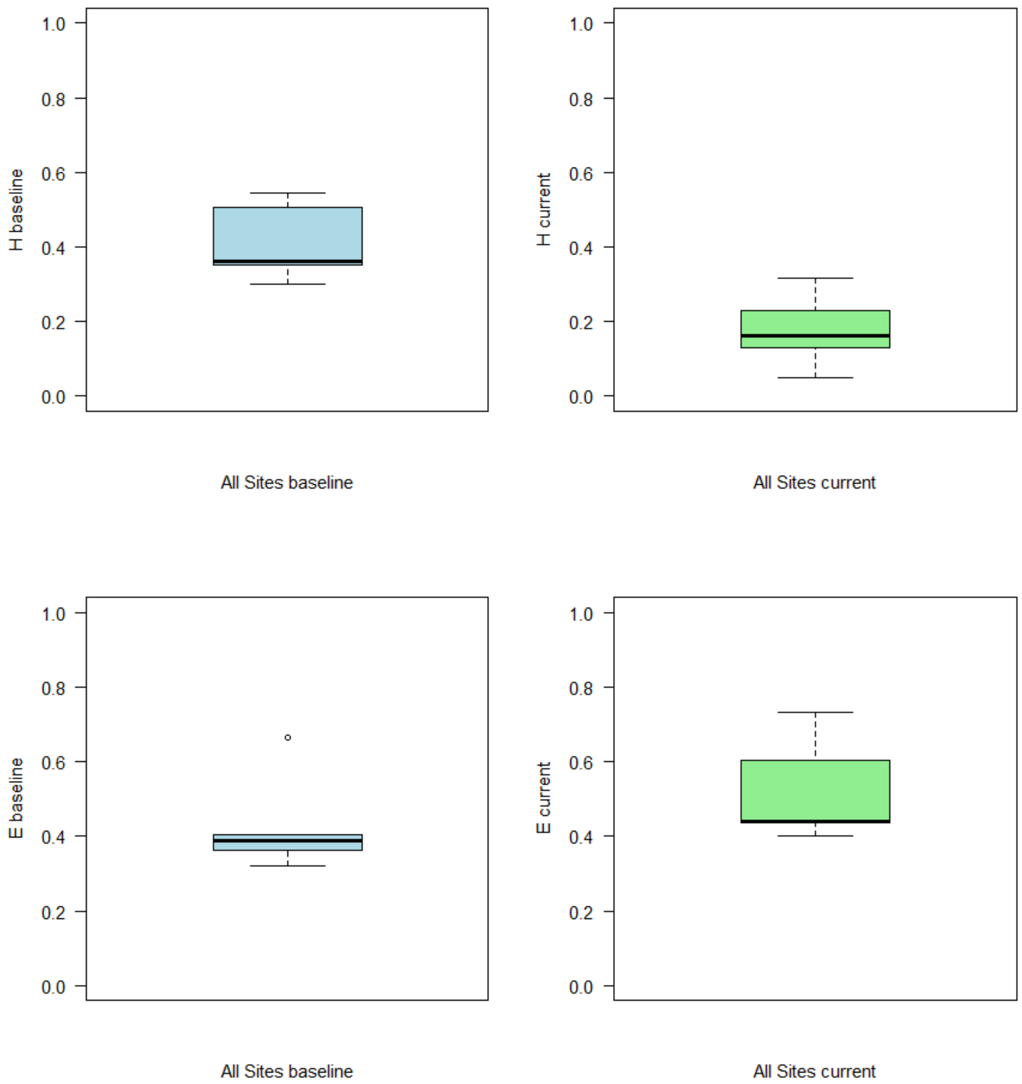


Figure 7: Boxplots showing the ecological integrity (E) and the human forcing (H) scores across sites for baseline (blue) and current (green).

d. Changes in Human inputs and outputs ($S_{i,o}$) across sites and over time

Similarities between sites can be shown, when regarding the individual indicators that quantify for the human forcing component ($S_{i,o}$). Most notably the reduction in intensity and total area designated to grassland, forestry, and farmland production improved the human forcing score for all sites. Other notable human inputs and outputs that were reduced and resulted in positive changes to the overall rewilding progress across the range were indicators such as harvesting of aquatic wildlife, deadwood removal, reductions in artificial supplementary feeding of wildlife (>5kg), population reinforcement and carrion removal (figure 8).

e. Changes in Stochastic Disturbances (S_d) across sites and over time

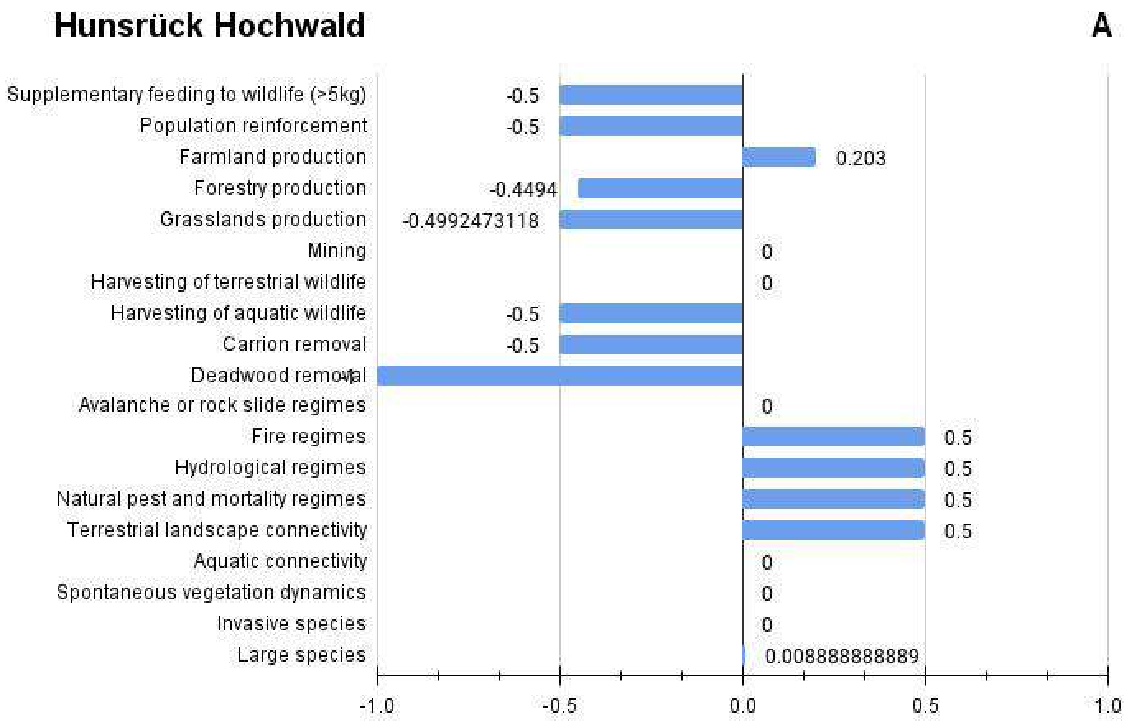
Indicators for the stochastic disturbance component of the rewilding framework (S_d), show no or very little improvement over the time periods across sites. The indicators showing the strongest improvement within this component were improvements to the hydrological regimes and pest & mortality regimes with +0.22 each. Scores for a site's fire regime differed on average by only +0.1, while the avalanche and rockslide regimes of one site in particular (Schwarzwald NLP) brought the average score difference down to -0.2, showing the only negative trend within this indicator group (figure 8).

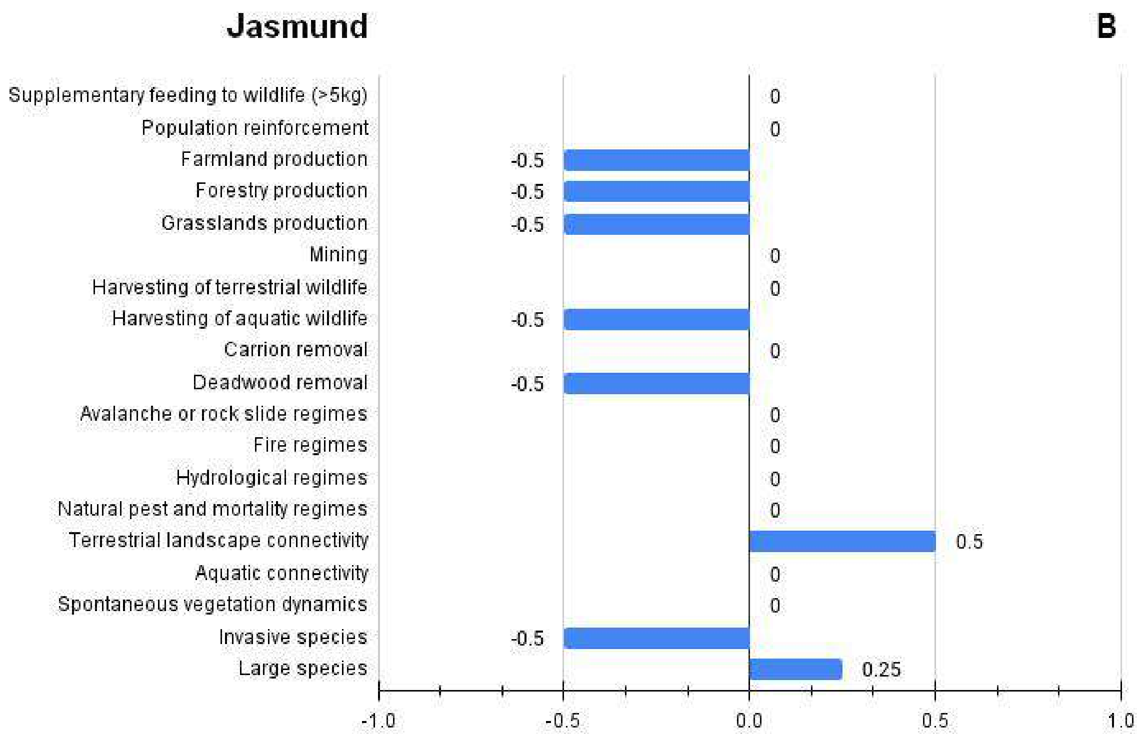
f. Changes in Connectivity (S_c) across sites and *over time*

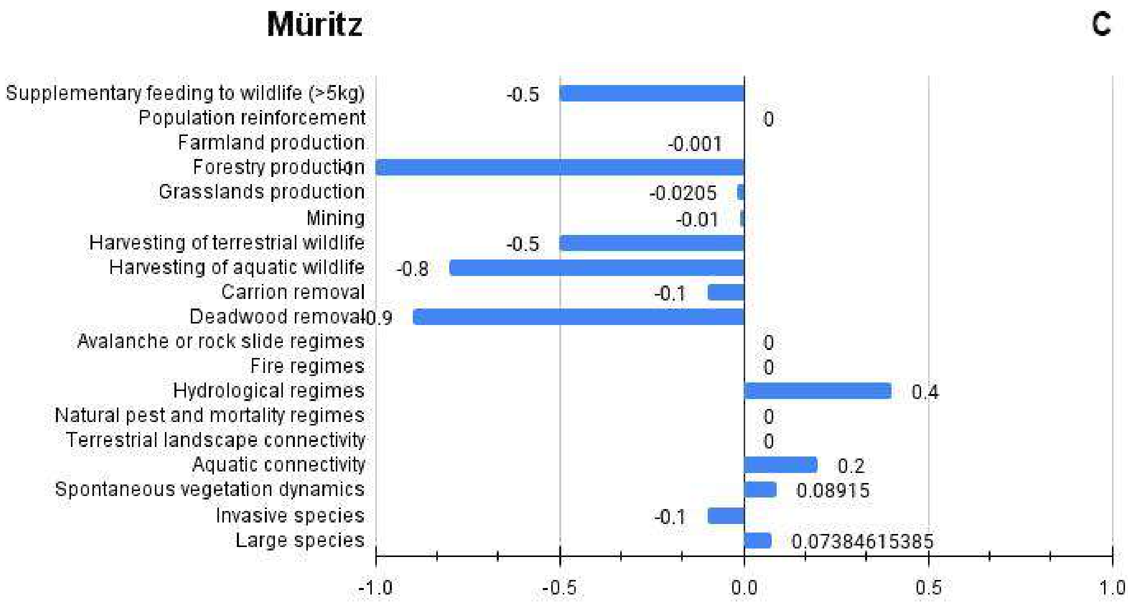
Similarly, the connectivity component of the scores (S_c) showed only moderate improvements for sites. With an average score difference of +0.22, the terrestrial landscape connectivity indicator favourably influenced the overall Rewilding Score the most within this group. The aquatic connectivity of sites and the spontaneous vegetation dynamics only increased slightly with averages of +0.04 and +0.02 respectively. However, the harmful invasive species indicator showed on average a negative trend of -0.08 across sites (figure 8).

g. Changes in Trophic Complexity (S_t) across sites and *over time*

Looking at the last Rewilding Score component, the trophic complexity indicator (S_t), a positive trend across all sites apart from the Schwarzwald NLP is reported, with more large species (<5kg) being present in the sites following their designation/fusion. However, while some native species have regained a foothold in some sites, other, non-native or naturalised species have also become more present in sites, particularly *Procyon lotor*. Changes in score difference across time are on average +0.10, with Jasmund NLP showing the highest score difference of +0.25 with an increasing presence of animals and three new species being present today (*Halichoerus grypus, Phoca vitulina, Procyon lotor*) (figure 8). The Schwarzwald NLP shows the lowest difference (0.00) for the assessment period. The Hunsrück Hochwald NLP shows a moderate increase of this indicator's score (+0.01), with three new species being present in the area since its designation as a NLP (+ *Castor fiber, Lynx lynx, Canis lupus*), albeit only in low numbers, passing through the area or present on a small percentage of the area. In between these lie the Müritz NLP with a score difference of +0.10 after reporting two new species to the area (*Canis lupus, Castor fiber*) and a reduction in Mouflons (*Ovis gmelini musimon*) following the increasing activity of wolves in the area. The Harz NLP reports an increase of +0.18 with one new species being present *(Canis lupus)* in the area and two species showing a strong recovery (*Lynx lynx, Felis silvestris*). Racoons (Procyon lotor) have also increased in this site.






Müritz
C
Supplementary feeding to wildlife (>5kg)
Population reinforcement
Farmland production
Forestry production
Grasslands production
Mining
Harvesting of terrestrial wildlife
Harvesting of aquatic wildlife
Carrion removal
Deadwood removal
Avalanche or rock slide regimes
Fire regimes
Hydrological regimes
Natural pest and mortality regimes
Terrestrial landscape connectivity
Aquatic connectivity
Spontaneous vegetation dynamics
Invasive species
Large species
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-0.001
-1
-0.0205
-0.01
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-0.8
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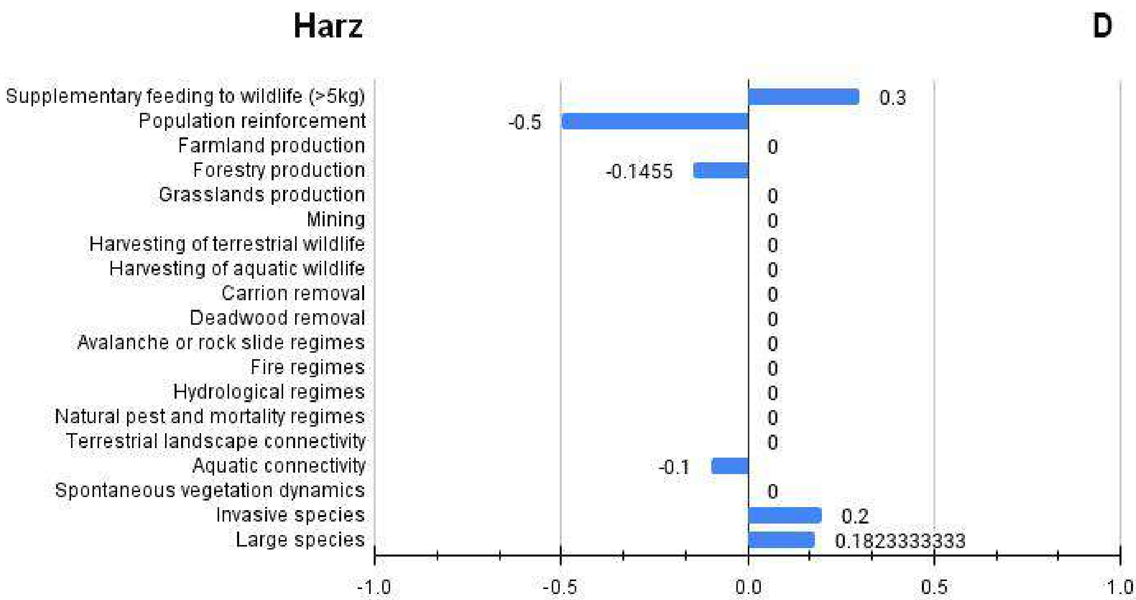
Harz
D
Supplementary feeding to wildlife (>5kg)
Population reinforcement
Farmland production
Forestry production
Grasslands production
Mining
Harvesting of terrestrial wildlife
Harvesting of aquatic wildlife
Carrion removal
Deadwood removal
Avalanche or rock slide regimes
Fire regimes
Hydrological regimes
Natural pest and mortality regimes
Terrestrial landscape connectivity
Aquatic connectivity
Spontaneous vegetation dynamics
Invasive species
Large species
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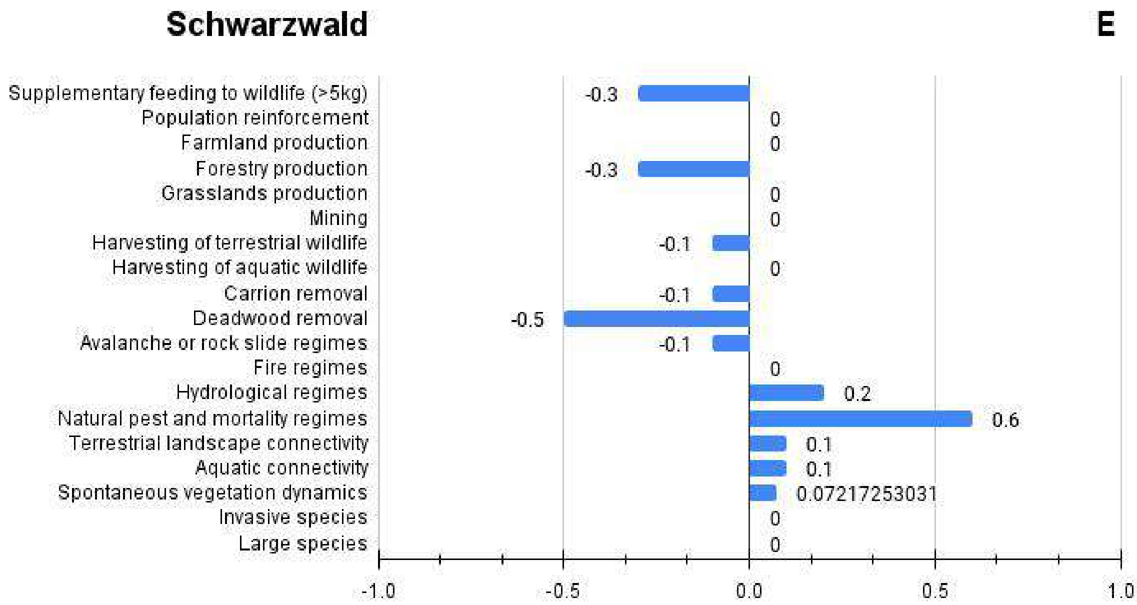


Figure 8 (A-E) showing the score differences for each indicator from baseline to current for each site over time. Negative score differences for the first ten indicators (H) and positive score differences for the remaining nine indicators (E) result in a positive rewilding progress over time.

6. Discussion

Above all, this work has shown that even with strict limitations to time and human resources, as is often the reality in national parks and other rewilding areas, the practicality and cost-effectiveness of this method holds true. Some troubleshooting with regard to minor misunderstandings and questions to certain details of indicators was necessary during the scoring process, however the overall working process with the local experts was smooth and time-effective. This is an encouraging result for other national parks to evaluate and to keep monitoring their “rewilding journey” in the future, as they continue working towards a wilder nature to pass on to generations to come. As stated in Heiland et al (2020), one of the weaknesses of national parks in Germany is their ability to allocate resources, in particular trained personnel, to monitoring and evaluating, while simultaneously undertaking a plethora of other duties and responsibilities directed to various fields of activity. This cost-effective method therefore lends itself very well to overcoming this challenge in these circumstances.

In the present work, the scores of the five aforementioned national parks in Germany have been quantified by local experts. As expected, all National Parks showed an

increase after the initial interventions upon designation. However it is worth noting that the method of assessing depends highly on the accuracy of the expert's judgement. Given the guidelines in the questionnaire for indicator scores that show descriptions of three score levels (0, 05.,1) by Segar et al (2021), scores can be biassed towards these three levels, as more nuanced score descriptions for other levels on this continuous scale are not shown. This has led to one site, the Jasmund NLP, reporting many scores for different indicators with either a 0, 0.5 or 1. While this makes it difficult to compare the progress between sites that have given their scores more accurately, it is reflective of the benefit of this method. Since, depending on how much time and effort a site has to spare for such an assessment, the resolution of the results can be altered. Thus, a clear positive trend for this NLP towards self-sustainability is observable regardless of the lower resolution given. For instance, in line with the other parks, a clear reduction in Human forcing (-83.3%) since designation can be observed, relative to a more moderate increase in the ecological integrity (+10.1%).
Incidentally, this is also the smallest of all NLPs in Germany, with only 3070 ha under protection. This aspect alone gives rise to the question if a National Park of such a small size, can be expected to show a strong increase in its ecological integrity score, even after a period of over 30 years? Being largely disconnected and isolated to other larger protected areas in the region, reaching the maximum Rewilding Score indicating pristine wilderness and self-sustainability seems like an ambitious undertaking. This does not only apply to the smallest NLP in Germany, since the other parks are similarly disconnected and isolated, despite lying adjacent to various other forms of nature protection sites (Biosphere reserves, Nature Parks, sites protected under the EU Birds and Habitats Directive, etc.).
In other words, is the National Parks primary objective achievable on such a relatively small scale, in such a densely populated country? While this study can not attempt to answer this question, it is worth noting that, especially ecological processes and dynamics require not just large spaces but also large time spans. And with the oldest National Park in Germany being "only" 52 years old, one can not expect the National Parks to show high levels of ecological integrity today, given the geographic and historic context of these sites. Instead of trying to achieve the end goal prematurely, it is advisable to "move up the scale of wildness", or as the Schwarzwald NLP communicates it: "Eine Spur wilder", which translated means "one step wilder". Again, this is where the benefit of this study can be noted, since the "steps" to become wilder can be identified and monitored through the method proposed by Torres et al. (2018) and Segar et al. (2021).

Looking at the progress of rewilding in these sites to date since their designation, shows challenges, opportunities and the potential of rewilding in these five national parks in Germany. These are explored further below by looking at each one of the four Rewilding Score components (S_d, S_c, S_t, S_{io}) that can lead to the self-sustainability of an ecosystem as suggested by Perino et al (2019).

a. Human forcing ($S_{i,o}$) in German National Parks

By comparing the results of the 19 indicators with the other rewilding sites that have been scored in Europe to date (n=9) , the opportunities and challenges for rewilding in Europe become even more clear. The experts in Segar et al. (2021) identified six threat factor categories that affected their site's rewilding progress, namely human-wildlife conflict, law & policy, land & water management, land-use change, pollution and biotic pressures (figure 4 in Segar et al. (2021)). Further specifying these, the most common threats across all sites were poaching, species persecution, the Common Agricultural Policy (CAP) and other development policies, drainage & river regulation, habitat loss & fragmentation and hunting.
While many of the sites assessed by Segar et al (2021) are not under the strong legal protection by law, as are National Parks, challenges and threats differ. For instance, six and five sites reported that the Common Agricultural Policy (CAP) and other development policies threaten the rewilding progress in their areas respectively. Despite active rewilding interventions by the local practitioners, this can even reverse the overall rewilding progress, as seen in the Rhodope Mountains in Bulgaria (-13%) and Velebit Mountains in Croatia (-6.7%) that form part of Rewilding Europe's network of pilot sites <www.rewildingeurope.com>. With the exception of poaching and species persecution, many of these threat factors should not negatively impact the rewilding progress of National Parks when compared with these examples mentioned above. Based solely on their legal framework and management plans, many of these threats, such as intensive agriculture or hunting, are prohibited by law. Thus, it seems that one can expect national parks to achieve a more stable rewilding progress over time, as reported in this study, compared to rewilding areas that do not operate under their own legal framework or receive reliable basic funding streams as do the national parks.

In comparison, national parks seem to stand on a firm and strong foundation, providing a good starting position to achieve their goals. However, despite being protected areas that aim to allow for natural processes and dynamics to unfold with minimal human influence in theory, in the densely populated country of Germany various human interventions are unavoidable in reality(15). Measures regarding health and safety for wildlife and society, within the park's boundaries and beyond, are necessary to maintain the delicate balance between protecting the welfare of society, the regional economy and ecology. These include more moderate interventions, such as the cutting of trees along infrastructure or the maintenance of some roads and pathways for visitors to maintain a certain safety standard. But also more intense interventions such as the culling of herbivores, in particular red deer (*Cervus elaphus*) even in the "nature dynamic zones", or the cutting of bark-beetle infested or weakened trees (*Picea abies*) in a certain buffer distance within the park's boundaries. The latter measures are aimed at protecting the neighbouring properties with conflicting land use aims, such as forestry production and agriculture ("Anrainerschutz"). Due to the African Swine Flu virus, hunting pressure on wild boar (*Sus scrofa*) has also been intensified in recent years and is a measure that affected

national park administrations are obliged to execute by law. Other interventions that are aimed at conserving particular species and communities, such as the maintenance of open grassland areas and other threatened habitats, also require direct human intervention. This can be seen as a necessary substitute for the lack of large herbivores, following the past defaunation, that would otherwise shape the landscape through natural grazing.
These measures that are important to uphold to maintain the acceptance within the local and wider society, mean that the primary objective of national parks are missed. This is true, especially during the winter season, where artificial feeding may be intensified to direct red deer away from forests with conflicting land-use interest. Outside of national parks, this pressure on red deer is exemplified in the extreme reduction of this ungulate's distribution.
An example of this and the previously noted shifting baseline syndrome can be the highly restricted and isolated administrative management units (AMUs) for red deer (*Cervus elaphus*) in Germany. In many federal states, red deer are entirely restricted to live in small, often completely isolated populations, due to the conflict this animal causes between the interests and responsibilities of agriculture, forestry and the hunting communities. By law, these animals are to be shot, should they exit these AMUs. This has not just halted the ecological processes this herbivore is involved in by prohibiting any natural movement and migration but has also imperilled the genetic diversity of the red deer population in Germany by limiting gene flow and thus the viability of sub-populations in the long term (25, 26).

Looking further at the average score differences for each indicator quantifying for this Rewilding Score component ($S_{i,o}$)(figure 5) shows the indicators that have seen the strongest reduction across sites. Note, that a negative score difference for the human forcing indicators results in an overall higher Rewilding Score and is favourable. The opposite is true for the indicators quantifying for the ecological integrity of a site, which are discussed further below.
The strongest mean score difference is represented by the dead wood removal indicator (-0.58). The lack of deadwood removal interventions is a simple and cost effective way of increasing the score. Following the park's legal framework of prohibited extractive activities, indicators referring to these measures score highly across the sites. Forestry production shows the second highest score difference (-0.49) among these. Interestingly, the mean score difference for harvesting of aquatic wildlife is stronger than the indicator with the lowest mean score difference, namely the harvesting of terrestrial wildlife (-0.12), which reflects the aforementioned interventions that are necessary to uphold the socio-economic balance of the region as well. The regulatory interventions of culling activities are often in combination with supplementary feeding of wildlife (<5kg) as illustrated above, which showed improvements across sites.

b. Stochastic disturbances (S_d) in German National Parks

The indicators that showed the highest mean differences in scores for all sites are Hydrological regimes, and Pest and Mortality regimes, both with a mean score difference of 0.22. The fire regimes showed a moderate increase of +0.1, and the avalanche and rockslide regimes presented a negative mean trend of -0.2 as a mean for all sites. Due to the responsibility of maintaining a safe and open access to visitors to enjoy and experience nature, measures to secure the infrastructure are sometimes necessary.
Salvage logging was done in the Schwarzwald prior to its designation and has been terminated. This method of cleaning up forests after disturbances negatively impacts saproxylic diversity and cavity nesting species (Perino et al. 2019).

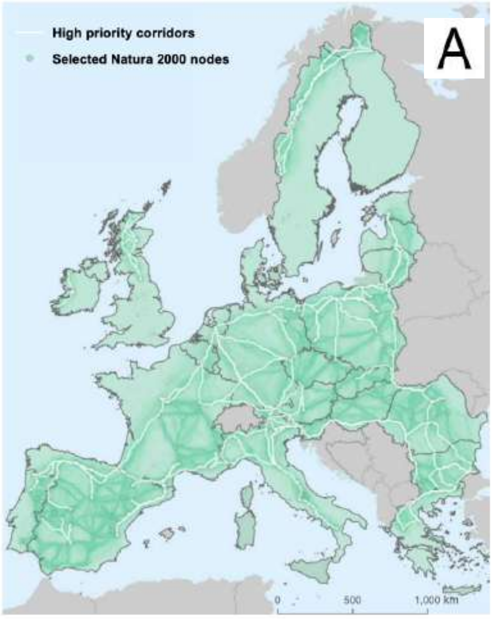
c. Dispersal and connectivity in German National Parks (S_c)

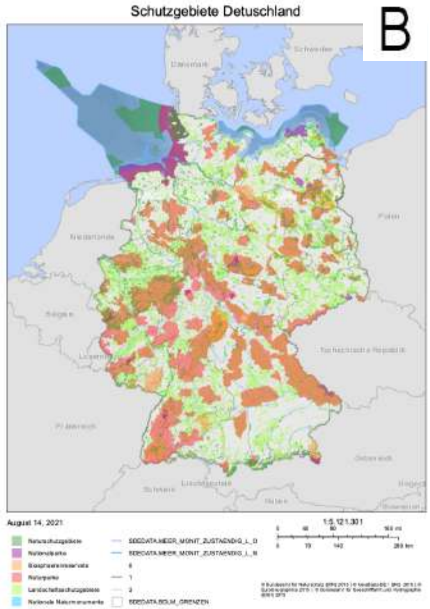
Looking at the four indicators quantifying the connectivity component of the Rewilding Score, the terrestrial landscape connectivity shows the highest mean score difference (+0.22) across all sites over the various periods of assessment. Followed by the aquatic connectivity with a more moderate mean score difference of (+0.04) and the spontaneous vegetation dynamics indicator that increased by +0.02. The latter indicator is one that will show changes over a longer period of time and the three national parks the relatively short assessment period can not show changes this quickly, apart from already existing areas, for example the old growth forests such as the “Bannwald” in the Schwarzwald NLP or “Serrahn” within the Müritz NLP, which have positively influenced the scores for these sites. Another aspect that has positively increased this score is the total area designated as a “nature dynamic zone” which has increased over time for all NLPs. This increases the area in which spontaneous vegetation dynamics, without human influence, can occur. However, these differences can only be shown in the long-term due to the slow nature of these developments.
Another notable development for all sites is the invasive species indicator that shows a negative trend with a mean score difference of -0.08 for all sites. This increasing pressure and threat is partly due to an increase in species such as bark beetles and racoons, next to other, more site specific species. This is in line with the threats identified by the other rewilding sites assessed thus far by Segar et al., and show trends that are applicable to the wider European context.

Taking a step back and looking at Germany from a European landscape level, the ecological index developed by Fernandez et al. (2020) (figure 9 map C), shows how low the trophic integrity of large mammal communities is, how poorly the natural landscapes are connected, and how intense the human forcing in natural and semi-natural areas is (27). Thus the need to restore ecosystems in Germany, with a rewilding framework, is urgent to mitigate the negative effects of the high level of anthropogenic global change.

As shown above, one of the strongest indicator changes for all five sites was the improvement of the terrestrial landscape connectivity within their boundaries. Additionally, increases in aquatic connectivity were also noted. However, efforts to increase the connectivity for the larger area outside of these boundaries lie outside of the influence of these sites. An opportunity may lie with the many small-scale and often poorly managed Natura 2000 sites. By enhancing transboundary connection and increasing the ecological integrity of the broader network of Natura 2000 sites, Germany can contribute to the goals of the EU Nature directives and global biodiversity targets and increase connectivity at landscape level (figure 9 map A) (27). This can in turn beneficially influence the ecological integrity of national parks in the future. However, this needs a change in the framework of policy and administration, as in other countries of the EU (23).

In addition, a large percentage of Germany's 357 582,00 square kilometre total surface area is under some form of nature protection, based on international, national or federal legislation (4, 5) (figure 9 map B). Each category of nature protection is defined differently due to its characteristics and has a different strategy for its preservation, as already discussed above. Rewilding addresses a few crucial aspects of the IUCN's definition of national parks (category II), and in light of the recent EU Biodiversity strategy 2030 and the UN's Decade of Ecosystem Restoration, rewilding efforts in general could count on stronger political and financial support going forward (27). The large areas, like national and natural parks, in combination with the more numerous, smaller protection sites, are possibly the best-suited areas to apply the rewilding approach to ecosystem restoration in Germany. Thus applying the methodology used in this study to such sites is favourable and could give insights into how to "make further steps" towards wildness and self-sustainability of ecosystems within national parks, and outside. To date, there are no feasibility studies known to the author about the potential of rewilding in Germany as a national strategy and in the national context. Historic opportunities and limitations for rewilding in Germany are unknown. Albeit it is clear, that rewilding can provide the necessary framework to achieving the biodiversity goals and targets set (27). While it will be hard to address the pressing issues that degrade our biodiversity on a daily basis, such as grey infrastructure development and habitat fragmentation, there is the potential to make the regional, terrestrial and aquatic connectivity between the numerous existing areas of nature protection sites, more ambitious, following the frameworks, guidelines and best-practises set by rewilding practitioners and scientists thus far.





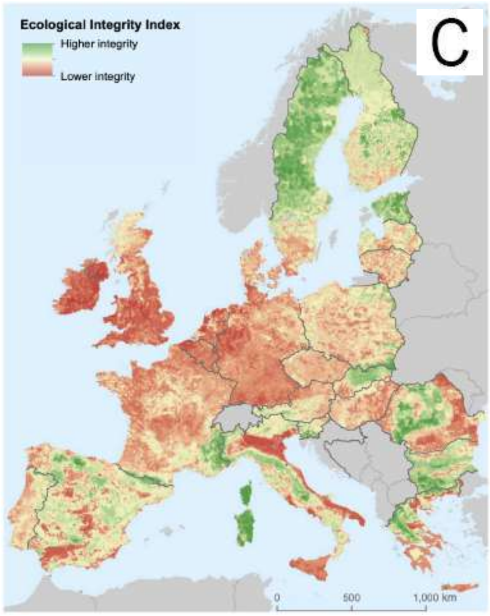


Figure 9: A) Map of Europe showing the identified high priority corridors, selected by Fernandez et al. (2020) that need to be restored and preserved to enhance the connectivity of Natura 2000 sites in order to address the long-term conservation of biodiversity in Europe (27).
B) Map of Germany's numerous nature protection sites excluding Natura 2000 areas (28).
C) Map of Europe showing the Ecological Integrity of Germany in the European context based on trophic functions, connectivity and natural processes for the year 2012 (27).

d. Trophic complexity (S_t) in German National Parks

As in the continents outside of Africa, such as North America, South America and Australia, Europe, too, has been depleted of its "megafauna" (average body weight over 1000 kg) since the Lateglacial period (15.000- 10.000 BP). Especially, slow-breeding, long-lived and large mammals with large home ranges have gone extinct without replacement by other species in this late Pleistocene extinction event. The extinction of the megafauna is a significant and unique characteristic of this event. This has ruled out less selective causes, such as cosmic catastrophe or epidemic diseases and is left with two contending hypotheses. The first being the influence of climate change and failure of megafauna to adapt to it in the Lateglacial period, and the other being the so-called "Overkill hypothesis", which stems from the coincidental arrival of anatomically modern humans to these continents, exterminating the poorly adapted and thus easy to kill animals. While both hypotheses are challengeable, the latter is favoured, as human predation during these changing climatic conditions seems to be the most probable cause for this extinction event (29). While the extinction was more moderate and less sudden in Eurasia than in North America, Europe, too, lost the crucial mega-herbivores that played different roles as keystone species in the so-called “mammoth steppe”. Some of these included are woolly mammoths (*Mammuthus primigenius*), woolly rhinoceroses (*Coelodonta antiquitatis*), and giant deer (*Megaloceros giganteus*), to name only a few. This is the very ecosystem in which the ancestors of many extant species living in Europe today evolved, such as the European bison (*Bison bonasus*).

With the background of this defaunation, the dominion of man obviously changed the species compositions further and with the onset of settlement and agriculture increasingly changed the landscape and has done so to extremes to this day. The remaining large herbivores in Europe, which have played an important role in increasing the pressure on expanding forests and maintaining complex, natural mosaics of habitats across the continent, have been either driven to extinction or to the brink of it in the recent past. Examples of these include the auroch (*Bos primigenius*), which survived into the 17th century, until the last individual, a female, was shot in Jaktorowska, Poland in 1627. The auroch is the ancestor of all domesticated cattle present today. The tarpan (*Equus ferus ferus*), ancestor of domesticated horse breeds and the endangered Przewalski’s horse (*Equus przewalskii*), lived on in small populations in Europe until the 19th century, before ultimately going extinct. It, too, is a grazer, contributing significantly to maintaining open landscapes. And the European bison, an intermediate feeder being a browser and grazer, almost fell victim to the same fate, though narrowly survived the first world war in Poland. The European bison population of today goes back to 54 Individuals, with a proven pedigree, from zoos and reserves across Europe that were used in a subsequent breeding program to save the species. After being extinct in the wild in the first half of the last century, this species is now on the brink of a comeback, being already successfully rewilded in places such as the Southern Carpathians in Romania (25). The effects of this species on the forest alone, in driving back pioneering tree species and the encroaching forests is in effect what human management interventions try to mimic, where the species is missing, as is the case in some of the national parks assessed in this study. These three large and social herbivores alone have tremendous power in creating habitats for many rare and flagship species for conservation.

These large species are part of a crucial guild of herbivores that play a significant part in maintaining open habitats and grasslands and creating microhabitats and opportunities for a plethora of other organisms. By being large herbivores, for example, they trample and break the snow cover in the winter-times to allow other, smaller animals access to food and pathways. Following a more generalist feeding strategy, they take up a lot more biomass than smaller, more specialised herbivores, which are still present in our landscape across Europe, such as roe deer (*Capreolus capreolus*). And in doing so, they have a bigger impact on the vegetation and create disturbances. Picking up on the long co-evolutionary history with native plants they are key facilitators of seed-dispersal. The carcasses of these key stone species return nutrients back to the ecosystem by providing a high quantity of food to support the diverse guilds of scavengers and predators, such as birds, mammals, arthropods, fungi and many more. Their faeces fertilise the ground, while at the same time providing microhabitats for spiders, arthropods, like beetles and flies. These in return provide protein-rich larvae, which are important for a successful breeding period for many bird species. The extinction of these large, native herbivores from the natural and cultural landscape in Europe, and especially Germany, has had profound effects on the vegetation and has diminished their effects on natural disturbances and trophic complexity to an ecosystem. The lack of these and other keystone species, acting as a strong force against the dominant spread of forests in the experience of nature in today's generations, has supported the misconception or conclusion, that the apex state of nature in Germany is a closed-canopy forest (5, 31).

So, while native herbivores are driven to extinction and are suppressed, surrogate species are introduced temporarily, such as domesticated cattle, horses, and non-native sheep and goats to maintain open areas and try to counteract the dominant forces of the spreading forests into habitats of conservation concern, such as grasslands. An action, which implies a shepherd with his sheep-dogs managing the herd, and often, expensive, mobile electric fences to mitigate human-wildlife and human-sheep conflicts. One could criticise this conservation measure as only tending to the symptoms and not the origin of the problem.

Rewilding offers a new approach, in that it does not follow this linear approach but aims for the reinstatement of natural processes with their inherent, cyclical nature. Natural grazing is one way to enable the necessary dynamics of disturbances, dispersal and trophic complexity in ecosystems that are key in increasing the self-sustainability of ecosystems and are beneficial for biodiversity, as shown by Perino et al. (12). These interactions are kickstarted and increased through the re-introduction of missing and native keystone species.

While Nationalparks face contentious subjects, especially with regards to large-bodied wildlife management, it is important that they remain true on their path of reaching their goal to enable natural processes and dynamics within their boundaries, or at least 75% of their area. The same can be said for the rewilding movement in general. The indicator, quantifying for the trophic complexity of the ecological integrity, takes into account large species with weights over five kilograms, and further scores these by calculating a proxy of each species ability to unfold their ecological potential. However, as the identification of missing large species for sites is not just contentious but requires further studies and clarity, species that theoretically can be expected to live and have lived in the five sites, such as brown bear (Ursus arctos), European bison and others, were not taken into consideration. This is due to the limit of this study, by not being able to create an inventory of species that can be expected to be found in each one of the sites, based on historic and paleoecological evidence and purley ecological restrictions. While this is regrettable and results in higher scores for this indicator, as only the species changes over the assessment period can be compared, this does hint to the potential of future studies that can take this into consideration.

Another interesting aspect, stemming from the discussions around scores for the trophic complexity index of the National Parks, is the unbiased position of the administrations towards “invasive species” (32). The monitoring method does not further define this term with regards to species being native, non-native, or naturalised. Therefore it is noteworthy that there are non-native and naturalised species present in all assessed national parks. Some are clearly harmful to native species, such as the omnivorous racoon (Procyon lotor), while others are seen by some as an added value to the natural processes such as fallow deer (*Dama dama*) and mouflons (*Ovis gmelini musimon*), due to the general lack of larger herbivores and their influence on vegetation dynamics.
The past extinctions of large terrestrial species is a problem that holds a lot of conflict potential for various societal interests, but has implications to the natural dynamics of a system and ultimately plays out in the degree to which human forcing is necessary from a management position. Missing species belonging to the guilds of large herbivores and carnivores such as brown bear and European bison are examples that clearly show the developmental limits of National Parks in Germany to date. While other non-native species, most of which have been introduced in very recent history to the continent for economic reasons such as the fur industry, trophy hunting and other interests, or through accidental introductions, are tolerated to various degrees under the umbrella slogan of “letting nature be nature”. However, this can be debated further in light of the lack of native species. Harsh critics could see a double standard in this approach, while reality proves that this is largely based on the limitations of national parks and their difficult and often impossible job of maintaining the delicate balance between ecology and society as mentioned above.

With the strong legal framework giving national parks real chances to pioneer rewilding in Germany, this indicator quantifying ecological integrity could be adapted for National Parks. Including the missing, native and often keystone species into the scoring process could give a more precise image of the road ahead to achieve the self-sustainability goals of national parks. As seen in the Müritz NLP, the passive wildlife comeback can answer the contentious questions areas may face by driving out non-native species such as mouflons without having to open up the “can of worms”, namely the discussion of a maximally complete trophic community within a highly degraded landscape. Further, the potential of wildlife comeback, such as roaming bears, wolves, lynx and even wild European bison or other larger herbivores could be taken advantage of by addressing the connectivity and dispersal aspect on landscape level as addressed in the previous section. Making use of these historic opportunities, national parks could play a key role in rewilding by pioneering and creating reference points for us to learn from in our national context. Thus these sites could play a crucial role in combating the pressing crisis of climate and biodiversity and reversing the negative trends from past centuries.

7. Conclusion

While rewilding is increasingly seen as a solution and appropriate approach to ecosystem restoration on a global scale, Germany is still lacking clear national strategies and examples for rewilding actions to be implemented at site- and landscape-level. The urgent need for ecosystem restoration and the historic opportunity of an increasing awareness and political support, combined with the general wildlife comeback in Europe and the far reaching technological advances of recent times, create a good framework for rewilding to be applied creatively, even in the densely populated European or German territory.

In order to scale up rewilding across Europe, it is crucial to have a solid, science-based methodology to monitor the progress at site-level. As the rewilding movement in Europe has been largely pioneered by practitioners thus far, it is encouraging to see practical scientific support building up. Cost effective methodologies like this, that have a strong theoretical framework at their core and aim to guide the movement further, can enable a firm foundation for future development and learnings and steer conversations away from an anecdotal approach to a more scientific approach. With only five National parks assessed within the limited framework of this work (10 weeks incl. preparations, one study coordinator (author) and five experts), this study can only hint at the potential of a full assessment of all 16 National Parks in Germany and the learnings that can be derived from such a study. With the potential to use more data-driven scores for each of the 19 indicators to supplement the cost effective expert-based data, for instance through remote sensing, a clearer picture of a site’s progress can emerge. As seen with the Jasmund NLP, in comparison to the other sites, the scoring result is only as precise as the score for each indicator that is given. If the scores are of a more categorical nature (e.g. 0, 0.5, 1), rather than a score along a continuous scale, then the resolution of the site's progress is low and it is harder to see more accurate changes. Despite this, trends and direction of progress for Jasmund NLP can still be shown. And it is an indicator for the broad applicability of this methodology. Depending on the availability of experts for this expert-based iteration process, varying amounts of time and resources can be allocated by a site’s administration to scoring these indicators.

While the five German National Parks struggle to increase some of the indicators quantifying for the ecological integrity of their area due to the reality of the regional contexts, the legal framework has shown considerable effects with regards to the reduction of human forcing on the systems across all sites. This is a powerful opportunity for national parks to build upon and become reference points for rewilding in Germany. Other rewilding sites in Germany and Europe face numerous threats that are outside of their control. These commonly involve conflicting land-use policies and EU subsidies counter-acting active rewilding interventions, hunting and poaching, species persecution, habitat fragmentation and river regulations (12). With these threats being largely excluded based on the legal framework and international agreements, national parks can instead focus on the opportunities that present themselves to decrease human forcing and increase the ecological integrity of their sites.

In this study, the time spans of monitoring for some sites (>30 years) are considerably longer than the monitoring cycles of minimally 5 years suggested by Torres et al. (2018). However, this is favourable, as many natural processes and dynamics unfold over a longer period of time. So while a minimal monitoring cycle of around 5 years is suggested, the longer the period, the more one can report on the dynamics and processes, which can give interesting insights into effective and ineffective management interventions for specific sites. Thus it would be sensible to do this monitoring of rewilding progress for the remaining 11 national parks in Germany, to learn from and gain a clearer picture of the rewilding progress of these sites. Further, a definition of an appropriate monitoring cycle to be applied for this protected area category in the future could be sensible to allow for comparisons and learning across sites.

The marked wildlife comeback of larger species in Europe can be seen as another historic opportunity to be seized across the sites. With the return of some larger native species already reported in this study, such as wolves, lynx and beaver, other animals from different taxonomic groups are showing a recovery across the continent (33). One large predator, still missing in Germany, like the brown bear could further increase the ecological integrity aspect of a site's ecosystem by playing crucial roles in the complex, trophic processes. The return of native species that have previously been driven to extinction or to unsustainably low numbers across the continent, especially those larger than 5kg, could have complex and cascading effects on the ecosystem, as hinted in the observations of the Müritz NLP following the return of the wolves. The seizing of this opportunity will likely depend more strongly on human-wildlife mitigation and conflict management, than any ecological intervention directed at the ecosystem. Next to carnivores, the same is true for large herbivores. In many National Parks proxy-species or substitute species for extinct large herbivores are being used to conserve and maintain certain habitats, most notably cattle, horses and sheep. While these species do shape the landscape more naturally than any human interventions can do, they remain domesticated or at the most semi-domesticated animals, only present for a limited amount of time in very predetermined areas. Meaning their full ecological potential as natural grazers and browsers is being repressed and is therefore missing in the system. Large natural grazers, like European bison (*Bison bonasus*) play key roles in dispersing seeds, creating mosaics of complex habitats by shaping the landscape, among many other effects, and ultimately provide a crucial contribution to the foundation of scavenger communities through their large carcasses. While at this stage reintroductions of large herbivores such as European bison would increase the ecological integrity and reduce the human forcing component of sites simultaneously, these remain unrealistic for the relatively small and often isolated national parks in Germany at this stage. However, an adapted trophic complexity indicator, taking these key stone species into account for National Parks could be a valuable consideration to make first steps towards including these missing species into the ecosystem. This, in combination with better human-wildlife management schemes and further discussions about natural grazing and rewilding in Germany could prepare for either active reintroductions or passive immigration. Well known examples of such missing species returning passively to Germany, such as the brown bear shot in Bavaria in 2006 or the European bison shot in Lebus in 2017, tragically demonstrate these opportunities, which were not seized at the time.

An increasing body of scientific publications, guidelines and frameworks continue to support the theoretical foundation and political advances of rewilding in Europe. The active reintroductions of native, large herbivores in particular, together with the inclusion of society and the creation of a green economy to support a comeback of wildlife and natural processes, for instance through sustainable and small scale ecotourism, are powerful tools to not just halt the biodiversity crisis but initiate a restoration movement on a larger scale. Germany can contribute by creating corridors and connecting nature protection areas with green infrastructure and allowing natural processes to be restored and protected. By transitioning to a dynamic, large-scale and diverse rewilding management of its nature protection sites, with leading examples such as the iconic national parks, Germany can increase its chances to meet the biodiversity and climate targets of the future. For a change, this ambitious approach could leave a more diverse state of nature with a stronger self-sustainability and reliable ecosystem services for the next generation, rather than an increasingly impoverished and degraded natural heritage. A wilder Europe with natural processes at its core could thus contribute to the psychological welfare of society, by transitioning from a doom-and-gloom conservation message to a more inspirational and positive narrative of the 21st century.

8. Thank you

I would like to thank Josiane Segar for her support and patience in answering my varied questions over the course of this work. I also thank all local experts and contributors from the five National Parks administrations for their patience and openness to dedicate their time into providing the necessary data for the scores.

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