land

Article

Challenges and Solutions for Forest Biodiversity Conservation in Sweden: Assessment of Policy, Implementation Outputs, and Consequences

Per Angelstam [1,2,*], Terrence Bush [3,†] and Michael Manton [4]

[1] School for Forest Management, Faculty of Forest Sciences, Swedish University of Agricultural Sciences (SLU), SE-73921 Skinnskatteberg, Sweden
[2] Faculty of Applied Ecology, Agricultural Sciences and Biotechnology, Inland Norway University of Applied Sciences, N-2480 Evenstad, Norway
[3] Mapping Specialists, 3000 Cahill Main, Suite 202, Fitchburg, WI 53711, USA; tjbush@uwalumni.com
[4] Faculty of Forest Science and Ecology, Vytautas Magnus University, Studentu Street 13, LT-53362 Akademija, Lithuania; michael.manton@vdu.lt
* Correspondence: per.angelstam@inn.no or per.angelstam@slu.se; Tel.: +46-702444971
† Formerly at Southern Swedish Forest Research Centre, Faculty of Forest Sciences, Swedish University of Agricultural Sciences (SLU), SE-230 53 Alnarp, Sweden.

Abstract: Swedish policies aim at conserving biological production, biodiversity, cultural heritage and recreational assets. This requires compositionally and structurally functional networks of representative habitats, the processes that maintain them, and resilient ecosystems. The term green infrastructure (GI) captures this. We review (1) policy concerning forest biodiversity conservation from the 1990s; (2) the implementation outputs, including the formulation of short-term and evidence-based long-term goals for protected areas, education, and the development of hierarchical spatial planning; (3) the consequences in terms of formally protected and voluntarily set-aside forest stands, as well as conservation management and habitat restoration. We assess the successes and failures regarding policy, outputs and consequences, discuss challenges to be addressed, and suggest solutions. Policies capture evidence-based knowledge about biodiversity, and evidence-based conservation planning as an output. However, the desired consequences are not met on the ground. Thus, the amount of formally protected and voluntary set-aside forests are presently too low, and have limited quality and poor functional connectivity. GI functionality is even declining because of forestry intensification, and insufficient conservation. Challenges include limited collaborative learning among forest and conservation planners, poor funding to conserve forest habitats with sufficient size, quality and connectivity, and national politics that ignores evidence-based knowledge. As solutions, we highlight the need for diversification of forest management systems with a landscape perspective that matches forest owner objectives and regional social-ecological contexts. This requires integrative approaches to knowledge production, learning and spatial planning.

Keywords: connectivity; disturbance regimes; forest policy; green infrastructure; habitat network; multi-functional landscape; nature restoration; protected areas; social system; spatial planning

check for updates

Citation: Angelstam, P.; Bush, T.; Manton, M. Challenges and Solutions for Forest Biodiversity Conservation in Sweden: Assessment of Policy, Implementation Outputs, and Consequences. *Land* **2023**, *12*, 1098. https://doi.org/10.3390/land12051098

Academic Editor: Thomas Panagopoulos

Received: 3 April 2023
Revised: 14 May 2023
Accepted: 16 May 2023
Published: 20 May 2023

1. Introduction

To protect, manage and restore ecosystem services (ES) for human well-being and welfare, e.g., [1,2], the continued alteration, fragmentation and loss of natural forest and cultural woodland biotopes and urban green space must be tackled. Simultaneously, increased production of provisioning ES on forest and agricultural land is desired, and more space is used for grey infrastructures, e.g., [3]. At the same time, global climate change [4], knowledge resistance [5] and an increasingly ideologically polarized world affecting migration and competition for natural resources [6,7] have led to uncertainties.

This stresses the urgency to improve the adaptive capacity and secure resilient social-ecological ecosystems. Coping with these complexities is a challenge to the sustainable development (SD) process toward sustainability—a development that implies that finite resources and the environment are not consumed or degraded in an irrevocable manner, to the detriment of future generations, e.g., [8].

In Sweden, a long history of forest management for sustained yield wood production [9–11] has moved managed forest landscapes far away from their natural and historical range of variability in terms of forest disturbance processes and functions, e.g., [12–15], habitat structures, e.g., [16,17] and species composition, e.g., [18–20]. In urban landscapes, green spaces shrink as housing, transport, communication and energy and different kinds of grey infrastructure demand more space [21], which is a development that poses threats to human health [22].

Concerns about species' extinction emerged in Sweden more than a century before the term biodiversity appeared [23]. Already in 1877, Säve [24] called for actions to halt the loss of species. While the Swedish Parliament passed an act for the establishment of National Parks to protect nature for the benefit of science and tourism in 1909, modern forest conservation in terms of setting aside protected areas with habitat for species emerged only in the mid to late 20th century [25]. The State Forests (Domänstyrelsen) began set-aside of forest areas (Domänreservat) in 1913, and stipulated nature considerations in managed forests in 1924 [26,27]. Public reactions against intensive forest management, such as to establish forest plantations on cultural woodlands [28], large clear-cuts [29], use of herbicides to remove the deciduous trees in young forests in the 1970s [30], and loss of old-growth forest [31], triggered this development.

The Nature Conservation Act of 1964 included the creation of nature reserves. The Swedish Environmental Protection Agency was created in 1967, focusing on environmental protection including nature conservation and outdoor recreation [32]. The increase in protected areas from the 1980s was based on the first nation-wide old-growth forests inventory conducted between 1978 and 1981 [33].

In 1993, the Swedish parliament deregulated the national forest policy, and established an environmental goal on par with the previous, long-standing goal of high wood production. The establishment of a series of national environmental objectives adopted by the Swedish parliament in 1999 triggered increased efforts to protect forest areas. The "Living Forests" objective with the interim target to increase the amount of formally protected forest by 400,000 ha, and the area voluntarily set-aside forests by 500,000 ha in productive forests below the mountain region before the end of 2010 was a result of this increased effort [34,35].

To communicate the need for improved biodiversity conservation and the provisioning of ecosystem services supporting human well-being, a range of policies targeting the sustainable use of natural resources have emerged since the 1990s at EU and Swedish policy levels, e.g., [36–39]. The synonymous concepts functional habitat network and green infrastructure (GI), used in both research [40] and policy [37], captures the urgency to sustain adaptive and resilient ecosystems with sufficient functional connectivity of representative land overs in landscapes and regions. These can then provide ecosystem services, and support adaptation to climate change and socio-economic drivers.

However, the evidence-based policy vision forming the foundation for GI work is in stark contrast to the present poor functionality of habitat networks in Sweden [20,41–43]. Captured in the current Swedish forest policy [44], the Government's environmental quality objectives and the strategy for biodiversity and ecosystem services [44], the Government [45] commissioned a range of authorities to produce guidelines and plans for implementation of regional action GI plans at the level of county administrations.

While biodiversity conservation and GI development have been clearly pronounced in Sweden through international and national laws and policies, e.g., [25,38,46], the subsequent implementation process in terms of creating protected areas needs to be assessed regarding its effectiveness to satisfy agreed policy. In a review of formally and informally protected forest area development 1991–2010, Angelstam et al. [41] showed that establishment of functional GIs involves a long chain from policy creation via the outcomes of implementation processes including outputs in terms of policy instruments, and finally consequences on the ground in ecosystems and social systems.

However, in addition to the establishment, management and restoration of networks of functional habitats including protected areas, GI development also includes the management of the matrix in the surrounding landscape. Thus, it is also necessary to understand the consequences of actions by multiple actors and stakeholders at multiple levels, which aim at improving the managed forests surrounding protected areas both rural and urban settings [47]. Such research is inherently interdisciplinary, e.g., [48], and requires collaboration among actors and societal sectors involved with management and governance of GIs in forest, rural and urban landscapes [41,49–52].

The aim of this study is to endeavor an assessment of progress with forest biodiversity conservation by focusing on the contributions to conservation, management and restoration of representative habitat networks during a 30-year phase from the early 1990s of the current iteration of Swedish forest policy cycles. This period is characterized by the ambition to balance wood production and environmental objectives. We review the extent to which evidence-based knowledge from conservation biology and landscape ecology is applied in policy, leads to outputs, and has consequences on the ground [53]. First, concerning policy development we focus on the environmental objective slogan "Living forests". Second, we cover the outputs in terms of evidence-based performance targets for conservation, education and hierarchical planning. Third, we concentrate on the consequences for GI functionality on the ground as a means of supporting biodiversity conservation and human well-being. This forms the base for discussing the extent to which policy objectives are met, and the prospects of maintaining forest biodiversity by zoning encompassing strict protection, nature restoration and forestry, in landscapes and regions. Taking stock of transnational effects on forest ecosystem services related to global climate change and an increasingly polarized world, we also discuss the importance of understanding both ecological and social sub-systems of GI development. Finally, stressing the urgency of adaptation and securing resilient ecosystems supporting multifunctional forest landscapes, we argue in favor of a system transition that encourages new modes of transdisciplinary integrative knowledge production and collaborative learning.

2. Methodology

2.1. Sweden as a Case Study

Sweden hosts regions with considerable forest loss due to clearing for the development of agriculture over millennia, regions with high forest management intensity, and the last remnants of the European Union's intact forest landscapes [47]. When the international frontier of wood mining reached Sweden, the process of transforming once naturally dynamic forests, e.g., [16], into an effective wood production system, commenced. Currently, most forests are now managed by clear-felling systems with short rotations compared to naturally dynamic forests. The frontier of forest landscape transformation continues to reduce the remaining remnants of near-natural forests in Sweden [54–56]. Sweden has 23.6 million ha of productive forest (annual wood production > 1 $m^3 ha^{-1}$) and 4.6 million ha unproductive forest land [57]. There are five different forest ecoregions that range from broad-leaved deciduous nemoral forests and hemi-boreal forests in the south, to south and north boreal as well as sub-alpine forests in the north. These five forest ecoregions are linked to both latitudinal and altitudinal factors affecting the vegetation growing period, forest site production capacity and species distributions. The northern borders of the nemoral and hemi-boreal forest ecoregions broadly parallel the northern contiguous distribution of beech (*Fagus sylvatica*) and oak (*Quercus robur*), respectively. Together with the two boreal ecoregions further north, which are dominated by Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*), these four ecoregions are widely used for intensive wood production. In contrast, the sub-alpine ecoregion, confined to the Scandinavian mountain range's eastern edge, hosts the lowest proportion of productive forest among all ecoregions and is dominated by Norway spruce and mountain birch (*Betula pubescens* ssp. *czerepanovii*). When it comes to land ownership (Figure 1), Swedish forests are mostly owned by non-industrial private forest owners (49%), private forest industry (23%), and the rest by the National Property Board, the state forest company Sveaskog Co., public bodies such as municipalities and regions, the church and forest commons (28%) (Figure 1). The human population density is high in the south and very low in the northwest (Figure 1).

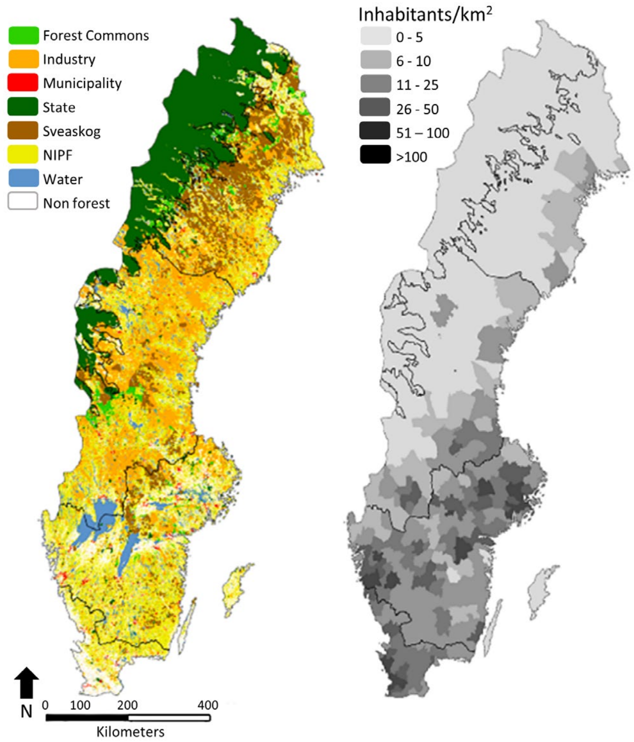

Figure 1. Distribution in Sweden of different categories of forest ownership (**left**), and human population density (**right**) [20].

2.2. Framework for Evaluation of Policy, Implementation and Consequences

Evaluating governance and management for biodiversity conservation is a crucial step for understanding the progress towards satisfying agreed policy goals in the real world. This heading's topic matches the essence of the concept policy cycle, and how development of complex processes can be assessed (Figure 2). This requires studying the policy creation process, the implementation outputs, and the consequences on the ground [53]. Evaluation of the policy creation process involves assessment of what is good or democratic governance [8,58,59], including elements such as more and improved information management and learning, a legitimate process, and the normative aims of transparency and participation. According to Rauschmayer et al. [53], the outcomes of policy creation processes have two parts. The first part is about implementation outputs in terms of policy norms and rules to be applied by governors at multiple levels, and pronouncements of norms [60] in terms of strategic performance targets. Examples include short-term and long-term goals for the required amount of protected areas, e.g., [61], retention of fine-scale nature consideration in the managed landscape surrounding protected areas [62], as well as collaborative tactical planning and operational management approaches to enhance functionality of green infrastructures [50]. The second part is about the consequences on the ground of actual operational implementation by managers of strategic plans. This includes the progress towards a sufficient and functional network of representative forest and woodland habitats as a GI that conserves biodiversity [37], and provides human well-being [63].

Table 1. The term policy cycle, e.g., [64–66] is a simplified description of the long-term dynamic of iterated policy creation in a particular field. This can be linked to Rauschmayer et al.'s [53] proposed series of three systematic steps to understand (1) the policy creation, (2) and implementation outputs that lead to (3) consequences on the ground in both ecological and social systems. Finally, assessment of the extent to which policy requirements are met on the ground in social-ecological systems can be made. The methodology, results and discussion in this paper about formally protected and voluntary set-aside forests and trees contributing to green infrastructure for biodiversity conservation track steps 1–3 in the extended policy cycle shown in Figure 2.

Analytic Steps		**Phases in Policy Cycle (Extended Version)**	**Type of Science**	**Includes the Following Sub-Steps**	**Key Sources for This Review**
1. Policy creation		Policy process	Social	Problem perception, agenda setting, decision-making	Bush [46]
2. Implementation		Policy implementation outputs	Social	Policy instruments and norms	Angelstam et al. [41]
3. Consequences	3.1.a. Ecosystem; Stand level	Protected area development	Natural	Outcome consequences in terms of protected area	Angelstam et al. [20,41]
	3.1.b. Ecosystem; Landscape level	Habitat network functionality/Green Infrastructure	Natural	Outcome consequences in terms of green infrastructure functionality	Angelstam et al. [20,41,54,67], Jonsson et al. [47], Svensson et al. [68]
	3.2. Social system	Operational planning processes	Social	Consequences in terms of spatial planning processes	Angelstam et al. [20,41,54,67], Eriksson and Hammer [50]
Assessment		Is policy leading to desired states and trends?	Integrative	Holistic evaluation of protected areas and matrix, and planning processes	(Comparison of step 3 with step 1 in the discussion)

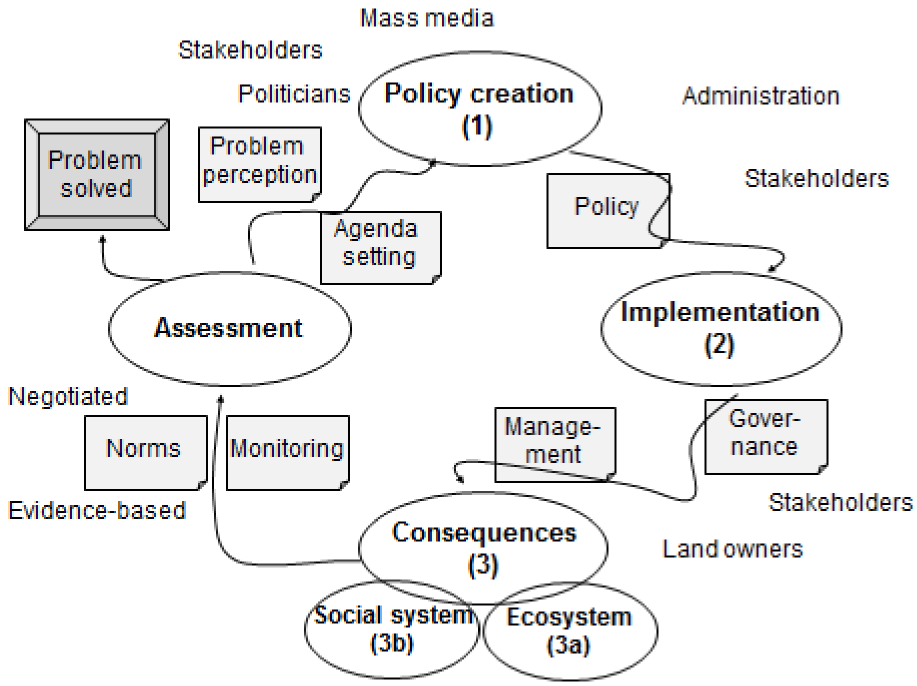

Figure 2. The term policy cycle describes the complex process from (1) policy creation (2) via implementation of instruments, to (3) analyses of consequences in both social and ecological systems, and finally assessment of whether or not policy requirements are met (for details see Table 1). Own illustration.

This study spans a period of ca. 30 years, from the early 1990s when the current forest policy was formulated until 2023, and relies on a wide range of informants, and sources published in a diversity of contexts over a long time. This period matches the current forest policy cycle with its explicit focus on maintaining viable populations on naturally occurring species. Methodologically, we concentrate on summarizing a suite of thematically and temporally narrow studies by applying a holistic policy cycle approach (see Table 1). Our study can thus be characterized as participatory due to the senior author having been engaged by ministries and agencies in several assessments, which have only been published in Swedish. The second author published a comprehensive analysis of relevant policy, and the third author was engaged in several analyses of the consequences on the ground.

2.3. Policy Creation Process

This review is based on public records, reports and interviews with staff at the Swedish Forest Agency and the Swedish Environmental Protection Agency made 2010–2012 (see also [41]), and also actors in forest companies and County Administrative Boards 2019–2022. Records examined included the archives of the forestry policy review committee established to develop what became the Forestry Act of 1993, and archives of the review of the Nature Conservancy Act, as well as the histories of the earlier versions of the Forestry Act and the environmental legislation enacted in 1988 and 1991. Review of legislative records encompassed relevant ministry publications, Swedish government official reports, referral submissions from affected organizations, and government propositions presented to parliament; in the case of the 1993 Forestry Act, this also included an examination of the legislative debate in committee and in parliament. Items relating to developments in forestry policy following passage of the revised Forestry Act include materials from the Swedish Forest Agency, the Swedish Environmental Protection Agency, the Swedish Society for Nature Conservation, and applicable news reports. For methodological details, see Bush [46], Angelstam et al. [9,20,41,42]. To assess the match with evidence-based knowledge and policy, we refer to fundamental conservation biology principles for the conservation of naturally occurring species such as habitat loss thresholds [40,69], representation [70] and habitat quality [71].

2.4. Implementation Outputs

The formulation of a new forest policy triggered a long sequence of activities to translate policy to practice via strategic, tactical and operational outputs supporting tangible consequences on the ground in both social and ecological systems. We summarize the policy implementation process concerning formally protected and voluntary set-aside areas as presented in Angelstam et al. [20,41,42]. The process of implementing Swedish biodiversity conservation policy by creating protected forest areas was divided into four phases: (1) interpretation of policy content and norms for implementation in planning and practice, and the subsequent hierarchical conservation planning process in terms of (2) use of evidence-based knowledge about forest and woodland ecology and conservation biology as a base for formulation of long-term strategic quantitative targets regarding the necessary amount of protected forest areas in Sweden, (3) education and public awareness of stakeholders, (4) development of systematic conservation planning to establish functional networks of protected areas in relation to the government's provision of financial resources.

2.5. Consequences on the Ground

2.5.1. Ecological System: Protected Area Development

We compiled data about the amount of formally protected and voluntarily set-aside areas [20,41,42,61,72–74]. Data are presented both for the period 1991–1997 before the interim target for formally protected and voluntarily set areas was formulated, and for the period of implementation (1998–2021).

2.5.2. Ecological System: Habitat Network Functionality

The functionality of formally protected and voluntarily set-aside areas as building blocks of functional GIs can be assessed by spatial modelling [20,70,75,76]. Functionality depends on the extent to which forest habitat patches have sufficient quality and size, and their spatial configuration allows for persistence of local populations in the short and long term (e.g., [77]). With good knowledge about the interconnectedness and functional links among species, habitats and processes for forests, e.g., [78,79], rapid assessment using estimator-surrogate data such as habitat types sensu [80] is possible, e.g., [81]. This requires (1) wall-to-wall digital spatial data of the habitats of interest, (2) knowledge about focal species' [82] habitat requirements, which is based on the idea that conservation of specialized and area-demanding species can contribute to the protection of many other less demanding co-occurring species, e.g., [83], and (3) suitable spatial modelling algorithms [70,84].

Functional GIs are formed by both natural and anthropogenic disturbance regimes [37,85–87]. Natural disturbance regimes in Sweden can be divided into three broad types of natural forest dynamics, e.g., [79,88]. First, gap dynamics where regeneration of shade-tolerant trees (e.g., Norway spruce in boreal forest, and broad-leaved tree species in the hemiboreal and nemoral ecoregions) take place in small patches (i.e., gaps) created when one or a few trees disappear from the canopy because of mortality. Kuuluvainen and Aakala [89] sub-divided this category into patch dynamics driven at fine scales (<200 m^2) and intermediate scales (>200 m^2). Second, succession related to large-scale disturbance caused by high intensity fire, wind throw or insect outbreaks, often favoring deciduous trees in early and mid-successions. Third, cohort dynamics with partial loss of shade-intolerant trees on dry sites (e.g., Scots pine in the boreal, and oaks in the hemiboreal and nemoral ecoregions) caused by low-intensity fires. In addition, especially in southern Sweden, there are high conservation value cultural woodlands with a mosaic of forest, wooded grasslands, large trees and agricultural land [90–92] as a result of anthropogenic disturbance regimes [85].

Results of analyses of GI functionality can be presented in three steps, e.g., [67,75]. The first reflects the amount of habitat (e.g., combination of biotopes as for example different land cover types) for the focal species. The second step concerns the selection of all resulting habitat patches, which meet the area requirements of focal species individuals. The third step is to identify tracts with concentrations of suitable habitat that satisfy species-specific critical thresholds for the occurrence of a local population. Angelstam et al. [76] provide an overview of variables and parameter values for focal bird species listed in, for example, EU-level policies linked to biodiversity, and thus useful for assessment of GI functionality for different habitat types. For Sweden, several types of wall-to-wall land cover data have been used for assessments by practitioners, and in research [41]. The first is the k-NN dataset produced by the Swedish University of Agricultural Sciences [93]. It was derived using a combination of remote sensing of satellite images and data from the Swedish National Forest Inventory. The second is the Land Cover Data (SMD) from the National Land Survey. The SMD emits from the EU CORINE land cover program [94], and has been updated as a National Landcover Data. The third is the mapping of High Conservation Value Forests (HCVFs) [20]. A fourth approach is to expand these data using artificial intelligence; see [95].

2.5.3. Does Sweden Satisfy Its Forest Biodiversity Targets

To conserve forest biodiversity in Sweden, set-asides are made in many different ways at different spatial scales. First, trees, groups and strips of trees are left from harvesting within stands (so-called retention forestry, e.g., [62,96]). Second, some stands with high conservation values (e.g., woodland key biotopes) are voluntarily set aside, for example, in the context of forest certification schemes [97,98]. Finally, clusters of stands or entire landscapes are managed for the benefit of different species [99]. Key challenges are to measure, aggregate and assess these efforts in a landscape or an ecoregion so that it is possible to communicate the consequences of the conservation efforts at different spatial scales, i.e., tree, stand and landscape, and to different stakeholders [99]. Ideally, in addition, correction factors describing the efficiency and longevity of conservation considerations at each spatial scale in each main forest ecosystem and ecoregion should be made. Next, the total proportion of functional habitat could be compared with performance targets based on the habitat thresholds for focal species with different degrees of specialization at each spatial scale.

We summarize the approach applied by Angelstam et al. [20] to use CBD's Aichi target #11 quantitative and qualitative criteria reflecting conservation science as a relevant normative model [100] for assessing contributions from formal protection, voluntary set-asides, unproductive forest and other attempts to establish effective area-based conservation measures to GI functionality. We compiled data about formally protected areas, voluntarily set-asides, nature consideration areas and unproductive land officially presented as potential assets to meet CBD's Aichi target #11. To evaluate the effectiveness of these conservation instruments, we also compared these conservation instruments with respect to their size, duration, decision-making, control and method for monitoring (for details, see [20]). We also summarized the conclusions of the Swedish Forest Agency's in-depth recent report evaluating the environmental objective "Living forests" [43].

2.5.4. Social System: Planning Processes

The operational spatial planning process to implement forest biodiversity conservation policy on the ground can be studied by qualitative methods. The examples given in this study include analyses of the content and visions of policies, and planners' understanding, capacity, and willingness to act according to policies [101,102] using interviews [103,104]. This includes several steps. An interview manual is first developed, based on a normative model for the implementation derived from environmental and forest policies [49,52]. The normative model can be described as a translation of the policy content to an ideal approach for implementation. To identify interviewees, a bottom-up approach is used, meaning that the study included informants at the operational level of the conservation planning process [102]. The informants are then asked about their understanding, capacity, and willingness to act related to biodiversity conservation planning and collaboration among stakeholders. During interviews, the interviewees should be given full freedom to express themselves. The interviews are then transcribed and analyzed with qualitative methods with the aim that the results should be thoroughly supported by and grounded in empirical data [103,105]. A framework for data analysis would use the following steps: (1) a thorough reading and initial analysis of the data with the aim to build a general and comprehensive picture of the data; (2) an evaluation of the validity of the data including cross-evaluations with the results from the natural science analysis; (3) structuring and writing of a rough version of the results, which resulted in an unstructured text; (4) structuring the text; (5) a return to the data for comparisons, confirmation and rewriting; (6) comparison and confirmation with other scientific studies of similar subjects; (7) discussions within the group of authors. The writing and analysis process went through much iteration, back and forth between these seven points. The results are thus repeatedly scrutinized by iterative comparison with data, other research and discussions [105,106]. This approach provides empirical data to assess the level of compliance between planners' planning processes and the normative model derived from policies [101].

3. Results

3.1. Policy Creation Process

Sweden's current forest and environmental policies are the result of several major forces. The first is the growth of modern environmentalism and its subsequent focus on the conservation of remnants of boreal forests with high conservation value in northern Sweden, as well as cultural woodlands in southern Sweden. Nature conservation as a social movement in Sweden dates to the late 19th century but expanded greatly in reach and influence after World War II [30,107–109]. The Swedish Society for Nature Conservation (Swe: Svenska Naturskyddsföreningen) and the Swedish Environmental Protection Agency (Swe: Statens Naturvårdsverk) created in 1967 started to focus on the growing scientific knowledge regarding relationships between organisms and their environments, and the changes that contemporary forestry practices caused to ecosystems [110–114]. The conservation of habitats for endangered or threatened plant and animal species through formal area protection became a dominant theme, achieving official recognition in Swedish environmental legislation and policy. This expanded the limited nature conservation provisions added to the Forestry Act in 1974 by explicitly including the conservation of biological diversity [115,116]. Notably, this occurred at a time when environmental ideas were at the forefront of concerns among Swedish citizens [117,118]. A subsequent review of the Nature Conservation Act led to the creation of a special type of legal conservation for small biotopes [119,120]. Questions surrounding the interaction between this new form of conservation and Forestry Act regulations [121], as well as the environmental legislation, subsequently became catalysts for a full legislative review of the Forestry Act initiated in 1990, which was directed to establish a precise environmental goal for Swedish forestry [122].

The second major force was the revisions to the Forestry Act in 1948 and 1979 which increased national regulations of the activities of Swedish forest owners. The 1948 revisions were a major expansion of government influence over private forestry, designed to foster larger, more valuable harvest volumes, to maintain employment and ensure a steady supply of raw material to the forest industry [123]. The 1979 revisions added an explicit legal requirement on forest management to maintain a high and valuable wood yield, and introduced a host of new regulations including an extensive system of silvicultural subsidies and a nationwide inventory of forestland owned by individuals, all supported by a special forestland tax. That law also established rotation forestry as essentially the only permissible type of forest management, to maximize timber and pulp production and thereby support national economic goals [115,124]. The strong focus on wood production under the 1948 and 1979 revisions of Swedish forest legislation had significant negative environmental consequences. For example, only about half of the forest structures required to be protected remained on areas subject to final felling under the 1974 general nature conservation provision of the Forestry Act, which was secondary to the production goal [125]. Ultimately, the environmental effects of industrial-scale silvicultural system under the Forestry Act in this period led the Swedish Society for Nature Conservation to conclude that the forest industry was impoverishing the natural environment in the pursuit of purely economic benefits [126], and forest owners to protest against what they saw as administrative micro-management of forestry [123].

The third force was the dramatic political and economic change that occurred while the forest policy review was underway. In the middle of the committee's work, Sweden experienced its deepest economic crisis since the Great Depression. High unemployment and a massive bank bailout caused the ouster of Social Democratic-led government in the autumn of 1991 [127,128]. The winning conservative coalition reconstituted the review committee, and directed the committee to focus on deregulation and by phasing out most of the silvicultural subsidies and the forestland tax [129]. Yet, formulation of a new environmental goal was still required. Thus, the committee had to find a way to safeguard forest productivity and biodiversity while controlling costs. Committee debate initially focused on an estimate that conservation of roughly 15 percent of productive forestland below the mountain regions would be necessary, in the absence of changes in common silvicultural practices [130]. The fiscal and practical problems with the type of approach forced the committee to consider improvements to production forestry in general that could simultaneously improve biodiversity and lower the potential cost [131,132]. Ultimately, and despite questions about the forest industry's ability and willingness to adopt general changes, e.g., [133], as well as the possibility of success to achieve the goals set out in the committee's directives, e.g., [134], the committee chose this approach [135].

Simultaneously, a gradual development of nature conservation policy regarding the managed forest landscape took place, e.g., [25]. In 1979, a section (§21) was added to the 1948 forestry act with the aim to implement stand-scale nature considerations in operational forest management in general. From the late 1980s, forest conservation was influenced by national and international environmental organizations, e.g., [136], the emergence of the sustainable development and sustainability policy principles, and different international agreements and conventions about forests and biodiversity, e.g., [137,138]. Regarding voluntary forest protection, the introduction of forest certification was crucial (i.e., FSC and PEFC; [139]).

After more than two decades of gradually increased societal interest in nature protection, the conservation of biodiversity, i.e., the composition, structure and function of ecosystems [140], became one of the nationally agreed forest policy objectives in Sweden [44,46,141]. From 1993, conservation and production were equal objectives of forest management in Sweden, e.g., [46]. In addition to this national policy development, Sweden has adopted several Pan-European [142,143] and EU policies and directives, such as the EU Birds, Habitat and Water Framework Directives [137,138,144], all of which include different legal obligations related to biodiversity conservation in forests.

The proposed government bill from 1990 [145], reflected a strong Swedish and Fennoscandian species-centered tradition, stating that naturally occurring species should be conserved by maintaining viable populations. This was continued with a policy addition aiming to secure the productive capacity of all forest land and to increase the protection for threatened species and different types of habitats [44]. In accordance with the principle of representation of conservation areas by ecoregions [146,147], the conservation discussion was divided in 1991 into two parts: productive mountain forests (Fjällnära skog in Swedish) and productive forest below them [148]. Moreover, it was stressed that natural functions and processes in forest ecosystems should be maintained [34]. Forest biodiversity conservation was also included into the environmental quality objectives, established by Parliament. The quality objective “Living Forests”, and its four interim targets (of which one focused on protected areas), signifies biodiversity as being important [34,35].

Following EU strategies and CBD [149], the Swedish Government’s strategy for biodiversity and ecosystem services [150] formulated both qualitative and quantitative targets for GI development as a tool to support the sustained delivery of ecosystem services supporting human well-being [63], and welfare built on nature-based outdoor recreation and tourism [151]. This strategy was the foundation for the government’s commission to a range of authorities to produce guidelines and plans for implementation of green infrastructure regional action plans at the level of county administrations [45].

To conclude, national policies concerning forest biodiversity and ecosystem services have remained intact until present time [43]. The content has been reinforced by the post-Paris agreement regulations concerning climate [152–154], the revised national forestry accounting plan for Sweden for 2012–2025 including a revised proposed forest reference level, EU-level strategies about biodiversity and forests [154,155], and proposed regulations on nature restoration [155].

3.2. Implementation Outputs

3.2.1. Interpretation of Policy

With clear guidelines at international, Pan-European, EU and national levels—and even within forest companies—that formulate society’s desire to conserve biodiversity in forest landscapes, formulation of tangible outcomes is indeed possible [73,74]. Thus, as Angelstam et al. [41] concluded: “*the Swedish policy pronouncements evidently capture the definitions of biodiversity and conservation well. Science-based biodiversity conservation thus gradually emerged.*” and “*The environmental objective of the Swedish forest and environmental policy pronouncements can be interpreted as having three key words and phrases concerning biodiversity conservation. These are “all”, “naturally occurring species” and “viable populations*”.

The word “all” refers to the interpretation that not only generalist species should be maintained, but also species adapted to natural and cultural disturbance regimes [41], which often have high demands on both habitat quality and area configuration [82]. This represented a so-called zero-vision for biodiversity loss compatible with EU-policy and the global 2010-target formulated in 2002 [149]. In reality, it is impossible to follow and manage all species, as for instance Sweden hosts more than 25,000 species connected to forest ecosystems. In Sweden, the national book of red listed species [156] has had a strong influence on practical conservation measures, including the development of 210 specific action plans for more than 500 species and species groups, many of which have their primary occurrence in forests. Additionally, the focal and umbrella species concepts [82,83,157] were accepted at the policy level. Hence, evidence-based knowledge of such species could be used to formulate quantitative conservation targets [73]. Empirical studies confirm that this is a useful approach [158,159], and have been validated by studies of how endangered species respond to changes in the amount of habitat [81,160]. However, there are still many knowledge gaps on the requirements of species with different life history traits and their thresholds levels for habitats, which is indicated in the EU forest strategy [154].

The term “*naturally occurring species*” links to the notion of representativeness, and that the Swedish forest and environmental policy does not require conservation of species introduced by humans. This means that patches and networks of protected areas and other set-asides should represent the biological variation in each ecoregion [161,162]. Hosting several types of natural forests [163] and cultural woodland regions [164], Sweden has a wide range of habitats with trees, each of which containing different species assemblages. When designing GIs for biodiversity conservation, and thus in the formulation of conservation targets, all forest and woodland systems need to be represented. There is also a temporal dimension: a long history of land use has transformed the landscape and thereby alienating landscapes from the range of natural variability, e.g., [78,165,166]. Species have adapted through natural selection to different natural processes in ecosystems (e.g., fire and flooding), and in the pre-industrial landscape to different traditional ways of managing forests and trees (e.g., grazing and mowing, pollarding). If processes are significantly altered, habitat quantity and quality will be reduced, as well as species' population sizes and genetic diversity, potentially leading to extirpation. Hence, there is a need for detailed knowledge of various ecosystems' ecology and historical development in different parts of the country's ecoregions.

The term "*viable populations*" refers both to population ecology and population genetics [167–169]. One approach for establishing how much habitat is needed in the long term for the persistence of naturally occurring species is to follow the umbrella species hypothesis. This requires estimating how much forest habitat the most demanding species need in the long term, for each representative disturbance regime and development stage in each natural geographic region. Because many properties in a forest environment are dynamic, one must consider the entire landscape dynamics over time. This means that some forest habitats can exist only in certain areas in perpetuity, while others will move throughout the landscape over time depending on forest stand age and use. It is thus a spatial planning and management issue to ensure the functionality of habitat networks. Finally, while the policies on biodiversity are reasonably explicit as to the level of ambition, the spatial scale for conservation is not. Species whose individuals are small are likely to require less area than species with large body size, and operating at higher trophic levels. Additionally, should all policy targets be accomplished on all land, in every municipality, county, or in the country as a whole? This complexity allows actors with different interests and power to interpret policies differently.

3.2.2. Use of Evidence-Based Knowledge

Forest and Woodland Ecology

A foundation for formulation of strategic goals for how much area ought to be devoted to conservation requires a thorough understanding of the composition, structure and function of forest ecosystems in time and space. This includes forest landscape history, e.g., [170–172], the emergence of the natural disturbance regime concept in forest policy and management, e.g., [86,173–175], and the insight that cultural woodlands are also important habitats for forest species, e.g., [176]. These research novelties were indeed incorporated in the discussion about biodiversity conservation as the policy implementation process evolved [61]. Contrary to what may be suggested by overly simplistic indicators of biodiversity, such as forest cover [177], there are many different forest ecosystems involving a rich diversity of species, habitats and processes at different spatial scales. Thus, forest-living species representing a wide variety of adaptations must be used to study the relation between the presence and viability of populations under different levels of human-induced changes to forest ecosystems [178].

How Much Habitat Is Enough?

Swedish forest and environmental policies presently focus on the maintenance of naturally occurring viable populations. A population's persistence in a forest landscape or region depends on how much habitat there is, whether individuals or propagules can move between different patches of suitable habitat, and how the habitat networks are maintained over time [167,168,179]. Additionally, the role of the matrix surrounding habitat patches aimed at focusing on conservation needs to be understood. While the term biotope refers to an environmentally uniform landcover, a habitat is defined by the properties that define the requirement of a species or a population [180]. Thus, a habitat often consists of several biotopes, such as for feeding, cover and breeding. Therefore, there is a need to identify and assess the quality of biotopes that form habitats. In addition, factors other than biotopes mapped as land cover types are parts of the habitat of a species, such as predators and competitors, as well as micro- and macroclimate [15,181]. The combination of decreasing amounts of habitat, which decreases the number of individuals that can be supported, and increased fragmentation, which makes it harder for individuals to move about in the landscape, are the most common reasons why species disappear locally and regionally, and finally completely.

There is both theoretical and empirical evidence for the existence of thresholds for extirpation of a population as the amount of available habitat is reduced [182–185]. The threshold refers to the fact that the risk for population extinction shifts from low to high within a limited range of further loss of habitat. The fact that there are limits to how much of different forest habitats may disappear without threatening the viability of populations of all naturally occurring species forms the basis for the formulation of long-term goals for how much of different forest habitats are needed, e.g., [19]. There is a clear parallel to the concept of critical load, which addresses the question of how much deposition of, for example, nitrogen and sulfur ecosystems can tolerate [186]. Studies attempting to answer the question, how much of different forest habitats are necessary for species persistence, are of two different types.

The first type of studies addresses the proportion of a local landscape that must consist of biotopes that form suitable habitat. An example is the statement that a species would need at least 30% of old Norway spruce forest in a local landscape to be present as a local population, no matter how much old spruce forest once existed in the natural landscape [187,188]. Systematic studies of how habitat loss affects species with different requirements can be used to formulate performance targets as to how much habitat species require [158]. Angelstam et al. [189] proposed the following steps: (1) stratify the forests into broad cover types as a function of their natural, or anthropogenic, disturbance regimes; (2) describe the historical spread of different management impacts in the respective ecoregions that moved the system away from forest naturalness or cultural landscape authenticity, e.g., [85,190]; (3) identify appropriate response variables (e.g., focal species, functional groups or ecosystem processes) that are affected by habitat loss and fragmentation; (4) for each forest type identified in step 1, combine steps 2 and 3 to look for the presence of non-linear responses and identify intervals of risk and uncertainty; (5) identify the "currencies" (i.e., species, habitats, and processes) which are both relevant and possible to communicate to stakeholders.

Empirical research shows that there is large variation in terms of what different species require of habitats depending on the life-history traits, and scale and ambition of the conservation work, e.g., [69,76,178]. For several specialized forest species, the presence of thresholds has been documented for the necessary amount of habitat at the landscape level [76,159,188]. For 17 species (birds, mammals and insects), the proportion of habitat needed was 10–50% with a mean of 19% [76]. Svancara et al. [69] reviewed evidence-based knowledge and norms agreed in policy processes about the area proportion needed for conservation. On average, the proportion of area recommended based on evidence-based studies in terms of conservation assessments (31%) and threshold analyses (42%) was almost three times as high as those recommended in policy-driven processes (13%). This is consistent with previous findings that 10–30% of a species' habitat is needed to maintain viable populations in a landscape [182,183,185].

The second type of studies providing knowledge relevant for evaluation of how species are affected by different amounts of resources involve comparative studies along forest history gradients [9,191–194]. Such studies focus on how much of various resources are needed compared to the range of variation in naturally dynamic reference landscapes regarding dead wood, e.g., [195–199], the proportion of deciduous trees in stands [200,201], and naturally dynamic forest old growth forest stands found in the managed landscape [17]. Research on how much of different characteristic habitat properties are needed in managed landscapes to maintain species dependent on natural forest properties indicates that at least 10–40% of the natural amount habitat needs to be maintained [76,196,202]. As this level is much higher than what is left in today's Swedish forest landscapes [195,196,203–205], specialized species are threatened [156,206].

Summarizing, to answer the key question "How much habitat is enough?", evidence-based knowledge is needed about (1) the composition, structure and function of the pre-industrial characteristics of forest landscapes and cultural woodland, e.g., [61,207,208], and (2) how much loss of that can be accepted. Hanski's [40] rule of thumb "a third of a third" is appropriate and is now being matched by evidence-based policy targets allocating 10% strict protection plus 20% aimed at conservation management and nature restoration, e.g., [154,209].

3.2.3. Education and Public Awareness of Stakeholders

To communicate the emerging evidence-based knowledge about forest and woodland ecology, cultural woodlands and conservation biology, Sweden's National Board of Forestry arranged several educational programs where nature conservation and sustainable forest management were important parts, i.e., Richer Forests, Cultural Heritage in the Forest, and Greener Forests [210–212]. Additionally, green forest management plans with specific focus on maintaining habitat for species appeared [213]. Several efforts have aimed at developing ways to contribute to a landscape perspective for biodiversity conservation (Landscape Ecological Core Areas (Swe: Landskapsekologiska kärnområden (LEKO)) [214]; inspired by the Finnish METSO programme, the KOMET programme [215] aims at providing complementary methods for nature protection (Swe: kompletterande metoder för skydd av natur) [216,217]; Regional Landscape Strategies (Swe: Regionala Landskapsstrategier) [218,219]. Since 2002, the Swedish Forest Agency has worked with first a national, and then also regional and local forest sector councils as an attempt to develop an interface towards and establish collaboration with the main forest sector stakeholders. This effort has had varied success, and in many places the local level has been omitted. Experiences from the national level show that stakeholder collaboration is not an easy task [220]. The main tools used for implementation of forest and environmental policies in Sweden are counseling and education. This informational approach to policy implementation has been shown to influence the behavior among forest owners in the short term but, might not affect underlying values and preferences [221]. In contrast, in a study where 25 forest and conservation planners were interviewed in central Sweden [41], some forest planners described the acceptance of the new forest policy in the early 1990s as a long process. Knowledge and gender are linked to the attitude toward conservation. For example, Uliczka et al. [222] showed that self-estimated knowledge about conservation and knowledge about forest species were all related to a positive attitude towards conservation. Thus, education can affect conservation consequences.

3.2.4. Systematic Conservation Planning

The Emergence of Hierarchical Planning

The introduction of the woodland key habitat concept [223,224] and a corresponding nation-wide mapping of biotopes with high conservation value, and substantially increased resources for protection of forest areas with high natural values for conservation purposes during the 1990s, created a potential foundation for spatial planning of voluntary set-aside areas [20]. However, conservation of viable populations requires sufficient amounts of suitable habitat configured to form functional networks [20,54,225,226]. In parallel, the first ideas about landscape ecological planning regarding forest conservation emerged [67,227]. As a result, the policy implementation process to conserve biological diversity gradually became hierarchical with strategic, tactical and operational planning in several steps similar to forest management planning [228].

Strategic Planning: Regional Gap Analysis

The purpose of a regional gap analysis is to estimate how much of different habitats remain in different regions compared to the pre-industrial amount and distribution [161,229–231]. Focusing on the role of protected areas for forest biodiversity conservation, Zackrisson et al. [130] and Liljelund et al. [232] pioneered attempts to formulate area targets for forest protection in Sweden. Nilsson and Götmark [146] conducted analyses of representation of protected areas for different types of land cover, and found that productive sites were underrepresented.

SOU [73,74], summarized by Angelstam and Andersson [61] and Angelstam et al. [41], took the gap analyses concept a step further by also estimating the extent to which there were gaps in the amount of habitat to maintain viable populations of naturally occurring species in each of Sweden's main ecoregions. A short ABC for a quantitative gap analysis [41,61,233] includes several steps (Table 2):

Table 2. Summary of variables associated with quantitative regional gap analyses concerning the proportion of a forest habitat or attribute that needs to be conserved (including protection, management and restoration) to maintain viable populations of naturally occurring species in an ecoregion; see [41,61,233].

Variable	Description
A	The amount of a particular forest environment which species have adapted to in the region [a]
B	Today's amount
B/A	Representation
C	Performance target or norm based on knowledge about the proportion out of the area of a particular natural forest environment required for retaining a viable population
A × C	Long- term target for the amount of a particular forest environment
B–(A × C)	Gap (if the value is negative)

a—in naturally dynamic boreal forest landscapes, e.g., [16], or traditional cultural landscape, e.g., [166].

(1) To estimate the pre-industrial area of the different representative forest habitats in a particular region (A). (2) To compare (A) with estimates of the current quantities of the same forest habitats (B), makes it is possible to estimate how representative different habitats are today (i.e., B/A or representation). (3) With knowledge about what proportion of a particular naturally occurring forest environment that is required for the most demanding species, i.e., focal or umbrella species, to maintain a viable population (C), one can estimate how much of different representative forest types need to be maintained to secure viable populations of all species. The quantitative gap analysis is thus based on the difference between B and A × C. A negative value indicates a gap in habitat area, and hence the need of restoration and re-creation of habitats [234,235]. However, the presence of habitat may still not lead to re-colonization of species. Species with poor dispersal ability may thus remain only as relicts of past landscapes doomed to extirpation, because they are unable to colonize isolated areas [236,237].

The existence of non-linear responses of species to habitat is central for the opportunity to formulate evidence-based norms for the conservation of biological diversity, e.g., [182–185,238]. By incorporating contemporary knowledge about forest ecology, forest history and conservation biology, SOU [73] concluded that in the long term (~50 years) 8–16% of forest landscapes, depending on ecoregion, should consist of functional GIs [61,74]; see Table 3. Subsequently, a short-term interim target was formulated by the government, stating that by the end of 2010 the amount of formally protected and voluntarily set-aside forests should increase by 400,000 and 500,000 ha, respectively [34,35]. These 900,000 ha correspond to 4.1%-units of productive forests at the national level.

It must also be noted that for many species, habitat is indeed maintained in managed forest landscapes even with conventional sustained-yield forest management systems. For example, area-demanding species such as Moose (*Alces alces*), brown bear (*Ursos arctos*) and capercaillie (*Tetrao urogallus*) [15,181,188,239], which have been extirpated in many parts of Europe, may thrive in managed forests. Thus, the estimated need to set aside forests to conserve viable populations was lower than the 20% rule of thumb [73,74], and varied among forest regions due to differences in the composition of forest environments and their dynamics in relation to how they are managed. Since clear-felling with tree retention is the norm in Sweden [13,54], and forests with internal dynamics (such as broadleaf or wet spruce forests), and cohort dynamic forests (i.e., multi-layered oak and Scots pine forests), and cultural woodlands, are more common in southern than in northern Sweden, the estimated need for forest protection was higher in southern (16%) than in northern Sweden (9–12%) (Table 3). Note that these estimates rested on the assumption that environmental considerations in managed forests reached the expected targets for tree retention in stands, that the network of protected areas was fully functional, i.e., composed of biotope patches with sufficient quality and connectivity, and that the general considerations are coordinated with all formally protected areas and voluntary set-asides.

Table 3. Summary of results of the quantitative gap analysis concerning productive forests below the mountain forest region in Sweden [74]. Using a general threshold value of 20% as a target for the necessary proportion of remaining habitat in the long term (I), the following steps were taken: individual assessment of 12 natural forest and 2 cultural woodland types according to their expected occurrence in the different ecoregions and (II) assessment of which of these forest types managed landscapes can deliver. The remainder (III) became the long-term target for set-aside of forests to maintain viable populations of naturally occurring species. This long-term target is satisfied by summing up (IV) the already protected area in 1997, taking into account (V) the nature values created by nature consideration and landscape planning in regular forest management, setting aside (VI) forests and woodlands with high nature values that were not protected, (VII) including the area of wooded grasslands of the cultural landscape, and finally (VIII) restore habitat by nature conservation management.

Item	Description	Average Proportion and Regional Variation (in Brackets) of Productive Forests below the Mountain Forest Region in % of 218,800 km^2
I	Threshold rule of thumb based on empirical studies of species' requirements (C in %; see Table 2)	≈20
II	Forest environments without needs for forest protection (%) (PG *)	10 (4–12)
III	Long-term goal (%) with sub-components IV–XIII below	10 (8–16)
IV	Formally protected area 1997 (%)	0.8 (0.4–1.6)
V	Reduction of the need for forest protection due to functional nature considerations at the stand level (%) (PF/K *)	0.9 (0.3–1.7)
VI	Short-term goals defined by existing unprotected forests with high conservation value (%) (NS and NO *)	3.2 (1.9–3.5)
VII	Wooded grasslands in cultural landscape (%)	0.8 (0–2.2)
VIII	Restoration needs (%) (PF/K *)	≈4 (3–11)

* the codes PG refers to wood production with general nature considerations, PF to production with reinforced natural consideration or K (combined goals), NS to nature conservation management.

Much has happened since the emergence of the contemporary forest policy in 1993 and the gap analysis from 1997. The evaluation of forest policy [240], a revised forest policy [141] "En skogspolitik i takt med tiden"), the addition of a 16th environmental quality objective, A Rich Diversity of Plant and Animal Life, and the new challenges of climate change and increased globalization are a few examples. To date, three audits of the 1997 regional gap analysis have been made. First, on 11 February 2004 the National Board of Forestry in Kristianstad organized a hearing on "Gap Analysis of Nemoral Forest". Second, the scientific background to quantify goals for maintenance of viable populations was the subject to a report [241], and a conference at the Royal Academy of Forestry and Agriculture on 21 March 2006. The conclusions from these revisions of the scientific background were that the regional gap analysis approach was a robust strategic planning tool, that new knowledge about species requirements showed that they were rather higher than lower compared to the Environmental Advisory Council estimates from 1997, and that there was a need to monitor and evaluate the results of investment in biodiversity conservation continuously. Finally, a review of the interim target Living Forests [242] did not change the conclusion about the required amount of protected areas, but pointed out that landscape ecological planning and collaboration among land managers need to be improved for formally protected and voluntarily set-aside areas to form functional green infrastructures for forest biodiversity conservation [42].

According to the Swedish Forest Agency's [43] in-depth evaluation of reach Living Forests, they will not be reached. The five most important problems to solve are:

- Decline and lack of important habitats in the forest landscape, and several types of habitats are becoming increasingly fragmented.
- Unfavorable status or negative development for many forest-dwelling species. Many threatened and sensitive species are declining, and populations are becoming increasingly fragmented.
- Several of the forest ecosystem services have insufficient status.
- Cultural heritage remains are destroyed in the forest landscape due to forestry measures.
- Negative impact on watercourses of the forest landscape.

Tactical Spatial Planning

The next step was to optimize functionality of forest habitat networks at the county level, e.g., [243] (see methods section for an approach to assess functionality of forest habitat networks). To aid this planning process, a national compilation of high conservation value forests [20,244] and analysis of the location of core areas for forest protection [245] were conducted by each county in Sweden. While the regional analysis in the previous strategic planning step only distinguished four broad forest regions, the tactical analysis was spatially explicit to match the resolution of individual protected areas across Sweden. The spatial planning strategy pronounced how protected area candidates should be selected for formal protection. The guiding principle for selection was the conservation value of an area, including structure and species composition of the forest itself, as well as its connectivity in the local landscape context in terms of distance to other high value forests. Additional criteria for formal protection were recreation and cultural heritage. Finally, the extent to which the protection was practical was considered. The need for dialogue with forest landowners was also stressed as an important component. Subsequently, the County Administrative boards and the Swedish Forest Agency formulated regional county-level strategies, including spatial analyses.

Forest companies have embarked on spatial planning by developing landscape plans [227]. For example, in 2003 the state forest company Sveaskog Co. developed the Ekopark concept [99]. This involved an approach for identifying forest landscapes of different types that should be devoted to the maintenance of viable populations of species based on sufficient habitat qualities across three spatial scales, i.e., tree, stand and landscape [99]. Today, there are 37 Ekoparks covering 2.5% of Sveaskog Co.'s holding, and with an average size of 6500 ha [246]. They have a much higher proportion of old forest (52% > 100 years old) compared to 15% outside the Ekoparks.

3.3. Consequences on the Ground

3.3.1. Ecological System: Protected Area Development

Productive Lowland Forests

Angelstam et al. [41,42] summarized the development of formally protected and voluntarily set-aside forests for the period 1991–2010. The first review of formally protected areas showed that about 0.5% of the productive forests below the mountain forest region was formally protected in 1991 [72]. By 1997, a total of 0.8% (174,000 ha) of the productive forest was formally protected [74]. By the end of 2008, the formal forest protection figures had reached 1.1% (244,500 ha). This corresponded to 61% of the interim target for formal protection to be reached by the end of 2010. As described in Angelstam et al. [41], the government promised to transfer up to 100,000 ha productive forest land from Sveaskog Co. to the state to speed up the process of reaching the interim target in time. This forest was to be used as a pool for forest land replacement when creating protected areas on privately owned land [247]. The most recent data add up to 11% of productive forests, and are equally distributed between formally protected and voluntarily set-aside forests.

Regarding voluntarily protected areas, these are less precise than the formally protected areas. A survey of woodland key habitats began in the early 1990s [223], and voluntary set-aside of forest commenced in the early 1990s. In 1998, the total area of voluntarily protected forests with conservation values was estimated at 230,000 ha below the mountain forest region [248,249], and in 2008 the Swedish Forest Agency [6,250] reported that this number had increased to about 936,000 ha. However, [7,250] estimated that about 75% of the voluntary set-asides had significant nature conservation values. The interim target of 500,000 ha voluntarily set-aside forest formulated after the regional gap analyses made in 1997 was thus probably reached by the end of 2010. The increase in formal protection and voluntary set-aside for the period 1909–2021 is summarized in Figure 3, and includes transfers from voluntary set-asides to formal area protection around 2015.

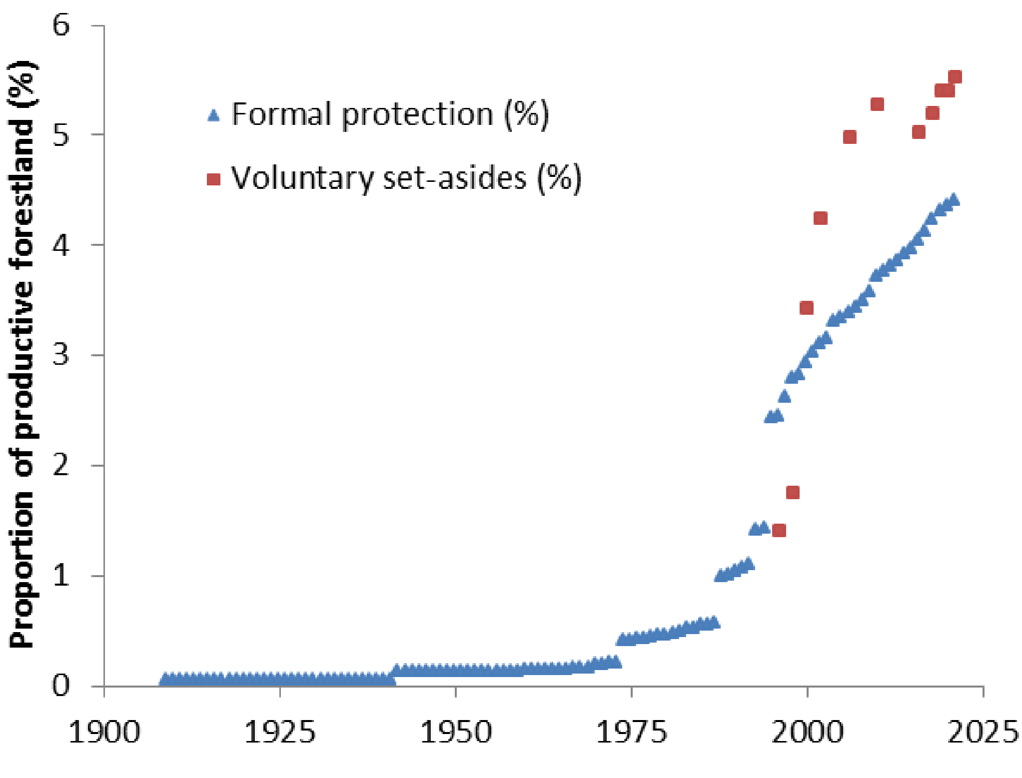

Figure 3. Development of the amount of formally protected (https://sverigesmiljomal.se/miljomalen/ett-rikt-vaxt--och-djurliv/skyddad-produktiv-skog/ (accessed on 1 March 2023)) and voluntarily set-aside areas ([251] and the data base https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__MI__MI0605/SkyddSkogFrivillig/ (accessed on 1 March 2023)) on productive forest land in Sweden (23.5 million ha). The voluntary set-asides from 2006 include forests with variable conservation values [201], and are on average one order of magnitude smaller than formally protected areas [20].

The Mountain Forest—The EU's Last Intact Forest Landscapes

The sub-alpine mountain forest region's forests and woodlands along the Scandinavian mountain range covers ca. 3.5 million ha, of which 1.5 million ha counts as productive [68,148]. According to Naturvårdsverket [72], 265,000 ha was protected as Domänreservat in 1991 (i.e., state forest company protected areas). Additionally, there were 325,000 ha nature reserves and national parks, thus amounting to a total of 590,000 ha (38%) with formal protection. According to SOU [74] and Naturvårdsverket [252], a total of about 660,000 ha (~43%) of the mountain forests was formally protected in 1997 [253]. Currently, 57% of the mountain forest region's productive forest is formally protected for conservation purposes ([251], Figure 4). Regarding voluntarily set-aside productive forest in the mountain forest region, Skogsstyrelsen [6,250] reported 197,000 (13%). The corresponding figures below the mountain forests are 3–5% and 6%, respectively.

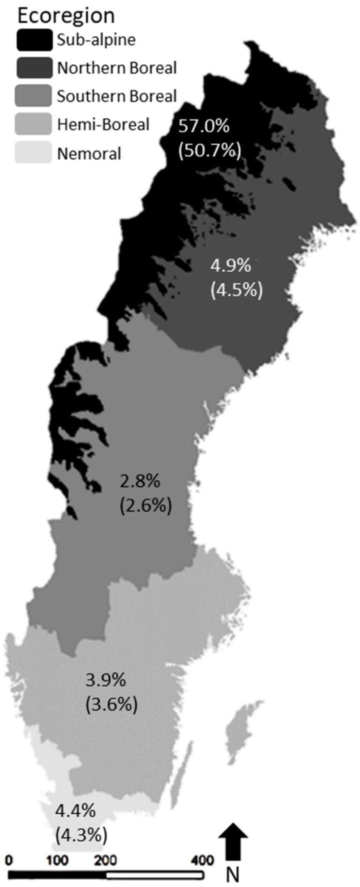

Figure 4. Proportion of formally protected forest of the total forest area for the five Swedish forest ecoregions fitted to county borders and the sub-alpine mountain forest border, and within brackets the proportions of protected productive forests per region [251].

The last large intact forest landscapes along the Scandinavian Mountain range in Sweden offer unique opportunities for conservation of biodiversity, viable populations and ecological integrity and resilience in the European Union ([47], Figure 4). Additionally, with a European perspective, the forests along the Scandinavian Mountains and the Ural Mountains, which run north–south, offer better conditions for species to survive the stress of climate change [254] than forest species in the Carpathian Mountains, the Alps and the Pyrenees, which run east–west. However, these last large intact forest landscapes are at a crossroad between intensified wood production aimed at bio-economy, and rural development based on multi-functional and resilient forest landscapes for future-oriented forest value chains [68].

Indeed, policy regulations have been successful in limiting forest harvesting since the beginning of the 1990s. However, like other unique natural forest remnants such as in the Bialowieza Forest in Poland [255], the Swedish mountain forests remain as a battleground. Key issues regard intensification of forest use and logging of forests that have never been subject to clear-felling systems, vs. reindeer husbandry, conservation of biodiversity and wilderness as foundations for rural development based on value chains other than the forest industry's [68].

3.3.2. Ecological System: Habitat Network Functionality

Spatial Differences

The historical and presently ongoing fragmentation and loss of natural forests and cultural woodlands implies that not all habitat patches satisfy criteria in terms of size, quality and connectivity, and will thus not form functional GIs [236,256–258]. Assessments of habitat network functionality over entire counties and regions confirm this [20,54]. In collaboration with the County Administrative Boards of Dalarna and Gävleborg, Angelstam et al. [67] conducted analyses of functional connectivity for focal species representing different forest and woodland habitat types, and found that regional gap analysis overestimated the area of functional habitat area. Using the same approach, covering nine counties in south-central Sweden, Angelstam et al. [41] applied spatial modelling to assess the functionality of three different forest habitats (old pine, old spruce, old deciduous) and one type of cultural woodland (forest-farmland edge). The analysis showed that on average 15% of all presently existing land with these land covers formed functional habitat networks (Figure 5). However, there were significant regional differences among the four forest habitats in the different boreal ecoregions depending to the history of forest use. This study did not assess the landscape level amounts needed to reach different conservation ambition levels, but only the extent to which presently existing biotopes formed functional habitat networks in landscapes. Later the same kind of analyses were conducted for all of Sweden. While functional connectivity was very good in the mountain forest regions, the situation deteriorated from northern to southern ecoregions. This clearly illustrates the reduced functionality of GI due to scattered and small remaining high conservation value areas (Figure 5).

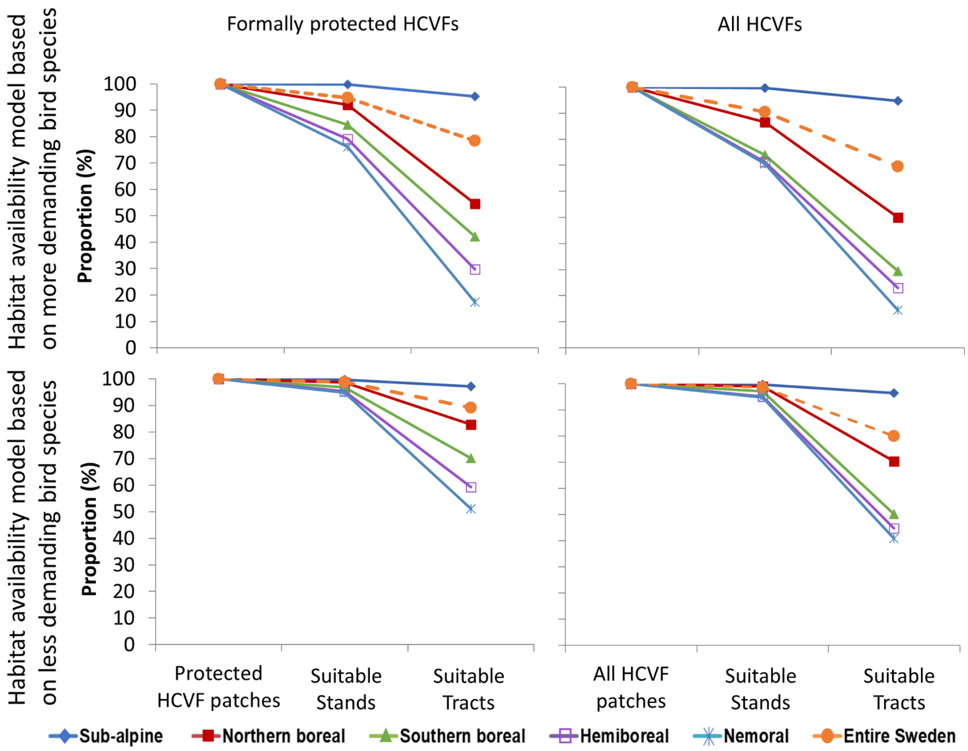

Figure 5. Proportions of HCVFs contributing to habitat network functionality for a less (**bottom**) and more (**top**) demanding virtual focal bird species, and for only formally protected (**left**) vs. all (**right**) HCVFs, across Sweden's five forest ecoregion (from [20]).

Temporal Trends

Few retrospective studies have compared the temporal consequences of loss vs. protection of high conservation value forests. Focusing on the two large counties Dalarna and Jämtland representing the characteristic expansion of the timber frontier in northern Sweden, Angelstam and Manton [54] showed that formal forest protection grew rapidly in the two counties from 1968 to 2020, and reached only 4% of productive forests. In contrast, from 2000 to 2019, habitat network functionality for old Scots pine declined by 15–41%, and for old Norway spruce by 15–88%.

3.3.3. Does Sweden Reach Forest-Related Environmental Quality Objectives?

The first evaluation of the implementation of the 900,000 ha interim target area for forest protection until 2010 [259] concluded that it would be difficult to reach this target by the end of 2010. Hence, Miljömålsrådet [260] stressed the need for intensified activities to reach this area target. Subsequently, Statskontoret [261] proposed that the government-owned Sveaskog Co. should offer compensation areas for productive forestland with identified conservation values on land belonging to industrial forest owners. Political pressure to speed up the area protection process prior to the Swedish parliament elections in autumn 2010 forced some county administrative boards to focus on establishing protected areas by purchasing the land designated for land exchange with the Sveaskog state forest company to reach the interim area target. As pointed out by Angelstam et al. [41], this exemplifies "*how economic and political circumstances may overthrow a well elaborated planning process*". As a result, because Swedish state forests are biased towards less productive forest types such as dominated by Scots pine, representativeness and functionality of habitats are reduced compared to if the tactical planning approach had been pursued.

The size, duration, decision-making, control and method for monitoring of the formal and voluntary conservation instruments, as well as unproductive forests, mean that they differ in conservation effectiveness (Table 4). Angelstam et al. [20] showed that there was a clear decline in the patch size and duration of different conservation instruments from formally protected areas (>20 ha and permanent) via voluntarily set-asides to nature consideration areas (<ca. 0.5 ha and unknown).

In Sweden, forests not used for wood production currently cover 26% of all forest land (28 million ha). Excluding current nature consideration areas, the figure is 24%. To assess the extent to which HCVF patches actually contribute to GI functionality, Angelstam et al. [20] presented spatial analyses adjusted for the lower biodiversity value of unproductive forest, which suggested a 50% reduction to 12%. Of this, 6%-units of forest land was formally protected, 3% voluntary set-aside, and 3% unproductive. In contrast, in the sub-alpine forest ecoregions 72% of the total forest area potentially contributed to functional GI, of which 54%-units contributed to Aichi target #11, and of which 44% was formally protected. For the four other forest regions, in which the focus is on production of industry raw material, the corresponding numbers were 14–23%, 3–8% and 1–3%, respectively, of all forests.

Angelstam et al. [20] concluded that there are two key aspects of the distribution of the four types of set-asides listed in Table 4 as components of forest GI in Sweden. First, there is a large difference in the GI functionality of the sub-alpine forests being dominated by unproductive forests compared with the other four forest ecoregions in which the focus is on high sustained yield forestry. Second, there is a considerable difference between the total area of different set-aside types and the estimated area of functional GI (Figure 6) and the lower biodiversity conservation value of unproductive forest.

Table 4. Basic information about four groups of conservation instruments in Sweden [20].

	(i.i) Formal; According to the Environmental Code		**(i.ii) Formal; According to the Land Code**	**(ii) Voluntary Set-Asides**	**(iii) Nature Considerations (§ 30, Forestry Law)**	**(iv) Unproductive (Wood Production <1 $m^3ha^{-1}yr^{-1}$) (§ 13a, Forestry Law)**
Aim	National park, nature reserve: Conserve and develop nature of high value for plants, animals and people	Biotope protection: Conserve terrestrial or aquatic habitat for threatened species	Conservation agreement: Conserve and develop qualities for biodiversity	A complement to formal protection	Consideration to biodiversity conservation in managed forest	Wood harvest not recommended
Establishment	1909 and 1964, respectively	1998	1993	1995	1979	1979
Target size	Usually >20 ha	Usually <20 ha	Variable	>0.5 ha	<0.5 ha	>0.1 ha
Duration	Permanent	Permanent	Variable	Unknown	Unknown	Permanent
Decision by	Parliament, Government, County, Municipality	Forest Agency, Municipality	Agreement between the State or Municipality and owner	Landowner	Parliament, Government, Forest Agency	Parliament, Government
Control	County	Forest Agency, Municipality	State	Forest certification	Forest Agency	Forest Agency
Monitoring	Georeferenced GIS polygons	Georeferenced GIS polygons	Georeferenced GIS polygons	GIS data and questionnaires	Random field sampling	National Forest Inventory

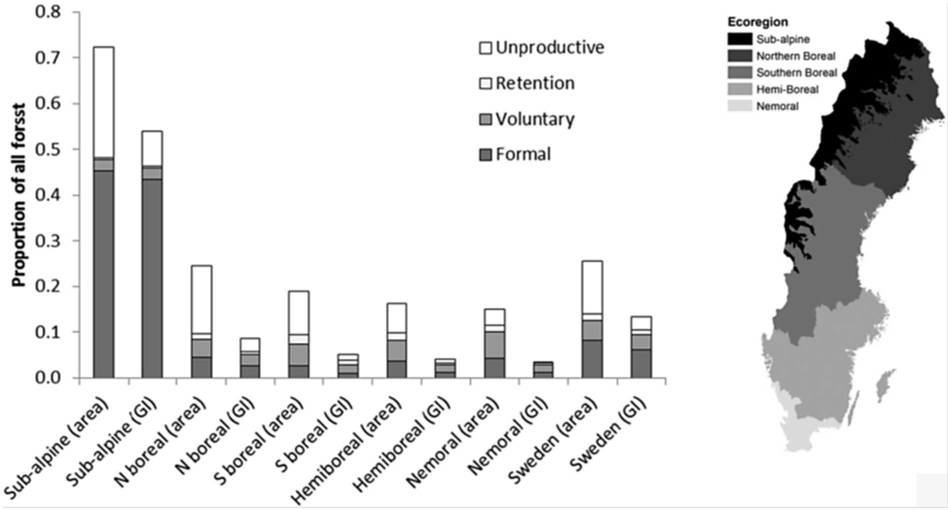

Figure 6. Regional variation in Sweden of the area proportion of all forest and wooded land being formally protected and voluntarily set-aside productive forests, unprotected unproductive forest likely not to be used for wood production, and retention forestry.

3.3.4. Social System: Operational Planning Processes

In Sweden, forest areas withdrawn from wood and biomass production can be divided into areas formally protected by law (national parks, nature reserves, biotope protection areas and conservation agreement), and voluntarily set-aside areas (Table 4). To conserve, manage and restore functional network of forest habitats in a district, county, or other geographical area requires collaboration between stakeholders, including landowners, government agencies and others representing different interests and uses. Statskontoret [261] presented results from interviews with county administration staff, who reported that collaboration related to protected area designation was only rarely a problem. This is corroborated by the fact that only 2% of the proposed protected areas led to disagreements and court cases. However, the counties felt limited by the staff available, access to forest land to compensate forest owners' loss of productive land, taxation rules and, above all, funding to compensate landowners. To facilitate the implementation of the 16th environmental quality objective on biodiversity (A Rich Diversity of Plant and Animal Life), landscape planning of protected areas was encouraged in terms of a pilot project commissioned by the Government in 2005. The objective was to develop regionally adapted landscape strategies, i.e., working arrangements and planning processes for conservation and sustainable use of natural resources using a holistic and cross-cutting perspective [262]. A total of seven pilot areas were included, ranging from mountain to regular managed forests, as well as in urban and rural areas. The case studies also represented different phases in the development of collaboration. As a result, a handbook was produced [263], and Jonegård [219] summarized the Swedish Forest Agency's experiences.

Few studies have systematically assessed the extent to which planning processes succeed with spatial conservation planning across different forest management units and forest owners' holdings, and different spatial scales. The Swedish model for biodiversity conservation is built on a shared responsibility among landowners, the forest industry and the government, and the principle of each sector's responsibility for the environment (see [145]). However, available knowledge on which to base future conservation decisions is not as comprehensive as the information used for decisions related to timber production. In a study of large forest companies in Sweden, Eriksson and Hammer [50] noted gaps in terms of absence of information about habitat connectivity at the landscape and smaller scales, and the effectiveness of protected areas for conservation. Similarly, as indicated by results from interviews made with 25 forest and conservation planners in central Sweden, Angelstam et al. [41] could not trace this shared responsibility at the landscape or regional level. The collaboration focused on the object or at a stand level, i.e., with the aim of identifying red-listed species, or certain biotopes. There was no general collaboration among forest owners, or with government agencies and forest owners, aiming to create functional forest habitat networks that cross ownership borders. Thus, the regional conservation strategies were never brought down to the ground, which means that they are not used by forest planners to assist a landscape perspective in their planning. In fact, regional administrations claimed that their responsibility is only for the protected areas, and not the whole territory. There were neither efforts to involve the public in collaborative learning processes, nor to develop socially robust solutions for conservation or to develop a common knowledge base among different stakeholder groups. Similarly, studies in Poland [49] and Lithuania [51] report no or low levels of collaboration among sectors and levels of governance. Reviewing other cases of natural resource planning processes, Sandström et al. [264] concluded that the government is still more important than governance (see also [265]).

4. Discussion

4.1. Assessment of Trends in Policy, Implementation Outputs and Consequences

4.1.1. Overall Patterns since the 1990s

Overall, policy concerning environmental dimensions of forests shows remarkable stability over time (Table 5). However, while public policy clearly is built on evidence-based knowledge about conservation biology and landscape ecology at international, EU and national levels, voluntary policy such as forest certification is not [266–268].

Policy instruments can be divided into the three categories "carrot, stick and sermon" [269]. The dominant type of tools for supporting the development of habitat networks as functional GIs has been carrot in terms of the state purchasing land to create formally protected areas, and sermon in terms of education campaigns and evidence-based analyses of high conservation value forests and their spatial configuration.

Outcomes in terms of increased number and area of formally protected areas took off in the early 1990s, and have continued to increase at rates that mirror the amount of state funding made available. However, rapid loss of remnants of high conservation value forests outweighs the increase of high-quality protected areas [20,54]. Platforms for stakeholder collaboration are widespread at national and regional levels of governance [270,271], but are generally neither linked to concrete landscapes on the ground, nor based on principles of evidence-based systematic conservation planning.

4.1.2. Policy about Forest Biodiversity Conservation Remains Intact

In Sweden, forest biodiversity conservation is dealt with in both forest and environmental policies. The opening paragraph of the current Forestry Act from 1979 [272] and its revisions establish production and environment as equally important objectives [141,273–275]. The system of regulations and subsidies under the previous law were abolished, and replaced with minimal regulations and high expectations for voluntary conservation by all actors within the forestry sector to achieve the goals of the new law [276]. This has been described as "freedom under responsibility" [115,277]. In exchange for greater freedom of forest management, forestland owners and the forest industry are expected to share a collective responsibility to voluntarily ensure that both production and environment objectives are met. This is sometimes referred to as the Swedish model for conservation, and the Swedish forestry model, as described by the Royal Swedish Academy of Agriculture and Forestry [278]. The aim was to foster forest management systems that are adapted to different site conditions able to both conserve and enhance biodiversity, and maintain and develop the productive capacity of forestland, reflecting recent scientific knowledge about the importance of species and ecosystem variation [44].

Table 5. Overview of the long-term temporal development of policy, instruments for implementation, and outcomes supporting the Swedish environmental objective in social-ecological systems on the ground.

Analytic Steps	Sub-Categories	Items							Overall Comments
		1990			2000	2010		2020	
Policy	International		SFM policy		CBD Aichi	Paris climate		CBD 2022	Stable evidence-based policy
	EU					GI policy	climate + biodiv.	nature restorat.	Increasing role of EU under the "The Green Deal"
	National		Forest policy with environmental objective			GI policy			Stable evidence-based policy
	Voluntary		FSC						Stable negotiated policy
Instruments	Carrot			Funding Protected Areas					Gradual increase of PAs, depending on politics
	Stick								NA
	Sermon		Gap analysis	Conservation planning	Gap analysis	GI plans	GI plans		Sustained science-policy interface
Outcomes	Protected areas	Formal protection	Voluntary set-asides						Gradual increase of PAs, depending on politics
	GI						Net loss		Forestry intensification over-rides effects of PAs
	Collaboration								Abundant, but often not evidence-based
	Planning				Landscape planning				Functional on public land and some industry; otherwise not
		1990			2000	2010		2020	

Major elements of the previous law that the latest Forestry Act retained include the reporting requirement for final harvests, regeneration regulations, and a prohibition on the conversion of existing deciduous forests comprised of species of significant ecological value [273]. The main role of the Swedish Forest Agency has shifted from a focus on regulatory oversight and administration of silvicultural subsidies to emphasis on national inventories of ecologically valuable habitats for formal and voluntary protection under the new policy, as well as policy implementation by providing information, education and advice to landowners and others in the forestry sector [210,211,221,223,279–281].

Additionally, the legal protection for small habitat patches, now encompassed within the revised Environmental Code of 1998 [282], remains in effect by the Swedish Forest Agency. The formal policies are also now supplemented by voluntary forest certification systems that have increased their area coverage significantly since the passage of the current Forestry Act [283–285], and with a combined cover a total of 19.2 million ha of forestland [286,287].

With its extensive reliance on voluntary contributions for biodiversity conservation and limited regulation, the new forest policy has been described as depending on "voluntary action as control". This implies a system built on self-responsibility and relying on non-compulsory but nevertheless standardized sector-wide measures such as guidelines, evaluations, and certification systems to achieve the environmental objective. This involves unresolved tensions between the production and environmental objectives [288]. Despite these concerns, in the latest of the periodic policy reviews, the Swedish government reaffirmed the major elements of the current forestry policy, including the emphasis on voluntary action to achieve nature conservation goals [141]. However, recent reports from the Swedish Forest Agency show that a significant share of final felling areas do not meet the minimum requirements of the Forestry Act [289,290], as well as reports of harvests in old-growth and other high-conservation forests [291]. This has fueled criticism of the forest policy as being too heavily reliant on voluntary contributions to reach the goals of the Swedish environmental and forest policy, e.g., [292,293]. In recognition of these problems, the Swedish Forest Agency has recently indicated that it plans to issue more legal orders prohibiting final harvests entirely, or requiring more detailed and extensive conservation than affected landowners had planned. The intent is to force landowners to oppose the agency in court in order to clarify the legal praxis surrounding the agency's interpretation of the conservation regulations established under the Forestry Act [290,294]. This would then provide guidance about how high a level of nature conservation that the Forestry Act actually requires landowners to accept, which was a central issue at the time the policy was created [295].

At the same time as the most recent forest policy revision has retained the balanced production and environmental goals [141], it states that raw material production should increase using more intensive methods [296]. Poudel et al. (2012) estimated that intensive forestry may increase forest production by up to 26% and annual harvest by up to 19%. The campaign "skogsriket" (English: "the forest kingdom") initiated by the ministry of rural development aimed at producing more raw materials in the forest industry and increasing the net value of forest product exports [275]. However, in the context of implementing the current forest and environmental policies, Strengbom et al. [297] concluded that intensively managed forests will "*only harbor species that are common and widespread in conventionally managed stands and that species of conservation interest will be lacking, due to the low heterogeneity and light intensity of even-aged monocultures with dense canopies, short rotation times and low availability of coarse woody debris*". In particular, the effects of management strategies for increased biomass production on soil resources, specialized species and water quality at landscape scales are inadequately understood [297,298]. A decade later, Felton et al. [14] found that these issues remained unsolved. In a similar study, Angelstam et al. [9] concluded that a strong forest management cropping system tradition can be a burden for reaching sustainable forest management objectives.

In addition, global factors are affecting Swedish forests and forestry. Beland Lindahl and Westholm [299] found that four areas stand out as particularly important: changing energy systems, emerging international climate policies, changing governance systems, and shifting global land use systems. Both domestic challenges of biodiversity conservation and rural development, and global challenges, will continue to be important for future Swedish forests and forestry. Hence, they concluded that the forest sector "*must be disembedded and approached as an open system in interplay with other systems*". This calls for integrated approaches to natural resource governance, planning and management, e.g., [9].

Summarizing, in parallel with the long delivery time for creation and restoration of ecological dimensions such as old trees, stands with several tree generations and decayed dead wood, a long-term perspective on the different phases of forest use as in successive long-term coarse policy cycles is appropriate (e.g., "societal contracts" sensu [9,300]). This study focuses on what can be characterized as a third phase in the development of Swedish policy cycles (Table 6). However, international [209] and EU policies about climate [152], biodiversity [153] and forests [154], as well as proposed nature restoration regulation [155] hint to a fourth phase in the evolution of policy about forests. Emerging new policy components include the importance of satisfying evidence-based conservation targets, halting the harvesting of primary and old-growth forests, adapting to and mitigating climate change, and coping with conflicts and competition in an increasingly multi-polar world [301].

Table 6. Current, past and emerging policy cycles in Sweden covering the time span for developing high conservation value forest ecosystems (i.e., >200–300 years [16]). This study focuses on Phase 3.0 and the emerging 4.0 (see Table 5).

Phase in the Evolution of Forest Policy		Approximate Time Period	Short Description
Phase 1.0		Medieval to industrial revolution	Livelihoods based on multiple use of landscapes in traditional village systems
Phase 2.0		ca. 1830–1970s	Even-aged sustained yield forest management for industrial raw material in three steps:
	Phase 2.1	Mid-1800s	- Sustained yield of wood for charcoal emerged regionally in mining and metallurgy
	Phase 2.2	1850s to 1903	- North Sweden is reached by successive frontiers of "wood mining", which triggered development of forest policy
Phase 2.3		1903 and 1947 forest laws to 1970s	- State subsidies and advice to increase wood production and industrial value was taken in several steps, and led to the 1947 policy focusing on forests as effective cropping systems
Phase 3.0		1970s to 1990 and the proposed forest law, and to the 2020s	Emerging focus on nature conservation in the mid-1970s, which shaped the 1993 forest policy by introducing production and environmental objectives under the slogan "Living Forests"
Phase 4.0		2020s–	Increased EU and international influence concerning climate, energy and nature restoration (EU's Green Deal and Biodiversity Strategy as well as regulations of emissions and removals from the land use, land use change and forestry (LULUCF), Deforestation and RED3)

4.1.3. Implementation Outputs

The need to increase the amount of protected areas in Sweden in the late 1990s was a consequence of Swedish and international guidelines and targets, which mirrored evidence-based knowledge about forest ecology and conservation biology. Following a hierarchical spatial planning approach that included strategic quantitative gap analysis for each ecoregion in Sweden [73,74], Angelstam et al. [41] concluded that "*there was a straight chain of decisions from the short-term interim target for protected areas decided by the parliament, a government decision, strategies by governmental agencies, and to the regional administrations' tactical planning to mitigate habitat fragmentation through spatial planning, as well as operational planning for designation, management and restoration of formally protected forests*". Hence, society has, so far, accepted evidence-based knowledge as a basis for biodiversity conservation (see [302]). However, to promote efficient conservation policy implementation consequences on the ground, it is important that these three planning levels are interconnected (e.g., [303]).

The process of implementing biodiversity conservation policies in terms of establishing protected areas in Sweden made use of contemporary knowledge about conservation biology, forest ecology and landscape ecology. This is in accordance with Barbour's et al. [304] information ladder, which includes three levels. Starting with data, analyses and peer-review publication, information transfer takes place by facilitators, and this satisfies users' need for "sound bytes" and narratives that interpret policy contents in an uncomplicated manner suitable for media and politics. Quantitative knowledge about species' requirements was indeed used in strategic spatial planning, and forest and landscape ecology as well as approaches to collaboration advocated in tactical planning.

Angelstam et al. [41] concluded that the difference between the long-term policy goal for protected areas based on the quantitative gap analysis regarding forests below the mountain forest region (on average 10% across all ecoregions) on the one hand, and what was protected in 1997 (approximately 0.8%) was planned to be reduced by about 5%-units. This corresponds to the short-term interim target of 900,000 ha for forest protection formulated for the period 1998–2010 [34,35]. In addition, there was a long-term restoration target of an additional 4%, thus about 10% in total. However, to reach the 20% long-term conservation target, it was assumed that improved voluntary conservation through application of increased proportions of other forest management systems than rotation forestry based on the clear-felling system, and higher levels of retention of natural forest structures, would be applied [86,174].

As discussed by Angelstam et al. [41], at the end of 2010 "*the short-term target (400,000 ha)* for formal protection below the mountain region was reached to 80%, and the voluntary set-aside target (500,000 ha) was estimated to be reached, but with poorly known quality". To fill the gap for formal protection, a pool of Sveaskog Co. land (100,000 ha) was made available. To conclude, while the political will was there to reach the interim target, and the support provided by the Sveaskog Co. was very important, the 900,000 ha area target was not fully reached.

Moreover, there are at least three additional challenges that need to be overcome to satisfy the policy target in terms of maintenance of viable populations of naturally occurring species in the long term. (1) To fill the gap between present amounts of habitat and what is needed to satisfy policies, different forms of nature conservation management, restoration and re-creation are needed (see [305,306]). (2) To ensure habitat quality of protected and set-aside forest areas (e.g., late successional stages and gap dynamics), and renewal of transient habitats (e.g., early successional stages such as burned forest and deciduous successions after disturbance), dynamic reserves may be needed [307]. (3) To assess the functionality of areas of different forest environments as representative habitat networks at the landscape and regional levels.

To conclude, a certain percentage of a region that is formally protected or voluntarily set aside, or low-productive forest not subject to harvesting, does not mean that functional GIs are in place in terms of providing sufficient amounts of habitat networks for viable populations of representative forest types. First, the quality of different categories of forest management potentially contributing to GIs differs considerably [201]. Additionally, the results emerging from spatial modelling to assess the functionality of different networks show that the functionality of small voluntary set-asides is generally unfavorable compared to formally protected areas [98,257,266]. Thus, reported levels of habitat network functionality may be overestimates because spatial modelling is based on remote sensing data with limited thematic resolution in terms of the ability to identify high conservation value forests [75]. Similarly, studies of biodiversity conservation planning show that there is very limited collaboration across forest ownership borders with the aim to improve habitat connectivity in landscapes [20,49,50,303].

Angelstam et al. [20,41] thus concluded "*the existing areas of high conservation value forests in Sweden are presently too small and too fragmented in relation to the current forest and environmental policy ambitions*". Biodiversity conservation thus requires a combination of maintaining existing conservation values, conservation management, and restoration of forest habitats in protected areas of different kinds, as well as in the surrounding matrix. Formal forest protection represents the main investment in biodiversity conservation.

4.1.4. Consequences in Ecological and Social Systems

Protected Areas and Levels of Ambition for Biodiversity Conservation

Conserving biological diversity spans a range of levels of ambition. These range from (1) presence of species in the short term, (2) maintaining viable populations of all naturally occurring species in the long term (i.e., a current environmental objective) to (3) ecological integrity and (4) social-ecological resilience [69,189] (Figure 7). Swedish forest and environmental policy regarding biodiversity conservation clearly goes beyond the first ambition level, and focuses on the second level of ambition. In this respect, one can categorize species into five groups that vary in specialization from being generalists to highly specialized [42]. First, species which can withstand virtually whatever we do with the forest; second, those that are not threatened today, but that depend on general consideration for their long-term survival; third, specialized species which require protected or especially managed habitats; fourth, species that are doomed under current conditions, but that can be conserved with active restoration measures, and fifth, those which are already doomed to extirpation no matter what is done (i.e., the so-called extinction debt [169].

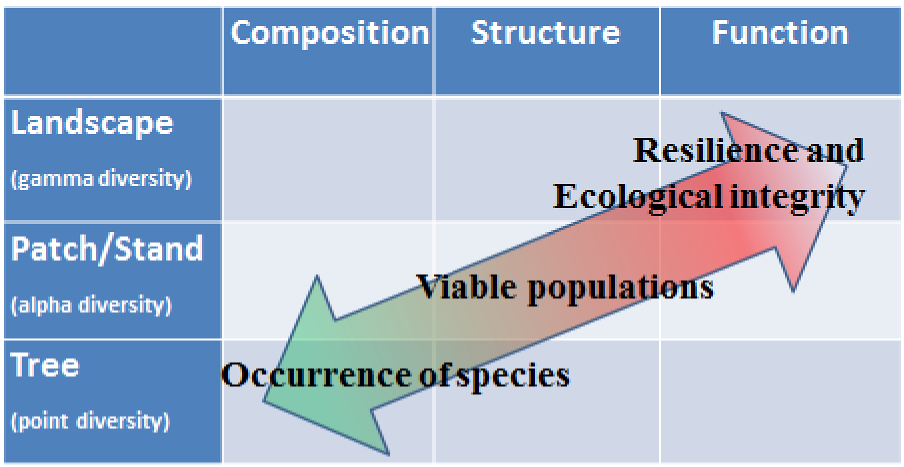

Figure 7. Biodiversity can be conserved with different levels of ambition. In the context of sustainable forest management, eco-labelling systems focus on the presence of species, while the Swedish forest policy's environmental goals target viable populations of naturally occurring species. Integrity and resilience are mentioned in policies on climate-related adaptation and adaptation (redrawn from [9]).

Even if Swedish forest and environmental policy goal can be interpreted as to conserve all native species in viable populations (the second level of ambition), evidence suggests that only the first level of ambition (presence of species for some time) may be possible to reach with the present levels of formal protection and voluntary set-aside of forest habitat. The reason is the Swedish landscape history context, representing a long history of strong focus on sustained yield forestry [9,165], and thus GIs with limited functionality. To achieve higher levels of biodiversity conservation ambition, remaining high conservation value forests need to be conserved and if necessary managed as parts of functional networks of different forest habitats, and large-scale efforts for active restoration of forest habitats commenced [9]. In contrast to the almost total domination of even-aged rotations in Nordic forestry with gradually lowered final felling ages, uneven-aged and mature even-aged forests (>80 years old) as well as protected areas are important to maintain biodiversity in boreal forests [308]. Their comprehensive meta-analysis thus highlighted that remnants of high conservation value forests need to be conserved to ensure the future of forest dependent species in Fennoscandia and European Russia. Thus, the most effective approach is to maintain mosaics of different forest types and development stages within landscapes.

One problem for effective conservation is that many forestry actors are not aware of, or are unwilling to accept, the need to sustain a range of different forest types and development stages, and to consider evidence-based conservation targets and the spatial configuration of conservation areas across forest ownerships [50,309]. Four methods that will contribute to achieve the policy objectives for the conservation of biological diversity are (1) forest management systems that mimic natural or cultural disturbance regimes [86], (2) conservation, management and restoration of habitats [306,310], (3) landscape ecological planning [166,227], and (4) if necessary to re-establish extirpated populations. Performance targets for the second level of ambition, to conserve native species in viable populations, imply that 10–30% of the forest should have biodiversity conservation as the main target [69,196,234,311], and the precise proportion will depend on how well the managed matrix satisfies species' requirements. Empirical assessments of the role of the managed landscape for GI functionality are thus crucial.

The third level of ambition is ecological integrity [312,313]. Large predator populations' control of the effects of large herbivores' browsing is one example of this [15,181]. Migratory fish and their relationship to water flow regimes and dynamics of other species in entire catchments is another [314,315]. Another example is the interaction between forest fires and species that depend on them [316,317]. The highest level of ambition represents resilience, which means to maintain a system's ability to recover from large-scale disturbances [318]. This issue was highlighted by Sweden at the International Meeting on Sustainable Development in Johannesburg in 2002 [319]. More frequent severe storms, long-term climate change and the associated risk of expanding fungal deceases and pest insects are other examples of threats to resilience. Additionally, international shifts in economics and desired products such as bioenergy may result in increasing pressure on the forest ecosystems. The resilience concept also has a deeper dimension linked to how societies are organized, how natural resources can be used sustainably, and how humans can live on or respond to and restore previous functionality after a large-scale disturbance. Adaption to climate change is another example. To emphasize the interconnectedness between ecosystems and people, resilience of social and ecological systems [320] or coupled human and natural systems [321] is stressed. Development of forums for inter-sectoral collaboration among actors from different sectors and at different levels plays a key role [322]. Possibly with the exception of the Swedish mountain forests, given the current intensive forest management regime, this highest level of ambition can only be satisfied in remote parts of the boreal biome on the European continent [47,323]. For this level of ambition, target levels in terms of set-aside necessary proportions are higher, likely around 40–60% [69]. This matches the current high proportion allocated to nature conservation in the Swedish mountain forests.

To conclude, during the past three decades the focus in Sweden has been to conserve species in the short term through the provision of small patches of formally protected or voluntarily set-aside forest areas. The long-term goal to conserve naturally occurring species in viable populations involves a higher level of ambition. EU-level policies pronounce even higher levels of ambition such as ecological integrity and resilience [37,154,324]. Increasing ambition levels of biodiversity conservation requires increased proportion of functional habitat networks in landscapes and regions [20,41,69]. Wilhere [302] criticized that researchers provide policy recommendations and called evidence-based conservation a myth. However, we agree with Rompré's et al. [238] conclusion that management approaches that combine thresholds to maintain managed landscapes within the limits of natural variability are a necessary avenue.

Habitat Network Functionality for Nature and People

Well-designed networks containing sufficient amounts of protected areas with sufficient quality, size and connectivity are important building blocks for the development of GIs for species and ecosystem functions, as well as ecosystem services and benefits of nature to people. This reflects that there are both biocentric and anthropogenic perspectives.

The understanding of ecological sustainability has developed from a biocentric view towards a more anthropocentric view on ecosystems, e.g., [325]. Biodiversity in the sense of composition, structure and function of ecosystems [140], as well as ecosystem services and benefits of nature [1,2,326] mirror this. A good recent example that aims at operationalizing this dual perspective is the emergence of the concept of GI and its role for humans [37]. Human health and well-being are dependent on biodiversity and ecosystem services provided by ecosystems' species, habitats, and processes in landscapes [327–330]. This was emphasized strongly by the Millennium Ecosystem Assessment [1]. Policy decisions, implementation processes and operational conservation, management and restoration of GI will thus have positive consequences for human well-being [331]. This includes a wide range of aspects from infectious diseases to impacts on quality of life, stress relief and often with complex functional relationships [330,332]. Although modern medicine is constantly making progress in fighting diseases and ill health, with few exceptions, about 60% of all causes of bad health, disease and premature death cannot be sought in simple relationships, such as exposure to pathogenic bacteria or genetic factors [333,334]. A considerable amount of current health hazards are lifestyle related, such as an increasingly sedentary life, physical inactivity and chronic psychological stress [335]. The ultimate reason behind such issues is a mismatch between the physical and social environment in which the human species evolved, and the dramatically changed environmental conditions in which modern humans live [336]. Recognition of the need to restore GI not only for wild species, but also humans, is necessary to reduce many of such problems [63].

Evidence from lab and field confirms positive health effects of contact with natural environments. Effects have been observed at cellular, individual and population levels [330,337]. Such effects can be utilized in health promotion. They seem most profound on diseases and disease pathways, which are responsible for a large proportion of the burden of poor health in 21st century Europe related to physical inactivity and psychological stress, poor mental health, cardiovascular and respiratory disease. This is significant because of the scale of health problems Europe faces. According to a systematic review of data from community studies in European Union (EU) countries, 27% of the adult population had experienced at least one mental disorder in the past year; an estimated 83 million people are affected. The economic cost of such problems in the EU is conservatively estimated to be 3–4% of the gross national product. The situation with physical disease is as bad. Cardiovascular disease causes over 4.3 million deaths in Europe per year, nearly half of all deaths in Europe (48%) [337]. To handle this requires a holistic approach that includes interventions related to nutrition, lifestyle, living environment as complements to pharmaceutical treatments [338,339]. Indeed, policy documents from governments, health service providers and land managers highlight the potential for natural environments to play a role in reducing the burden of poor health and narrowing health inequality. However, more effective landscape planning, management and access are needed to maximize potential benefits, and this requires a solid understanding of how natural environments, health and well-being are, and could be connected [63,340]. Research show that several different qualities are of significant importance—above all species richness, spatial extent of natural environments and silence [341]. To address this, Baldwin et al. [325] stressed the need to integrate traditional academic disciplines such as systematic conservation planning, and environmental design and planning, into biophilic design.

Integration of Planning Processes

The long history of forestry to supply the forest industry with raw materials in the Nordic countries, which have similar approaches to forest management, is one of the main reasons that a large number of forest species are red-listed [206]. The Swedish model for forest biodiversity conservation is characterized by small protected areas and general considerations in the surrounding landscape [20]. While the latter appears to have positive effects on some bird species [256,342,343], empirical studies indicate that while small protected areas of unproductive forest and retention trees do contribute to the conservation of biodiversity, they are insufficient to satisfy the environmental objective "Living forests" [20,172,201,257].

Currently, there is an increased interest in intensified forest management [9,14,54], cost-effective conservation, and development of attractive landscapes for tourism, recreation and human well-being [63,300]. To design functional GIs for biodiversity, ecosystem services and human health, all these driving forces need to be handled through increased integration of spatial planning processes for management of land and water. Additionally, more diversified suites of forest management systems are discussed [13,86,344,345]. As pointed out by Sandström et al. [300] and Axelsson et al. [344], this requires integrated bottom-up approaches, but also transparent information about the state of landscapes and regions [20,309,346].

There is indeed technical opportunity to develop input to communication, learning and spatial planning based on knowledge about species, habitats and processes by using geographical information systems to analyze data and produce maps [346], system analysis through group modelling [342,347], as well as decision-support systems [348,349]. However, because different sectors generally work in isolation from each other this is not enough. Additionally, improved collaboration among stakeholders to assure acceptable and socially robust solutions is needed. Moreover, responsible businesses and government agencies need to overcome scale mismatches and break down national and regional strategic plans to advise and counsel at tactical landscape and operational planning levels. However, in Sweden no organization has responsibility for spatial or territorial planning across sectors at the level of entire landscapes and regions. While landowners with large contiguous management units indeed have this opportunity, the most common situation is that many landowners and landowner categories are in the same local landscape or region. Three main public sector actors of relevance for GI planning are the Swedish Forest Agency, with a responsibility for forest biodiversity and the environmental objective Living forests, the county administrations, with a responsibility for protected areas, and municipalities. Swedish municipalities have a monopoly in spatial comprehensive planning, while counties and national-level government authorities produce strategic plans and ensure that municipal planning follows applicable national and EU policies [350,351]. There is an ongoing process to expand the responsibility of municipalities to cover all sustainability dimensions [352]. Additionally, knowledge-based collaborative learning forums or platforms for government functions, landowners, and other stakeholders representing different sectors and different societal levels can be encouraged [353]. The proposed way to address this issue is often called "landscape approach" [354–356]. With an international perspective, Biosphere Reserve [357,358] and Model Forest [353,359,360] are examples of such fora or platform concepts.

4.2. Challenges

4.2.1. Adding Conservation Efforts and Risks for Creative Book-Keeping

As a base for discussing what a certain percentage of protected areas and green tree retention actually means for biodiversity conservation, Shaffer and Stein [361] and Tear et al. [311] used the terms representation, redundancy and resilience. Representation means capturing all ecological elements or target of interest (e.g., a population, species, biotope, landscape type or ecoregion) [362]. Redundancy (i.e., to protect more than is required for a specific ambition level) is necessary to reduce the risk of losing representative examples of these targets [363]. Resilience, often referred to as the "quality" or "health" of an ecological element, is the ability of the element to persist through severe hardships [364].

The investment in biodiversity conservation by reaching the short-term interim target regarding protected areas formulated in 1997 [73,74] in terms of creating additionally 900,000 ha of formally protected areas and voluntary set-aside by the end of 2010 was reasonably successful from a numerical point of view [41]. However, spatial analyses presented in the same study indicated that requirements in terms of representation, redundancy and resilience were not satisfied. Additionally, the role of varying levels of green tree retention in final felling areas made in the matrix surrounding protected areas [96], intended to provide habitat and improve the permeability of the matrix surrounding protected areas, needs to be understood. This is also the case for areas not managed for wood production, such as forest and wooded land with low biological productivity (Swe: impediment) [20].

Regarding long-term targets for protected areas, a wide range of percentages are currently circulating among different stakeholders regarding the area proportion of forestland in Sweden that is and should be devoted to conservation of biodiversity, including species, habitats and processes. For example, Anon. [365] argued that a quarter of Sweden's forests are not used for wood and biomass production and that "Sweden satisfies the Nagoya agreement". This quote refers to CBD's strategic plan for biodiversity 2011–2020 and the Aichi target number 11, which states that 17% of lands and waters shall be protected [149]. The Aichi target of 17% protected areas refers to the result of negotiations at the CBD COP meeting held in Nagoya 2010 about whether 15–25% should be protected (P-O. Ståhl, pers. comm.). Additionally, target 11 states that areas "*are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape*" [366]. The Aichi targets consider both pattern and process, and address both quantitative and qualitative criteria [234]. More recently, the EU Forest strategy [154] has nominated a 10% strict protection target and an additional 20% protection target with management, thus totaling a 30% protection target. In 2022, the Kunming-Montreal Global Biodiversity Framework [209] replaced the Aichi targets, and set the same level of ambition, namely to "*ensure at least 30 per cent of areas of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration*" (Target 2) to "*ensure at least 30 per cent of terrestrial, inland water, and of coastal and marine areas are effectively conserved and managed*" (Target 2).

However, there is a very large difference in the proportion of forests not used for wood production between the generally unproductive subalpine mountain forest with a total of 83% of formally protected, voluntary set-aside, non-productive forests and retention set-asides, respectively, and 17–20% in the four other ecoregions. However, we stress that those numbers do not include assessments of the extent to which these areas form functional GIs [20]. For example, formally protected forest areas are generally neither representative [146] nor with sufficient functional connectivity [41,98,257]. Additionally, voluntarily set-aside forests are subject to higher losses due to lower levels of spatial planning [41,346] and do not always host species dependent on natural forest components (compare [172] and [367]). Finally, non-productive forests host only 2% of the red-listed species [368–370]. Additionally, the role of edge effects [257] and degradation of natural disturbances, and cumulative effects, needs to be understood and taken into account. These limitations of conservation instruments other than formally protected areas are illustrated by Kyaschenko et al. [201]. While slight increases in structural components indicating habitat quality were observed, this has not been reflected in documented improvements for red-listed forest species because increases in the availability of forest structural components are simply insufficient.

This clearly suggests that functionality for biodiversity conservation of the ca. 25% forests and woodlands not managed for wood and biomass production is severely over-estimated. Considering estimates for efficiency rates for the four categories of forest not managed for wood and biomass production, respectively, then the effective area should be considerably lower (11% for the whole Sweden, 47% in the mountain forest region and 5–6% in the four ecoregions mainly used for wood production; see Figure 6). While this argumentation merely points at the need for assessing the consequences on the ground for biodiversity conservation, the estimates show that with 7.5% formally protected area, Sweden does not reach international agreed conservation targets. Additionally, if the different ecoregions are assessed separately, then 93% of Sweden forming the productive forests reaches up to only 2–3% units of formal protection secured in the long term (Figure 6).

Additionally, considering the managed forest landscape it is fair to include areas with low productivity, and retention forestry. These methods can potentially be viewed as tools to both create habitat and to make the matrix around formally protected areas more permeable for dispersal of individuals of different species. The coarse estimate of total functionality of (1) formally protected areas, (2) voluntary set-asides, (3) areas not used for forestry and (4) retention forestry can then be viewed as estimates of the sum of Aichi targets 11 and 7. However, even then Sweden does not reach agreed targets.

Moreover, at the same time as there are positive effects of operational management supporting biodiversity conservation at multiple spatial scales, there are also negative effects in terms of continued gradual loss and transformation of forest stands never subject to clear-felling [20,47]. These host compositional, structural and functional aspects that are more favorable to biodiversity conservation than stands that originated from clear-felling and intensive forest management for wood and biomass [140,196,371]. Additionally, the effects of intensified forestry to improve wood and bioenergy yields need to be understood [96]. Taken together, this argumentation about set-asides of stands and landscapes for conservation, and matrix management by retention forestry, emphasizes the need to understand the cumulative effect on biodiversity of two groups of drivers. These are establishing protected forests areas with or without conservation management, active habitat restoration and what can be achieved by increased nature conservation in the managed matrix on the one hand, and what happens to the last remnants of high conservation value forests on the other [54,372]. This is a major unresolved challenge.

Summarizing, while forest biodiversity policies are evidence-based in Sweden, and relevant hierarchical planning processes have been developed for formal area protection, there are gaps when it comes to landscape planning processes that integrate formally protected and voluntarily set-aside areas across forest ownership categories, and with too limited funding to secure high conservation forest remnants. Sweden is thus far from a functional landscape planning process. Researchers and engineers can develop technical solutions such as systems for analysis and reports to support decision-making. Often, however, these are not socially robust [373], which means that they are not accepted, understood or practically useful for the involved parties.

4.2.2. The Perspective of Industry or Individual Forest Owners?

In Sweden, individual forest owners as a group have freedom and great opportunities to choose forest management system. One can focus on applying cropping systems to produce industrial raw materials, or apply a diversity of forest management practices that focus on delivering many different ecosystem services. Appreciation of a wider portfolio of ecosystem services and nature's benefits may lead to management aimed at mixed coniferous and deciduous forests, longer harvesting rotations and voluntary set-asides. The increased focus on adaptation to climate change has indeed increased the application of such adaptations [374,375]. Employing alternatives to even-aged rotation forestry that rely on natural regeneration reduce forest owner's costs, which in turn yield increased net monetary income because expenses decrease.

For individual forest owners, income from forestry motivates <10% of them to own forest land [376]. Instead, increasing real-estate values as well as social, cultural and ecological values are important [9,377]. At the same time, Hafmar [378] showed that a large proportion (53% in Jämtland county) of individual private forest owners are interested in using alternatives to the even-aged clear-felling system. In contrast to this, the industry's timber buyer market stresses the benefits of the clear-felling system with arguments that it maximizes the timber flow to the industry [379], which erodes the trust of forest owners [380]. The low application (ca. 3% in 2021) of "clear-cut free" forestry in Sweden has explanations that go far beyond the lack of knowledge and ecological limitations. Culture, forestry education, industrial investments, coalition networks and timber markets are important factors [9,381]. This points to a need for more comprehensive advice to forest owners on how different value chains can be developed most effectively [379]. However, an increased diversity of forestry methods means that smaller volumes of industrial raw material can be delivered.

4.2.3. Knowledge Production and Learning for Biodiversity Conservation

This review argues that to assure the functionality of GIs for biodiversity conservation and resilient ecosystems, as pronounced in policies at multiple levels, it is necessary to develop multi-sectoral and multi-level social learning processes [382] and knowledge-based collaboration [166,383]. A well-developed collaboration can be referred to as a partnership [384]. All involved stakeholders need to share the responsibility and feel that they are important parts of the problem-solving process. Obviously, no single stakeholder has all the knowledge, skills and resources needed to solve the challenges of biodiversity conservation in Sweden. The alternative is to learn stepwise through ongoing evaluations [385] and by active adaptive management [386,387]. Continuous evaluations are needed to improve policy processes, the outputs and the consequences on the ground [53].

At the same time, there is a need to understand the different levels of ambitions for ecological sustainability objectives as expressed in policies, and evidence-based knowledge about what this requires in the terms of composition, structure and function of ecosystems. Additionally, there is a need to create widespread awareness among stakeholders and the public about the contribution of different efforts in terms of conservation, management and restoration of species, habitats and ecosystem processes at multiple spatial scales. This involves social learning, i.e., how local actors learn about their place and the state and development trends of biodiversity with the aim to create an interest and to actively become a part of the development and to steer it [388,389]. This is in line with the World Forestry Congress' [390] recommendation that environmental monitoring and assessment should include stakeholders to improve their understanding, learning and awareness.

This necessary focus on both social and ecological systems, and their interactions, contrasts in many respects with current management and governance structures, which focus on social or ecological systems in isolation from each other. A transition away from this requires the development of neutral fora and platforms for partnership development, collaboration, and informed learning about biodiversity in combination with the use of decision-support systems, e.g., [300], and appropriate policy instruments. The development of multi-sectoral learning processes may benefit also other sustainability dimensions than the ecological. We conclude that there is an urgent need to (1) increase collaboration among academic and non-academic stakeholders to facilitate learning, collaboration and sharing of knowledge and experience, e.g., [383], and (2) develop evidence-based knowledge, e.g., [178,189,391] and approaches for integrated spatial planning of GI at scales from local to trans-national, which are adapted to local and regional contexts.

Ultimately, the increased range of desired goods, services and values from landscapes requires transformation of the Swedish forestry model characterized by general considerations, e.g., [9,278] into a zoning approach [68,392], such as TRIAD including conservation, multiple-use and production [267,393]. However, depending on landowners' preferences and available policy instruments, the opportunities for this vary considerably among local landscapes in different parts of Sweden [394]. The implementation of active adaptive management is challenged by the fragmented pattern of land ownership, limited collaboration among different forest and conservation planners [41], and the traditional sectoral management of natural resources and territorial development. This has been considered one of the reasons why the implementation of a participatory process in environmental governance is still rather limited in Sweden [264]. However, despite the inherent governance and management complexity of evidence-based participatory processes, they are a prerequisite for the sustainable development process, and ecological sustainability in the long term [320,382,395]. Informed stakeholder participation has the potential to create socially robust changes in attitudes, values and behavior because the process operates at a level where more basic human social and behavioral aspects can be reached and influenced [396]. In particular, there is a need to develop trust, equity and empowerment among involved stakeholders [397], with the aim to create space for experiential and adaptive learning where different stakeholders' perspectives and experiences meet, and new ideas develop to allow innovations, solutions or new ways to handle complex natural resource management situations [382]. Nowotny [398] called this "the hybrid space". This approach will in turn increase compliance and legitimacy [399,400]. Participation in collaborative learning processes with the aim to establish functional GI is a challenge since some forest sector stakeholders may see this as a threat to industrial forestry and employment in the forest sector [401]. However, the same study concluded that so far conservation has had only a limited impact on employment in the forest sector when compared to the impacts of internal processes of rationalization and mechanization. This suggests that funding for the protection and management of protected areas needs to be widened to also support concepts and initiatives aiming at cross-sectoral multi-level place-based evidence-based collaboration with the aim to create and maintain functional habitat structures in the landscape. Biosphere reserve [357,402], Model Forest [360] and Long-Term Socio-Ecological Research (LTSER) [403,404] are appropriate examples which also allow for exchange of international experiences.

Research that supports solutions to these challenges must integrate human and natural sciences, and academic and non-academic actors, e.g., [387,395,405]. Place and area-based production of new knowledge and ongoing evaluations of policy processes, outputs and consequences [53,385], and collaborative learning processes [382,406] are two important tools to carry out integrative problem-based research [405]. Thus, scholars and practitioners agree about the need to move away from the paradigm of "best-practices to be taught" based on disciplinary research, to transdisciplinary knowledge production, which produces knowledge that is socially robust and useful on the ground [385,407]. The importance of understanding ecological, societal and behavioral processes in the governance and management of GI clearly emphasizes the need for transdisciplinary knowledge production [395,407,408].

Eight actions requested in the short term by Skogsstyrelsen [43] to improve the implementation of the Swedish Environmental Objectives are:

- Intensify the development of digital high-quality geographical data about high natural and cultural forest values.
- The Government ensures that there are sufficient financial means to compensate landowners for the creation of formal forest protection, and to provide forest management recommendations.
- Clarify and elucidate today's contradictory political signals about how forests with high natural values should be managed; for example, is final felling of high conservation value forests allowed?
- The government ensures increased resources for relevant authorities to carry out more supervisory activities with the aim of achieving better legal compliance.

- The government develops a portfolio of measures to develop and promote clearcut-free forest management methods.
- The Forest Agency and the Environmental Protection Agency to propose financial instruments and measures aimed at making visible and incorporating conservation forests and forests with high natural values into the market economy in the same way as forests aimed at wood production.
- Specify how Sweden is to achieve the national environmental quality goals as well as international commitments for biological diversity.
- Systematically monitor biological diversity in entire forest landscapes.

Efforts to cope with climate and forest landscape change must include and integrate both ecological and social systems at multiple spatial scales, i.e., what geographers call landscapes. A development from "Business-As-Usual" forestry focusing on wood production, to proactively plan use and conservation and coping with climate change and climate adaptation, is complex, e.g., [234,374,375,409]. This requires collaboration between different stakeholders and learning based on evidence and systems analysis [9]. The concept of landscape approach has therefore been developed as a method; see [410]. Systems analysis is one such way to achieve this, e.g., [310,342,347]. A robust model for this approach is presented in Table 7.

Table 7. Overview of the need for development towards system analysis [347] and landscape approach [354,356] for climate change and climate adaptation that includes entire landscapes as linked ecological and social systems.

Aspects of a Landscape		At Present	In the Short Term (Decades)	In the Long Term (Centuries)
Ecological system	Forest	Even-aged clear-felling system dominates, 50–70 year rotations, monocultures	Apply forest management systems that store more carbon, longer rotations, more deciduous trees	Multiple methods, "triad" approach through zoning of functions, resilient forest ecosystems
	Farmland	Focus on high production of few crops	Increase the use of permacultures, agroforestry and grasslands	Focus on maintaining and improving soils
	Wetland	Landscapes with many ditches have reduced the capacity of retaining and storing water	Removing ditches, re-wetting to improve carbon storage; effects on biodiversity and trends for greenhouse gases	Re-create lost wetlands that can retain and store water
Social system	Ideology	View landscapes as predictable cropping systems	Transformation to a focus on handling uncertainties and risks	Ethics and moral focusing on the future, precautionary principle, reduced consumption
	Scales for planning and management	Forest stands, fields, individual landowners; fragmentation and polarization of actors and stakeholders	Improve collaborative learning with focus on functional habitat networks and ecological functions	Management for multiple ecosystem services in entire landscapes
	Governance	One dominating sector for forestry and agriculture, respectively; sectors as silos	A diversity of value chains based on both material and immaterial values; risk analyses	Integrated governance and planning of landscapes and regions, trade-offs among ecosystem services

4.2.4. Wicked Problems, Disciplinary Silos and Knowledge Resistance

Across multiple natural resource sectors, increased demands of goods, services and values on the one hand, and limited supplies of those on the other, have led to conflicts and controversies among actors and stakeholders. Salmon recovery, fracking and forestry are three examples. Increasingly, these can be characterized as wicked problems [411]. According to Rittel and Webber [412], such problems share three key characteristics by being unstructured, crosscutting and relentless. Unstructured refers to the complexity and uncertainty, and little consensus on neither problems nor solutions. Crosscutting refers to a diversity of problems that cut across sectors and levels of governance. Relentless refers to solutions that are unlikely and affect other sectors as well. Current politics around forests and their biodiversity, and climate, in Sweden are a good example [413,414].

The emergence of a fourth forest policy cycle (Table 6) highlights the contrast between proactive EU and international regulations and policy to cope with biodiversity conservation, climate change and consequences of war in Europe on the one hand, and narrow national politics advocated by the traditional forest industry sector ignoring evidence-based knowledge about biodiversity on the other. The recent debate about the role of forests and forestry to cope with climate change, and of protected areas for conservation and restoration of biodiversity is highlighted by recent communications to the European Commission. A "Scientist letter sent to European Commission, regarding the need for climate smart forest management" with >500 signatures [415] argued for less forest conservation and more wood production. In response, a scientific group, also with >500 representatives, responded with a letter to the European Commission on the need to reduce forest logging for the sake of mitigating climate change and safeguarding biodiversity [416]. This underlines the need for defining the system borders for knowledge-based deliberations (Table 7), as well as deep levers that can resolve wicked problems [9,14]. Unfortunately, however, while Sweden has a long tradition of stakeholder dialog at different levels of governance, we argue that informed collaborative dialog based on evidence-based knowledge about states and trends of different dimensions of sustainable forest management is limited. Such collaboration cannot be restricted to the narrow "forest sector", but should secure cross-cutting participation of actors and stakeholders engaged also in other value chains.

4.3. Solutions—Different Philosophies for Forest Biodiversity Conservation

4.3.1. Integration—Segregation—Triad

In Europe, there are increasing expectations that forests and forest landscapes should be multifunctional and provide many different ecosystem services. However, to achieve desirable levels of the various expectations is scale-dependent. To avoid trade-offs at small spatial extents (individual forest stands), one can manage conflicting goals on larger spatial extents (forest management unit or estate, and the entire landscape) by deliberately doing different things in different areas. A long series of articles discuss this for both forestry and agriculture [20,417–420], often based on three variants [421,422] (Figure 8).

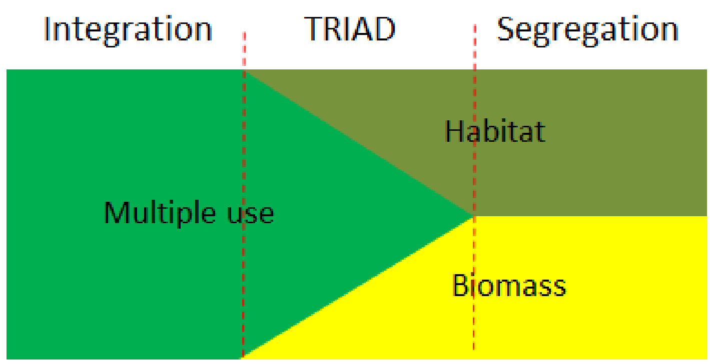

Figure 8. Illustration of three principles proposed to support the development of multifunctional landscapes (after [174,422]).

Integration ("Land Sharing")

Conservation considerations for various forestry measures during a rotation period is an attempt to integrate species conservation and timber production [96,423–425] (Figure 8). This is considered particularly important in forest landscapes with a large proportion of privately owned forests, which is the case for many parts of Europe [421,426]. If the amount of formally protected and voluntarily set-aside areas is not sufficient, and deficits in forests' structural diversity are found in the managed landscape, then nature restoration is needed [427]. Two crucial questions are how much of different habitat structures are conserved at different scales, and for how long they survive over time [428]. Current recommendations to save 5 to 10 trees per ha at final felling [424] is below the level based on evidence-based knowledge [196,267]. To maintain 90% of the unique species richness in a naturally disturbed area, 75% of its surface should be left unharvested [425]. This illustrates that the target of 5–10 saved trees (with 500–700 stems/ha this corresponds to 1–2%) mentioned above is very low. Threshold values for dead wood for intact diversity of different taxa related to dead wood vary from 20–30 m^3/ha in boreal forests to 45–50 m^3/ha in temperate forests [425]. The current amount of dead wood in Sweden averages about 8 m^3/ha, but does not include the diversity of decomposition stages [201,429]. For Slovenia, Nagel et al. [430] concluded that integrated management practiced on a large scale is insufficient to maintain viable populations of species dependent on naturally dynamic and old-growth forests. The same conclusion has been found in Finland [431,432] and Sweden [433]. Kuuluvainen et al. [268] expressed this kind of mismatch as "*The development of retention practices in Finland indicates that the aim has not been to use ecological understanding to attain specific ecological sustainability goals, but rather to define the lowest level of retention that still allows access to the market*".

Segregation ("Land Sparing")

This term refers to a spatial separation of high and efficient production of industrial raw materials on the one hand [337], and formally protected and voluntarily set-aside areas as components of GIs on the other (Figure 8). This requires forest management systems that achieve a regional balance between different goals. In Sweden, this has so far been solved by forests with high natural values being bought with state funds, or set aside voluntarily. Angelstam et al. [20] showed, however, that the extent of habitat networks and the functionality of representative GIs do not reach the conservation targets formulated in Swedish [45] and international policy [149]. Different species have different requirements. Those that disappear at too low levels of structures such as dead wood and old growth forest, or that need large undisturbed areas, are heavily dependent on segregative methods, but other less demanding species can be conserved through integration [419]. Combining both approaches is therefore necessary [430].

TRIAD

Combining several different management methods by zoning in landscapes is also called TRIAD, and has long been proposed as a system for sustainable forest landscape management [411,420,434]. According to this concept, protected areas and intensive forestry systems make up part of the landscape, while the rest is occupied by integrative, close-to-nature or ecological forest management systems (Figure 8). The latter forms a matrix around protected areas that can provide linkages among patches of habitat for forest species, and as a buffer to intensively managed forest stands. The Swedish state forest company Sveaskog's division of forest stands with different objectives into Ekoparks and other landscapes with an increasing focus on production, is an example [99,246]. Within complex mosaics of forest ownership polygons, however, this can be difficult. Nevertheless, Pohjanmies et al. [435] showed that planning over small forest areas (200 ha) can contribute effectively to trade-offs among different ecosystem services. Thus, landscape planning can be feasible even in small-scale forestry if it is combined with learning [377] and tools for financial compensation [436], which of course must be adapted to the interests and abilities of different forest owners.

4.3.2. Adding Efforts of Forest Owner Categories

After a long history of providing rural livelihoods by maintaining locally multifunctional landscapes in Sweden, when most people lived in the countryside (Phase 1.0 in Table 6), forestry became focused on producing industrial raw materials (Phase 2.0 in Table 6). Currently, however, after Phase 3.0 dealt with in this study, in a new appearing Phase 4.0 forest policy cycle encompassing biodiversity conservation, effects of climate change and demands of multifunctional landscapes, are emerging [9,437]; see Table 6.

Sweden, like the rest of Europe, has many different forest owner categories. These have different desires and opportunities to produce different portfolios of ecosystem services, and represent different driving forces for and against cooperation in and about landscapes [438]. With a landscape or regional perspective, consequences on the ground of applying policy instruments should, we argue, be seen as joint efforts based on different forest owners' own abilities and interests. A combination of several different forest management methods is an effective way to support biodiversity conservation, and a development towards resilient and multifunctional forest landscapes [439,440]. To illustrate this, the values that forests provide can be simplified into three different themes (i.e., biomass in various forms, multifunctionality, and habitat for species), and forest ownership into three groups (i.e., private industry, individual, and finally state and other public owners). This is visualized in Figure 9.

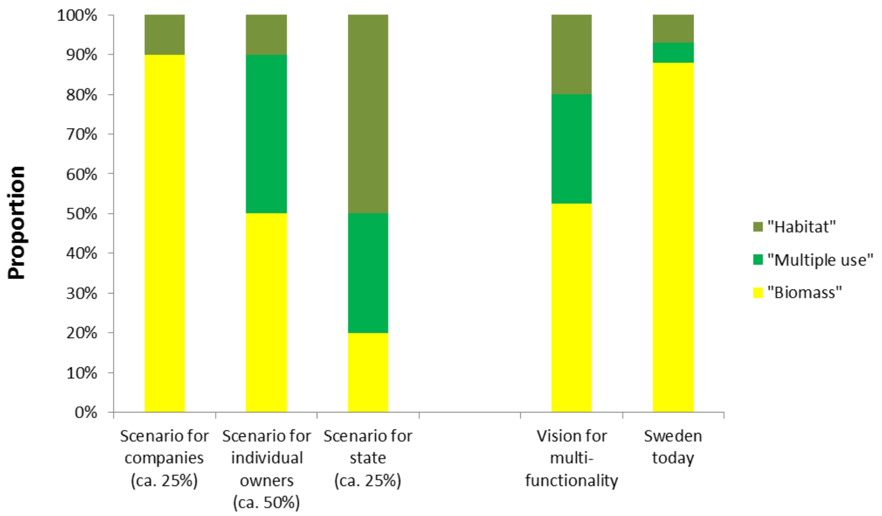

Figure 9. Illustration highlighting that different forest owner categories have different profiles in terms of focus on biomass, multiple use, and habitat, the consequences of which should be assessed holistically at the scale of landscapes and regions. The approximate percentages for the three types of forest ownership in Sweden are shown in brackets at the bottom of the illustration. By adding the category "habitat" and a part of "multiple use", the policy target of 10 + 20% of land aimed at strict area protection and nature restoration [153] could be satisfied. This target level is evidence-based as it satisfies the rule-of-thumb of "a third of third", meaning that a third of a landscape or region should focus on conservation, and a third of that would be protected areas [40]. However, today this target is not satisfied in Sweden [9].

Biomass is in demand in a wide range of different forms, and increasingly in an imagined future bioeconomy. In Sweden, about 97% of the available growth of wood is harvested [20,441], and increase in monetary value takes place in various types of industry focusing on export. Increased fellings therefore requires faster growth, or reduced efforts toward conservation and nature restoration. Shorter rotation times after harvest can contribute to reduced risks of storm damage [442] and forests with multiple tree species deliver more of more ecosystem services [443–445]. Forestry practices that lead to a greater proportion of high-quality timber with a higher price, the opportunity to store more carbon [409] and in the future receiving payment for this [446], and the creation of a higher property value, are therefore favorable. Local value-added products based on several different forest values can provide income and contribute to the local economy and social capital [47]. Other currencies for valuation than monetary are also needed. Multifunctional forests are represented by those found in and around urban areas, and are essential for people's well-being and health [447,448]. Additionally, forest companies today have good income from wind farms, land exploitation in urban areas and leases for hunting. This means a much wider use of the forests and several new value chains [47]. Habitat for species includes many different types of forest and woodland habitats. However, forests where the focus is on efficient timber production have difficulty delivering quality habitats, unless voluntarily set-aside old-growth forests, nature reserves, and forests with conservation management are available. Traditionally managed cultural landscapes with-wooded grasslands have been severely reduced, and it is crucial to maintain existing remnants [174,256].

Private forest industry companies focus on effective production of industrial raw materials based on a culture where forestry is seen as a cropping system [9,381]. Today, basic nature considerations are applied, but efforts aimed at functional GIs, ecological integrity and resilience are insufficient [449,450]. In contrast, individual forest owners are a heterogeneous group, which with a broader profile of advisory services than the one offered today, could further increase the breadth of ecosystem services delivered. This group also has a central role for biodiversity linked to traditional cultural landscape trees and wooded grasslands, which host much of the forest biodiversity in southern Sweden. The state and other public owners, in various forms, own most of the reported remaining natural and old-growth forests. Within the EU, Sweden, Bulgaria, Finland and Romania are the countries with the largest areas of high-conservation forests [451].

We argue in favor of encouraging that the portfolios of benefits (biomass, multiple use and habitat) should be differentiated among different forest owner categories (e.g., industry, individuals, state) (Figure 9). Finally, we discuss the opportunities for land sharing, land sparing and TRIAD forestry at the landscape and regional level to satisfy this diversified approach.

The sole use of land sharing is insufficient to conserve biodiversity. Tree retention [452] and small patches set aside within production forests do contribute to biodiversity conservation [453]. However, the retention approach cannot substitute for larger protected areas [201,308]. This is contrary to hopes of achieving higher levels of voluntary conservation ambition in earlier estimates of protected area needs [208,454].

Multiple use forest management based on a diversity of approaches is becoming of increasing interest among individual forest owners, especially because only about 20% of Swedish forest owners declare substantial income from forestry [455]. Instead, real-estate values, the feeling of owning forests, hunting and recreation are motivations for owning forest, e.g., [9,377].

The triad approach appears as the most effective in supporting multifunctional forest landscapes. Reviewing publications from Fennoscandia and European Russia, Savilaakso et al. [308] showed that compared to the current shorter (60 to 80 years) rotations of even-aged forest management systems, uneven-aged and mature even-aged forests (>80 years old) are important to maintain biodiversity in boreal forests. Importantly, their results also show that set-aside areas of natural forest remnants are needed to ensure conservation of forest dependent species. They concluded, as we do, that biodiversity conservation is best achieved by ensuring a mosaic of different forest management approaches within landscapes.

5. Conclusions

Developing planning and forest management practices that can deliver and maintain multifunctional forest landscapes, and adapting them to local and regional contexts, is complex and complicated. Simplistic statements about the areas or proportions of a certain forest type that can be harvested in time and space, protected or restored, or which forestry method is "best", are insufficient. Instead, several complementary strategies and measures need to be combined with a landscape perspective that involves both social and ecological systems at multiple spatial scales and levels of governance [71,372,456]:

(1) Create and maintain fora and platforms able to adapt planning and forest management to the desired ecosystem services and benefits of nature, and to local and regional conditions [457,458].
(2) Maintain Sweden's, and thus Europe's, last intact forest landscapes [47,68].
(3) Aim at maintaining representative functional habitat networks as GI by setting aside sufficient amounts of areas with sufficient quality, size and connectivity [459,460].
(4) If necessary, also restore and re-create habitat structures at different spatial scales, and regulate processes such as grazing and browsing pressure [461], allow natural disturbances [86], and regulate predation on ground-nesting birds and large herbivores [15,342].
(5) Support spatial planning and monitoring; combine multiple data sources to describe and measure natural forest and cultural woodland values. Note that forests that are less valuable from a wood production point of view due to low timber volumes ("green lies") can indeed have a high degree of naturalness [462], and deliver many non-wood benefits [417,463].
(6) Cope with wicked goal conflicts. For example, climate mitigation solutions that rely on forest bioenergy can be in conflict with carbon sequestration and storage in forests, and with climate adaption and the conservation of biological diversity [464]. Actions to manage climate change and conserve biodiversity must be integrated [465].
(7) Although evidence-based dialogue processes for learning can be used to evaluate outcomes in real life, the decisions made depend on the worldviews, cultures, professional identities and power of different actors and stakeholders, as well as political and legal realities [255].
(8) Encourage informed dialogues; use evidence-based qualitative and quantitative goals at multiple levels to support learning about the maintenance, management and restoration of multiple ecosystem services [20,149].
(9) View forests as complex adaptive systems [456], strive to maintain variety at all scales and at different levels, and accept uncertainties and unpredictable events in both ecological and social systems [301,466].
(10) Altogether, this places great demands on transforming forestry to match the objectives of different forest ownership categories, and forestry training so that forest management methods can contribute to a diversity of ecosystem services [14,154,467].

Author Contributions: Conceptualization, P.A., T.B. and M.M.; methodology, P.A.; writing—original draft preparation, P.A., T.B. and M.M.; writing—review and editing, P.A., T.B. and M.M.; visualization, P.A. and M.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data are included in the quoted references.

Acknowledgments: Critical and constructive comments from a wide range of colleagues and practitioners have stimulated us to carry out this comprehensive interdisciplinary study. In particular, we thank Robert Axelsson, Hanna Ekström, Bengt Gunnar Jonsson, Lars-Erik Liljelund, Helga Puelzl, Erik Sollander, Jan Terstad and Ida Wallin, as well as three anonymous reviewers. As authors, we take full responsibility for misinterpretations and errors.

Conflicts of Interest: The authors declare no conflict interest.

References

1. Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Synthesis*; Island Press: Washington, DC, USA, 2005.
2. Kumar, P. *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*; UNEP/Earthprint: London, UK, 2010.
3. IPBES. *Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services*; IPBES: Bonn, Germany, 2019.
4. IPCC. *Synthesis Report of the IPCC Sixth Assessment Report (AR6)*; Longer Report IPCC: Geneva, Switzerland, 2023; p. 85.
5. Klintman, M. *How Avoid Insight from Others*; Manchester University Press: Manchester, UK, 2019; p. 256.
6. Snyder, S. *Asylum-Seeking, Migration and Church*; Routledge: London, UK, 2012. [CrossRef]
7. Krastev, I. *Is It Tomorrow Yet?: Paradoxes of the Pandemic*; Penguin: London, UK, 2020.
8. Baker, S. *Sustainable Development*; Routledge: London, UK, 2006.
9. Angelstam, P.; Asplund, B.; Bastian, O.; Engelmark, O.; Fedoriak, M.; Grunewald, K.; Ibisch, P.L.; Lindvall, P.; Manton, M.; Nilsson, M.; et al. Tradition as asset or burden for transitions from forests as cropping systems to multifunctional forest landscapes: Sweden as a case study. *For. Ecol. Manag.* **2022**, *505*, 119895. [CrossRef]
10. Hagner, S. *Skog i Förändring—Vägen Mot ett Rationellt och Hållbart Skogsbruk i Norrland 1940–1990*; Kungliga Skogs och Lantbruksakademien: Stockholm, Sweden, 2005. (In Swedish)
11. Wieslander, G. Skogsbristen i Sverige under 1600- och 1700-talen. *Sver. Skogsvårdsförbunds Tidskr.* **1936**, *34*, 593–633.
12. Niklasson, M.; Granstrom, A. Numbers and sizes of fires: Long-term spatially explicit fire history in a Swedish boreal landscape. *Ecology* **2000**, *81*, 1484–1499. [CrossRef]
13. Axelsson, R.; Angelstam, P.; Svensson, J. Natural forest and cultural woodland with continuous tree cover in Sweden: How much remains and how is it managed? *Scand. J. For. Res.* **2007**, *22*, 545–558. [CrossRef]
14. Felton, A.; Löfroth, T.; Angelstam, P.; Gustafsson, L.; Hjältén, J.; Felton, A.M.; Simonsson, P.; Dahlberg, A.; Lindbladh, M.; Svensson, J.; et al. Keeping pace with forestry: Multi-scale conservation in a changing production forest matrix. *AMBIO* **2020**, *49*, 1050–1064. [CrossRef] [PubMed]
15. Angelstam, P.; Manton, M.; Pedersen, S.; Elbakidze, M. Disrupted trophic interactions affect recruitment of boreal deciduous and coniferous trees in northern Europe. *Ecol. Appl.* **2017**, *27*, 1108–1123. [CrossRef]
16. Pennanen, J. Forest age distribution under mixed-severity fire regimes-a simulation-based analysis for middle boreal Fennoscandia. *Silva Fenn.* **2002**, *36*, 213–231. [CrossRef]
17. Burnett, C.; Fall, A.; Tomppo, E.; Kalliola, R. Monitoring Current Status of and Trends in Boreal Forest Land Use in Russian Karelia. *Conserv. Ecol.* **2003**, *7*, 8. [CrossRef]
18. Roberge, J.-M.; Angelstam, P. Indicator species among resident forest birds—A cross-regional evaluation in northern Europe. *Biol. Conserv.* **2006**, *130*, 134–147. [CrossRef]
19. Hottola, J.; Ovaskainen, O.; Hanski, I. A unified measure of the number, volume and diversity of dead trees and the response of fungal communities. *J. Ecol.* **2009**, *97*, 1320–1328. [CrossRef]
20. Angelstam, P.; Manton, M.; Green, M.; Jonsson, B.-G.; Mikusiński, G.; Svensson, J.; Maria Sabatini, F. Sweden does not meet agreed national and international forest biodiversity targets: A call for adaptive landscape planning. *Landsc. Urban Plan.* **2020**, *202*, 103838. [CrossRef]
21. Tzoulas, K.; Korpela, K.; Venn, S.; Yli-Pelkonen, V.; Kaźmierczak, A.; Niemela, J.; James, P. Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landsc. Urban Plan.* **2007**, *81*, 167–178. [CrossRef]
22. Björk, J.; Albin, M.; Grahn, P.; Jacobsson, H.; Ardö, J.; Wadbro, J.; Östergren, P.-O.; Skärbäck, E. Recreational values of the natural environment in relation to neighbourhood satisfaction, physical activity, obesity and wellbeing. *J. Epidemiol. Community Health* **2008**, *62*, e2. [CrossRef]
23. Wilson, E.O. *Biodiversity*; National Academy of Science Press: Washington, DC, USA, 1988.
24. Säve, P.A. Sista paret ut. *Sven. Jägarförbundets Nya Tidskr.* **1877**, *15*, 70–86. (In Swedish)
25. Wramner, P.; Nygård, O. *Från Naturskydd till Bevarande av Biologisk Mångfald*; COMREC Studies in Environment and Development No. 2: Stockholm, Sweden, 2010.
26. Oldertz, C. Naturskydd och landskapsvård. In *Sveriges Skogar under 100 år. Part II.*; Arpi, G., Ed.; Kungliga Domänstyrelsen: Stockholm, Sweden, 1959; pp. 649–658. (In Swedish)
27. Domänverket. *Naturvård å Statens Skogar*; Domänverket: Stockholm, Sweden, 1951. (In Swedish)
28. Rosén, B. *Naturvård. Skid- och Friluftsfrämjandet*; Landby & Lundgrens Boktryckeri: Malmö, Sweden, 1953. (In Swedish)
29. Jordbruksdepartementet. *Kalhyggen. Ds Jo 1974:2*; Jordbruksdepartementet: Stockholm, Sweden, 1974; p. 250. (In Swedish)

30. Enander, K.-G. Framväxten av en Skoglig Miljöpolitik. In *Särtryck ur Skogssbrukssätt och Skogspolitik 1950–2000*; Rapporter 54; Institutionen för Skogsskötsel: Umeå, Sweden, 2003. (In Swedish)
31. Lloyd, S. *The Last of the Last: The Old-Growth Forests of Boreal Europe*; Taiga Rescue Network: Winnipeg, MB, Canada, 1999.
32. Höjer, O. *Swedish Nature Conservation 100 Years*; Naturvårdverket: Stockholm, Sweden, 2009.
33. Naturvårdsverket. *Urskogar: Inventering av Urskogsartade Områden i Sverige. 1 Allmän del. SNV PM 1507*; Naturvårdsverket, Ed.; Naturvårdsverket: Stockholm, Sweden, 1982. (In Swedish)
34. Regeringens. *Svenska Miljömål. Miljöpolitik för ett Hållbart Sverige: Proposition 1997/98:145*; Riksdagen: Stockholm, Sweden, 1997. (In Swedish)
35. Regeringens. *Svenska Miljömål—Delmål och Åtgärdsstrategier: Proposition 2000/01:130*; Riksdagen: Stockholm, Sweden, 2000.
36. MCPFE. *Resolution of the Ministerial Conference on the Protection of Forests in Europe, 16–17 June 1993*; Ministry of Agriculture and Forestry Finland: Helsinki, Finland, 1993.
37. European Commission. *Green Infrastructure (GI)—Enhancing Europe's Natural Capital. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*; European Commission on the Environment: Brussels, Belgium, 2013.
38. Naturvårdsverket. *Förslag till Plan för att Skapa och Behålla en Grön Infrastruktur. Redovisning av ett Regeringsuppdrag. NV4042-10*; Naturvårdsverket, Ed.; Naturvårdsverket: Stockholm, Sweden, 2011. (In Swedish)
39. Regeringens. *Regeringens Proposition 2008/09:214. Hållbart Skydd av Naturområden*; Riksdagen: Stockholm, Sweden, 2008. (In Swedish)
40. Hanski, I. Habitat Loss, the Dynamics of Biodiversity, and a Perspective on Conservation. *AMBIO* **2011**, *40*, 248–255. [CrossRef]
41. Angelstam, P.; Andersson, K.; Axelsson, R.; Elbakidze, M.; Jonsson, B.G.; Roberge, J.-M. Protecting forest areas for biodiversity in Sweden 1991–2010: Policy implementation process and outcomes on the ground. *Silva Fenn.* **2011**, *45*, 1111–1133. [CrossRef]
42. Angelstam, P.; Jonsson, B.-G.; Törnblom, J.; Andersson, K.; Axelsson, R.; Roberge, J.-M. *Landskapsansats för Bevarande av Skoglig Biologisk Mångfald: En Uppföljning av 1997 års Regionala Bristanalys, och om Behovet av Samverkan Mellan Aktörer*; Rapport 4; Skogsstyrelsen: Stockholm, Sweden, 2010. (In Swedish)
43. Skogsstyrelsen. *Levande Skogar Fördjupad Utvärdering 2023*; Rapport 12; Skogsstyrelsen: Stockholm, Sweden, 2022. (In Swedish)
44. Regeringens. *Om en ny Skogspolitik, Proposition 1992/93:226*; Riksdagen: Stockholm, Sweden, 1992. (In Swedish)
45. Regeringens. *En Svensk Strategi för Biologisk Mångfald och Ekosystemtjänster, Dated 2014-03-13*; Regeringenskansliet: Stockholm, Sweden, 2014; p. 141.
46. Bush, T. Biodiversity and Sectoral Responsibility in the Development of Swedish Forestry Policy, 1988–1993. *Scand. J. Hist.* **2010**, *35*, 471–498. [CrossRef]
47. Jonsson, B.G.; Svensson, J.; Mikusiński, G.; Manton, M.; Angelstam, P. European Union's Last Intact Forest Landscapes are at a Value Chain Crossroad between Multiple Use and Intensified Wood Production. *Forests* **2019**, *10*, 564. [CrossRef]
48. Vucetich, J.A.; Nelson, M.P. Sustainability: Virtuous or Vulgar? *BioScience* **2010**, *60*, 539–544. [CrossRef]
49. Blicharska, M.; Angelstam, P.; Antonson, H.; Elbakidze, M.; Axelsson, R. Road, forestry and regional planners' work for biodiversity conservation and public participation: A case study in Poland's hotspot regions. *J. Environ. Plan. Manag.* **2011**, *54*, 1373–1395. [CrossRef]
50. Eriksson, S.; Hammer, M. The challenge of combining timber production and biodiversity conservation for long-term ecosystem functioning—A case study of Swedish boreal forestry. *For. Ecol. Manag.* **2006**, *237*, 208–217. [CrossRef]
51. Lazdinis, M.; Angelstam, P.; Lazdinis, I. Maintenance of Forest Biodiversity in a Post-Soviet Governance Model: Perceptions by Local Actors in Lithuania. *Environ. Manag.* **2007**, *40*, 20–33. [CrossRef]
52. Sandström, U.G.; Angelstam, P.; Khakee, A. Urban comprehensive planning—Identifying barriers for the maintenance of functional habitat networks. *Landsc. Urban Plan.* **2006**, *75*, 43–57. [CrossRef]
53. Rauschmayer, F.; Berghöfer, A.; Omann, I.; Zikos, D. Examining processes or/and outcomes? Evaluation concepts in European governance of natural resources. *Environ. Policy Gov.* **2009**, *19*, 159–173. [CrossRef]
54. Angelstam, P.; Manton, M. Effects of Forestry Intensification and Conservation on Green Infrastructures: A Spatio-Temporal Evaluation in Sweden. *Land* **2021**, *10*, 531. [CrossRef]
55. Svensson, J.; Bubnicki, J.W.; Jonsson, B.G.; Andersson, J.; Mikusiński, G. Conservation significance of intact forest landscapes in the Scandinavian Mountains Green Belt. *Landsc. Ecol.* **2020**, *35*, 2113–2131. [CrossRef]
56. Svensson, J.; Andersson, J.; Sandström, P.; Mikusiński, G.; Jonsson, B.G. Landscape trajectory of natural boreal forest loss as an impediment to green infrastructure. *Conserv. Biol.* **2019**, *33*, 152–163. [CrossRef]
57. Naturvårdsverket; Statistiska Centralbyrån. *Protected Nature 2017-12-31*; Statistiska Meddelanden MI 41 SM 1801; Naturvårdsverket: Stockholm, Sweden, 2018. (In Swedish)
58. Currie-Alder, B. Unpacking participatory natural resource management: A conceptual framework to distinguish democratic governance from resource capture. *Environments* **2005**, *33*, 1–16.
59. United Nations. *Building Bridges between the State & the People: An Overview of Trends and Developments in Public Administration and Local Governance*; United Nations Development Programmes: London, UK, 2010.
60. Lammerts van Bueren, E.M.; Blom, E.M. *Hierarchical Framework for the Formulation of Sustainable Forest Management Standards*; Tropenbos Foundation Wageningen: Wageningen, The Netherlands, 1997.
61. Angelstam, P.; Andersson, L. Estimates of the needs for forest reserves in Sweden. *Scand. J. For. Res.* **2001**, *16*, 38–51. [CrossRef]

62. Vanha-Majamaa, I.; Jalonen, J. Green Tree Retention in Fennoscandian Forestry. *Scand. J. For. Res.* **2001**, *16*, 79–90. [CrossRef]
63. Elbakidze, M.; Angelstam, P.; Yamelynets, T.; Dawson, L.; Gebrehiwot, M.; Stryamets, N.; Johansson, K.-E.; Garrido, P.; Naumov, V.; Manton, M. A bottom-up approach to map land covers as potential green infrastructure hubs for human well-being in rural settings: A case study from Sweden. *Landsc. Urban Plan.* **2017**, *168*, 72–83. [CrossRef]
64. Howlett, M.; Ramesh, M.; Perl, A. *Studying Public Policy: Policy Cycles and Policy Subsystems*; Oxford University Press: Oxford, UK, 2009; Volume 3.
65. Mayers, J.; Bass, S. *Policy That Works for Forests and People: Real Prospects for Governance and Livelihoods*; Earthscan: London, UK, 2004.
66. Bridgman, P.; Davis, G. What Use is a Policy Cycle? Plenty, if the Aim is Clear. *Aust. J. Public Adm.* **2003**, *62*, 98–102. [CrossRef]
67. Angelstam, P.K.; Bütler, R.; Lazdinis, M.; Mikusiński, G.; Roberge, J.-M. Habitat thresholds for focal species at multiple scales and forest biodiversity conservation; dead wood as an example. *Ann. Zool. Fenn.* **2003**, *40*, 473–482.
68. Svensson, J.; Bubnicki, J.W.; Angelstam, P.; Mikusiński, G.; Jonsson, B.G. Spared, shared and lost—Routes for maintaining the Scandinavian Mountain foothill intact forest landscapes. *Reg. Environ. Chang.* **2022**, *22*, 31. [CrossRef]
69. Svancara, L.K.; Brannon, R., Jr.; Scott, M.; Groves, C.R.; Noss, R.F.; Pressey, R.L. Policy-driven versus evidence-based conservation: A review of political targets and biological needs. *BioScience* **2005**, *55*, 989–995. [CrossRef]
70. Scott, J.; Heglund, P.; Morrison, M.; Haufler, J.; Raphael, M.; Wall, W.; Samson, F. *Predicting Species Occurrences: Issues of Scale and Accuracy*; Island Press: Washington, DC, USA, 2002; p. 840.
71. Hunter, M.L.; Schmiegelow, F. *Wildlife, Forests, and Forestry: Principles of Managing Forests for Biological Diversity*, 2nd ed.; Prentice Hall: New York, NY, USA, 2011; p. 259.
72. Naturvårdsverket. *Skyddad Natur 30 Juni 1991*; Naturvårdsverket, Ed.; Naturvårdsverket: Solna, Sweden, 1992. (In Swedish)
73. SOU. *Skydd av Skogsmark. Behov och Kostnader. Statens Offentliga Utredningar 1997:97*; Huvudbetänkande; Miljövårdsberedningen, Ed.; Miljövårdsberedningen: Stockholm, Sweden, 1997. (In Swedish)
74. SOU. *Skydd av Skogsmark. Behov och Kostnader. Statens Offentliga Utredningar 1997:98*; Bilaga 4; Miljövårdsberedningen, Ed.; Miljövårdsberedningen: Stockholm, Sweden, 1997. (In Swedish)
75. Manton, M.; Angelstam, P.; Mikusiński, G. Modelling habitat suitability for deciduous forest focal species—A sensitivity Analysis using different satellite Land cover data. *Landsc. Ecol.* **2005**, *20*, 827–839. [CrossRef]
76. Angelstam, P.; Roberge, J.M.; Lõhmus, A.; Bergmanis, M.; Brazaitis, G.; Dönz-Breuss, M.; Edenius, L.; Kosinski, Z.; Kurlavicius, P.; Lārmanis, V.; et al. Habitat modelling as a tool for landscape-scale conservation: A review of parameters for focal forest birds. *Ecol. Bull.* **2004**, *51*, 427–453.
77. Lafortezza, R.; Corry, R.; Sanesi, G.; Brown, R. Quantitative approaches to landscape spatial planning: Clues from landscape ecology. *WIT Trans. Ecol. Environ.* **2005**, *84*, 12.
78. Korpilahti, E.; Kuuluvainen, T. Disturbance dynamics in boreal forests: Defining the ecological basis of restoration and management of biodiversity. *Silva Fenn.* **2002**, *36*, 447.
79. Angelstam, P.; Kuuluvainen, T. Boreal forest disturbance regimes, successional dynamics and landscape structures: A European perspective. *Ecol. Bull.* **2004**, *51*, 117–136.
80. Margules, C.R.; Pressey, R.L. Systematic conservation planning. *Nature* **2000**, *405*, 243–253. [CrossRef] [PubMed]
81. Edman, T.; Angelstam, P.; Mikusiński, G.; Roberge, J.-M.; Sikora, A. Spatial planning for biodiversity conservation: Assessment of forest landscapes' conservation value using umbrella species requirements in Poland. *Landsc. Urban Plan.* **2011**, *102*, 16–23. [CrossRef]
82. Lambeck, R.J. Focal Species: A Multi-Species Umbrella for Nature Conservation. *Conserv. Biol.* **1997**, *11*, 849–856. [CrossRef]
83. Roberge, J.-M.; Angelstam, P. Usefulness of the Umbrella Species Concept as a Conservation Tool. *Conserv. Biol.* **2004**, *18*, 76–85. [CrossRef]
84. Store, R.; Jokimäki, J. A GIS-based multi-scale approach to habitat suitability modeling. *Ecol. Model.* **2003**, *169*, 1–15. [CrossRef]
85. Angelstam, P. Maintaining cultural and natural biodiversity in Europe's economic centre and periphery. In *The Conservation of Cultural Landscapes*; Agnoletti, M., Ed.; CABI Publishing: Wallingford, UK, 2006; pp. 125–143.
86. Kuuluvainen, T.; Angelstam, P.; Frelich, L.; Jõgiste, K.; Koivula, M.; Kubota, Y.; Lafleur, B.; MacDonald, E. Natural disturbance-based forest management: Moving beyond retention and continuous-cover forestry. *Front. For. Glob. Chang.* **2021**, *4*, 24. [CrossRef]
87. Muys, B.; Angelstam, P.; Bauhus, J.; Bouriaud, L.; Jactel, H.; Kraigher, H.; Müller, J.; Pettorelli, N.; Pötzelsberger; Primmer, E.; et al. *Forest Biodiversity in Europe. From Science to Policy 13*; European Forest Institute: Joensuu, Finland, 2022; p. 80.
88. Shorohova, E.; Kneeshaw, D.; Kuuluvainen, T.; Gauthier, S. Variability and dynamics of old-growth forests in the circumboreal zone: Implications for conservation, restoration and management. *Silva Fenn.* **2011**, *45*, 785–806. [CrossRef]
89. Kuuluvainen, T.; Aakala, T. Natural forest dynamics in boreal Fennoscandia: A review and classification. *Silva Fenn.* **2011**, *45*, 823–841. [CrossRef]
90. Sjöbeck, M. *Farm Forests, Their Care and Use*; Skånska Folkminnen: Sweden, 1927; pp. 36–62.
91. Ihse, M. Swedish agricultural landscapes—Patterns and changes during the last 50 years, studied by aerial photos. *Landsc. Urban Plan.* **1995**, *31*, 21–37. [CrossRef]
92. Garrido, P.; Elbakidze, M.; Angelstam, P. Stakeholders' perceptions on ecosystem services in Östergötland's (Sweden) threatened oak wood-pasture landscapes. *Landsc. Urban Plan.* **2017**, *158*, 96–104. [CrossRef]

93. Reese, H.; Nilsson, M.; Pahlén, T.G.; Hagner, O.; Joyce, S.; Tingelöf, U.; Egberth, M.; Olsson, H. Countrywide Estimates of Forest Variables Using Satellite Data and Field Data from the National Forest Inventory. *AMBIO J. Hum. Environ.* **2003**, *32*, 542–548. [CrossRef] [PubMed]
94. Engberg, A. Lantmatriet: Sweden, Produktspecifikation av Svenska CORINE Marktäckedata. 2002. Available online: www.lantmateriet.se/upload/filer/kartor/kartor/SCMDspec.pdf (accessed on 17 May 2023).
95. Jonsson, B.; Angelstam, P.; Bubnicki, J.; Mikusinski, G.; Svensson, J. *Bättre Sent än Aldrig—Indikatorer för Skogslandskapets Gröna Infrastruktur*; RAPPORT 7063; Naturvårdsverket: Stockholm, Sweden, 2022. (In Swedish)
96. Gustafsson, L.; Baker, S.C.; Bauhus, J.; Beese, W.J.; Brodie, A.; Kouki, J.; Lindenmayer, D.B.; Lõhmus, A.; Pastur, G.M.; Messier, C.; et al. Retention Forestry to Maintain Multifunctional Forests: A World Perspective. *BioScience* **2012**, *62*, 633–645. [CrossRef]
97. Timonen, J.; Siitonen, J.; Gustafsson, L.; Kotiaho, J.S.; Stokland, J.N.; Sverdrup-Thygeson, A.; Mönkkönen, M. Woodland key habitats in northern Europe: Concepts, inventory and protection. *Scand. J. For. Res.* **2010**, *25*, 309–324. [CrossRef]
98. Elbakidze, M.; Angelstam, P.; Andersson, K.; Nordberg, M.; Pautov, Y. How does forest certification contribute to boreal biodiversity conservation? Standards and outcomes in Sweden and NW Russia. *For. Ecol. Manag.* **2011**, *262*, 1983–1995. [CrossRef]
99. Angelstam, P.; Bergman, P. Assessing actual landscapes for the maintenance of forest biodiversity: A pilot study using forest management data. *Ecol. Bull.* **2004**, *51*, 413–425.
100. Hong, J.-P.; Shim, Y.-J. Development of an Integrated Evaluation Method for National Protected Areas Based on Aichi Biodiversity Target 11. *J. Korea Soc. Environ. Restor. Technol.* **2018**, *21*, 83–94.
101. Lundquist, L. *Implementation Steering. An Actor-Structure Approach*; Studentlitteratur: Lund, NV, USA, 1987.
102. Sabatier, P.A. Top-Down and Bottom-Up Approaches to Implementation Research: A Critical Analysis and Suggested Synthesis. *J. Public Policy* **1986**, *6*, 21–48. [CrossRef]
103. Kvale, S. *InterViews: An Introduction to Qualitative Research Interviewing*; Sage Publications: Thousand Oaks, CA, USA, 1996.
104. Kvale, S.; Brinkman, S. *InterViews: Learning the Craft of Qualitative Research Interviewing*; Sage Publications: Thousand Oaks, CA, USA, 2008.
105. Glasser, B.; Strauss, A. *The Discovery of Grounded Theory: Strategies for Qualitative Research*; Aldine Transaction: New Brunswick, NJ, USA; London, UK, 1967.
106. Alvesson, M.; Sköldberg, K. *Tolkning och Reflektion: Vetenskapsfilosofi och Kvalitativ Metod*; Studentlitteratur: Lund, Sweden, 1994. (In Swedish)
107. Haraldsson, D. *Skydda vår Natur! Svenska Naturskyddsföreningens Framväxt och Tidiga Utveckling*; Bibliotheca Historica Lundensis 63; Lund University Press: Lund, Sweden, 1987. (In Swedish)
108. Jamison, A.; Eyerman, R.; Cramer, J.; Læssøe, J. *The Making of the New Environmental Consciousness: A Comparative Study of the Environmental Movements in Sweden, Denmark, and the Netherlands*; Edinburgh University Press: Edinburgh, Scotland, 1990.
109. Schaar, C. *Naturskyddsbegreppet i Sverige. Ursprung, Historik, och Innebörd*; Universitet, M.V.I.L., Ed.; Lunds Universitet: Lund, Sweden, 1978; Volume 35. (In Swedish)
110. Larsson, E. *Sveriges Natur: Naturskyddsföreningens Årsbok: Årgång 64, Skogsbruk och Naturvård*; Svenska Naturskyddsföreningen: Stockholm, Sweden, 1973. (In Swedish)
111. Statens Naturvårdsverk. *Skogsbruket och Naturvården*; Allmänna Förlaget: Stockholm, Sweden, 1973. (In Swedish)
112. Statens Naturvårdsverk. *1980-Talets Stora Miljöfrågor: Naturvårdsverkets Långsiktsbedömning: Ett Bakgrundsdokument. Meddelande SNV PM 1591*; Naturvårdsverket: Solna, Sweden, 1982. (In Swedish)
113. Statens Naturvårdsverk. *Skogsbruket och Miljön: Handlingsprogram*; Naturvårdsverket: Solna, Sweden, 1983. (In Swedish)
114. Svenska Naturskyddsföreningen. *Levande Skog: Naturvårdens Synpunkter på Skogsbruket*; Svenska Naturskyddsföreningen: Stockholm, Sweden, 1987. (In Swedish)
115. Ekelund, H.; Hamilton, G. *Skogspolitisk Historia. Rapport 2001:8A.*; Skogsstyrelsen: Jönköping, Sweden, 2001. (In Swedish)
116. Regeringens. *Regeringens Proposition 1987/88:85. Miljöpolitiken Inför 1990-Talet*; Riksdagen: Stockholm, Sweden, 1988. (In Swedish)
117. Bennulf, M. *Miljöopinionen i Sverige. Studier i Politik/Studies in Politics No. 30, Statsvetenskapliga Institutionen, Göteborgs Universitet*; Dialogos AB: Lund, Sweden, 1994. (In Swedish)
118. Bennulf, M.; Holmberg, S. The Green Breakthrough in Sweden. *Scand. Political Stud.* **1990**, *13*, 165–184. [CrossRef]
119. SOU. *Översyn av Naturvårdslagen m.m:38*; Naturvårdslagsutredningen, Ed.; Allmänna Förlaget: Stockholm, Sweden, 1990. (In Swedish)
120. Naturvårdsverket. *Biotopskydd. Allmänna Råd 95:4*; Naturvårdsverket: Stockholm, Sweden, 1995. (In Swedish)
121. Ekelund, H. *Skriftlig Dokumentation av Synpunkter Muntligt Framförda vid Sammanträde Angående PM 6 den 4 April 1989/Unpublished Memorandum Dated 10 April 1989*; Skogsstyrelsen: Jönköping, Sweden, 1989.
122. Direktiv. Utvärdering och Översyn av Skogspolitiken: 47. *Published in Attachment 1 to SOU 1992:76; 1990.* Available online: https://lagen.nu/sou/1992:76 (accessed on 17 May 2023).
123. Ericsson, K.-E. Skogspolitiken och de enskilda skogsägarna. In *Skogspolitisk Historia. Rapport 2001:8A.*; Ekelund, H., Hamilton, G., Eds.; Skogsstyrelsen: Jönköping, Sweden, 2001. (In Swedish)
124. Bondesson, L. Skogsstyrelsens utvärdering av skogspolitikens effekter—SUS 2001. In *Skogsstyrelsens Meddelande 2002:1*; Skogsstyrelsen: Jönköping, Sweden, 2002. (In Swedish)

125. Eckerberg, K. *Tillämpning av Skogsvårdslagens 21§—Slutrapport Från Fältundersökning*; Report 65; Institutionen för Skogsekonomi, Sveriges Lantbruksuniversitet: Umeå, Sweden, 1986. (In Swedish)
126. Olsson, R. *Levande Skog—Skogsbruket i Naturvårdsperspektiv*; Venska Naturskyddsföreningen: Stockholm, Sweden, 1985. (In Swedish)
127. Petersson, O. *Swedish Government and Politics. Translation by Frank Perry of Svensk Politik*; CE Fritzes AB: Stockholm, Sweden, 1994.
128. Lindbeck, A.; Molander, P.; Persson, T.; Petersson, O.; Sandmo, A.; Swedenborg, B.; Thygesen, N. *Turning Sweden Around*; The MIT Press: Cambridge, UK, 1994.
129. Direktiv. Tilläggsdirektiv till 1990 års Skogspolitiska Kommitté: 99. *Issued 11-28-1991. Published in Attachment 1 to SOU 1992:76.* 1991. Available online: https://lagen.nu/sou/1992:76 (accessed on 17 May 2023).
130. Zackrisson, O.; Liljelund, L.-E.; Pettersson, B. *Underlag för Specialanalys av Behovet av Nya Skogliga Reservat för att Vidmakthålla den Biologiska Mångfalden*; Unpublished Analysis Dated 20 January 1992; Forestry Policy Review Committee: Stockholm, Sweden, 1992.
131. Bäckström, P.-O. *Angående ett Miljömål för Skogspolitiken*; Unpublished Memorandum: PM 33 dated 7 February 1992; Forestry Policy Review Committee: Stockholm, Sweden, 1992.
132. Bäckström, P.-O. *Ytterligare Synpunkter på Miljömål för Skogspolitiken*; Unpublished Memorandum: Dated 4 May 1992; Forestry Policy Review Committee: Stockholm, Sweden, 1992.
133. Skogsbruket. *Så Kan vi Klara Miljömålet i Skogen—En Avsiktsförklaring*; Unpublished Letter Dated 14 May 1992 Signed by Representatives from Major Swedish Forest Industries; Swedish Forest Industries Federation: Stockholm, Sweden, 1992. (In Swedish)
134. von Sydow, U. *Hur Långt når Frivilligheten när det Gäller att Bevara Skogsekosystemens Mångfald? Unpublished Letter to Forestry Policy Review Committee, Dated 25 May 1992*; Forestry Policy Review Committee: Unbyn, Sweden, 1992.
135. SOU. *Skogspolitiken Inför 2000-Talet. 1990 års Skogspolitiska Kommitté: 76*; Allmänna Förlaget: Stockholm, Sweden, 1992. (In Swedish)
136. Kortelainen, J. Old-growth forests as objects in complex spatialities. *Area* **2010**, *42*, 494–501. [CrossRef]
137. European Commission. *Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora*; Council of the European Communities: Brussels, Belgium, 1992.
138. European Commission. *Directive, 2000/60/EC of the European Parliament and of the Council of 23rd October 2000. Establishing a Framework for Community Action in the Field of Water Policy*; European Commission: Brussels, Belgium, 2000.
139. Auld, G.; Gulbrandsen, L.H.; McDermott, C.L. Certification Schemes and the Impacts on Forests and Forestry. *Annu. Rev. Environ. Resour.* **2008**, *33*, 187–211. [CrossRef]
140. Noss, R.F. Indicators for monitoring biodiversity: A hierarchical approach. *Conserv. Biol.* **1990**, *4*, 355–364. [CrossRef]
141. Regeringens. *En Skogspolitik i Takt Med Tiden, 2007/08:108*; Jordbruksdepartementet: Stockholm, Sweden, 2007.
142. Forest Europe. State of Europe's Forests. In Proceedings of the Ministerial Conference on the Protection of Forests in Europe, Oslo, Norway, 14–16 June 2011; Liaison Unit: Oslo, Norway.
143. European Landscape Convention. *Council of Europe Treaty Series No. 176. European Landscape Convention and Reference Documents*; Council of Europe: Florence, Italy, 2000.
144. European Commission. *Council Directive 79/409/EEC of 2 April 1979 on the Conservation of Wild Birds*; European Centre for Nature Conservation: Brussels, Belgium, 1979.
145. Regeringens. *En God Livsmiljö: Proposition 1990/91:90*; Riksdagen: Stockholm, Sweden, 1990.
146. Nilsson, C.; Götmark, F. Protected Areas in Sweden: Is Natural Variety Adequately Represented? *Conserv. Biol.* **1992**, *6*, 232–242. [CrossRef]
147. Olson, D.M.; Dinerstein, E. The Global 200: A Representation Approach to Conserving the Earth's Most Biologically Valuable Ecoregions. *Conserv. Biol.* **1998**, *12*, 502–515. [CrossRef]
148. SOU. *Skog Utan Gräns? Betänkande Från Gränsskogsutredningen. Statens Offentliga Utredningar 2009:30*; SOU: Stockholm, Sweden, 2009. (In Swedish)
149. Convention on Biological Diversity. *The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets*; Convention on Biological Diversity: Nagoya, Japan, 2010.
150. Regeringens. *En Svensk Strategi för Biologisk Mångfald och Ekosystemtjänster*; Proposition 141; Regeringskansliet: Stockholm, Sweden, 2013.
151. Beery, T.H.; Raymond, C.M.; Kyttä, M.; Olafsson, A.S.; Plieninger, T.; Sandberg, M.; Stenseke, M.; Tengö, M.; Jönsson, K.I. Fostering incidental experiences of nature through green infrastructure planning. *AMBIO* **2017**, *46*, 717–730. [CrossRef] [PubMed]
152. European Commission. The European Green Deal. COM(2019) 640 final. In *Communication from the Commission*; European Commission: Brussels, Belgium, 2019.
153. European Commission. *EU Biodiversity Strategy for 2030: Bringing Nature Back into Our Lives*; European Commission: Brussels, Belgium, 2020.
154. European Commission. New EU Forest Strategy for 2030. In *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*; European Union: Brussels, Belgium, 2021; p. 28.
155. European Commission. *Proposal for a Regulation of the European Parliament and of the Council on Nature Restoration. Brussels, 22.6.2022, COM(2022) 304 Final 2022/0195 (COD)*; European Commission: Brussels, Belgium, 2022.

156. Gärdenfors, U. *Rödlistade Arter i Sverige 2010—The 2010 Red List of Swedish Species*; ArtDatabanken, SLU: Uppsala, Sweden, 2010.
157. Roberge, J.-M.; Mikusiński, G.; Svensson, S. The white-backed woodpecker: Umbrella species for forest conservation planning? *Biodivers. Conserv.* **2008**, *17*, 2479–2494. [CrossRef]
158. Roberge, J.-M.; Angelstam, P. Selecting species to be used as tools in the development of forest conservation targets. In *Setting Conservation Targets for Managed Forest Landscapes*; Villard, M.-A., Jonsson, B.-G., Eds.; Cambridge University Press: Cambridge, UK, 2009; pp. 109–128.
159. Roberge, J.-M.; Angelstam, P.; Villard, M.-A. Specialised woodpeckers and naturalness in hemiboreal forests—Deriving quantitative targets for conservation planning. *Biol. Conserv.* **2008**, *141*, 997–1012. [CrossRef]
160. Stighäll, K.; Roberge, J.-M.; Andersson, K.; Angelstam, P. Usefulness of biophysical proxy data for modelling habitat of an endangered forest species: The white-backed woodpecker Dendrocopos leucotos. *Scand. J. For. Res.* **2011**, *26*, 576–585. [CrossRef]
161. Scott, J.M.; Davis, F.; Csuti, B.; Noss, R.; Butterfield, B.; Groves, C.; Anderson, H.; Caicco, S.; D'Erchia, F.; Edwards, T.C.; et al. Gap Analysis: A Geographic Approach to Protection of Biological Diversity. *Wildl. Monogr.* **1993**, 3–41.
162. Austin, M.P.; Margules, C.R. Assessing representativeness. In *Wildlife Conservation Evaluation*; Usher, M.B., Ed.; Chapman & Hall: London, UK, 1986; pp. 45–67.
163. Nordic Council of Ministers. *Representative Types of Nature in the Nordic Countries*; Nordic Council of Ministers: Berlin, Germany; Arlöv, Sweden, 1983; p. 60 pp + map.
164. Sporrong, U. *Odlingslandskap och Landskapsbild. Studier till Kulturmiljöprogram för Sverige*; Riksantikvarieämbetet: Stockholm, Sweden, 1996. (In Swedish)
165. Kuuluvainen, T. Forest Management and Biodiversity Conservation Based on Natural Ecosystem Dynamics in Northern Europe: The Complexity Challenge. *AMBIO J. Hum. Environ.* **2009**, *38*, 309–315. [CrossRef]
166. Angelstam, P.; Manton, M.; Yamelynets, T.; Fedoriak, M.; Albulescu, A.-C.; Bravo, F.; Cruz, F.; Jaroszewicz, B.; Kavtarishvili, M.; Muñoz-Rojas, J.; et al. Maintaining natural and traditional cultural green infrastructures across Europe: Learning from historic and current landscape transformations. *Landsc. Ecol.* **2021**, *36*, 637–663. [CrossRef]
167. Hanski, I. *Metapopulation Ecology*; Oxford University Press: Oxford, UK, 1999.
168. Hanski, I. The shrinking world: Ecological consequences of habitat loss. In *Excellence in Ecology*; International Ecology Institute: Oldendorf, Germany, 2005; Volume 14.
169. Hanski, I.; Ovaskainen, O. Extinction Debt at Extinction Threshold. *Conserv. Biol.* **2002**, *16*, 666–673. [CrossRef]
170. Östlund, L.; Zackrisson, O.; Axelsson, A.-L. The history and transformation of a Scandinavian boreal forest landscape since the 19th century. *Can. J. For. Res.* **1997**, *27*, 1198–1206. [CrossRef]
171. Ranius, T.; Kindvall, O. Extinction risk of wood-living model species in forest landscapes as related to forest history and conservation strategy. *Landsc. Ecol.* **2006**, *21*, 687–698. [CrossRef]
172. Hottola, J.; Siitonen, J. Significance of woodland key habitats for polypore diversity and red-listed species in boreal forests. *Biodivers. Conserv.* **2008**, *17*, 2559–2577. [CrossRef]
173. Fries, C.; Johansson, O.; Pettersson, B.; Simonsson, P. Silvicultural models to maintain and restore natural stand structures in Swedish boreal forests. *For. Ecol. Manag.* **1997**, *94*, 89–103. [CrossRef]
174. Larsen, J.B.; Angelstam, P.; Bauhus, J.; Carvalho, J.F.; Diaci, J.; Dobrowolska, D.; Gazda, A.; Gustafsson, L.; Krumm, F.; Knoke, T. *Closer-to-Nature Forest Management. From Science to Policy 12*; EFI European Forest Institute: Barcelona, Spain, 2022; Volume 12.
175. Angelstam, P. Maintaining and restoring biodiversity in European boreal forests by developing natural disturbance regimes. *J. Veg. Sci.* **1998**, *9*, 593–602. [CrossRef]
176. Zechmeister, H.G.; Tribsch, A.; Moser, D.; Peterseil, J.; Wrbka, T. Biodiversity 'hot spots' for bryophytes in landscapes dominated by agriculture in Austria. *Agric. Ecosyst. Environ.* **2003**, *94*, 159–167. [CrossRef]
177. EEA. *Halting the Loss of Biodiversity by 2010: Proposal for a First Set of Indicators to Monitor Progress in Europe*; EEA Technical Report 11/2007; EEA: Copenhagen, Denmark, 2007.
178. Villard, M.-A.; Jonsson, B.-G. *Setting Conservation Targets for Managed Forest Landscapes*; Cambridge University Press: Cambridge, UK, 2009.
179. Paltto, H.; Nordén, B.; Götmark, F.; Franc, N. At which spatial and temporal scales does landscape context affect local density of Red Data Book and Indicator species? *Biol. Conserv.* **2006**, *133*, 442–454. [CrossRef]
180. Udvardy, M.F.D. Notes on the Ecological Concepts of Habitat, Biotope and Niche. *Ecology* **1959**, *40*, 725–728. [CrossRef]
181. Angelstam, P.; Pedersen, S.; Manton, M.; Garrido, P.; Naumov, V.; Elbakidze, M. Green infrastructure maintenance is more than land cover: Large herbivores limit recruitment of key-stone tree species in Sweden. *Landsc. Urban Plan.* **2017**, *167*, 368–377. [CrossRef]
182. Fahrig, L. How much habitat is enough? *Biol. Conserv.* **2001**, *100*, 65–74. [CrossRef]
183. Fahrig, L. Effects of habitat fragmentation on biodiversity. *Annu. Rev. Ecol. Evol. Syst.* **2003**, *34*, 487–515. [CrossRef]
184. Bender, D.J.; Contreras, T.A.; Fahrig, L. Habitat loss and population decline: A meta-analysis of the patch size effect. *Ecology* **1998**, *79*, 517–533. [CrossRef]
185. Andrén, H. Habitat Fragmentation, the Random Sample Hypothesis and Critical Thresholds. *Oikos* **1999**, *84*, 306–308. [CrossRef]
186. Nilsson, J. Critical Loads for Sulphur and Nitrogen. In *Air Pollution and Ecosystems*; Mathy, P., Ed.; Springer: Dordrecht, The Netherlands, 1988; pp. 85–91. [CrossRef]

187. Jansson, G.; Andrén, H. Habitat Composition and Bird Diversity in Managed Boreal Forests. *Scand. J. For. Res.* **2003**, *18*, 225–236. [CrossRef]
188. Angelstam, P. Habitat thresholds and effects of forest landscape change on the distribution and abundance of Black Grouse and Capercaillie. *Ecol. Bull.* **2004**, *51*, 173–187.
189. Angelstam, P.; Boutin, S.; Schmiegelow, F.; Villard, M.-A.; Drapeau, P.; Host, G.; Innes, J.; Isachenko, G.; Kuuluvainen, T.; Mönkkönen, M.; et al. Targets for boreal forest biodiversity conservation: A rationale for macroecological research and adaptive management. *Ecol. Bull.* **2004**, *51*, 487–509.
190. Brumelis, G.; Jonsson, B.G.; Kouki, J.; Kuuluvainen, T.; Shorohova, E. Forest naturalness in northern Europe: Perspectives on processes, structures and species diversity. *Silva Fenn.* **2011**, *45*, 807–821. [CrossRef]
191. Naumov, V.; Manton, M.; Elbakidze, M.; Rendenieks, Z.; Priednieks, J.; Uhlianets, S.; Yamelynets, T.; Zhivotov, A.; Angelstam, P. How to reconcile wood production and biodiversity conservation? The Pan-European boreal forest history gradient as an "experiment". *J. Environ. Manag.* **2018**, *218*, 1–13. [CrossRef]
192. Gu, W.; Heikkilä, R.; Hanski, I. Estimating the consequences of habitat fragmentation on extinction risk in dynamic landscapes. *Landsc. Ecol.* **2002**, *17*, 699–710. [CrossRef]
193. Löbel, S.; Snäll, T.; Rydin, H. Metapopulation processes in epiphytes inferred from patterns of regional distribution and local abundance in fragmented forest landscapes. *J. Ecol.* **2006**, *94*, 856–868. [CrossRef]
194. Angelstam, P.; Albulescu, A.-C.; Andrianambinina, O.D.F.; Aszalós, R.; Borovichev, E.; Cardona, W.C.; Dobrynin, D.; Fedoriak, M.; Firm, D.; Hunter, M.L.; et al. Frontiers of protected areas versus forest exploitation: Assessing habitat network functionality in 16 case study regions globally. *AMBIO* **2021**, *50*, 2286–2310. [CrossRef] [PubMed]
195. Angelstam, P.; Dönz-Breuss, M. Measuring forest biodiversity at the stand scale: An evaluation of indicators in European forest history gradients. *Ecol. Bull.* **2004**, *51*, 305–332.
196. Müller, J.; Bütler, R. A review of habitat thresholds for dead wood: A baseline for management recommendations in European forests. *Eur. J. For. Res.* **2010**, *129*, 981–992. [CrossRef]
197. Shorohova, E.; Tetioukhin, S. Natural disturbances and the amount of large trees, deciduous trees and coarse woody debris in the forests of Novgorod Region, Russia. *Ecol. Bull.* **2004**, *51*, 137–147.
198. Aakala, T. Coarse woody debris in late-successional Picea abies forests in northern Europe: Variability in quantities and models of decay class dynamics. *For. Ecol. Manag.* **2010**, *260*, 770–779. [CrossRef]
199. Jonsson, B.-G.; Kruys, N.; Ranius, T. Lessons from species ecology for dead wood management at a landscape scale. *Silva Fenn.* **2005**, *38*, 289–309.
200. Mikusiński, G.; Angelstam, P.; Sporrong, U. Distribution of deciduous stands in villages located in coniferous forest landscapes in Sweden. *AMBIO* **2003**, *32*, 520–526. [CrossRef]
201. Kyaschenko, J.; Strengbom, J.; Felton, A.; Aakala, T.; Staland, H.; Ranius, T. Increase in dead wood, large living trees and tree diversity, yet decrease in understory vegetation cover: The effect of three decades of biodiversity-oriented forest policy in Swedish forests. *J. Environ. Manag.* **2022**, *313*, 114993. [CrossRef]
202. Penttilä, R.; Lindgren, M.; Miettinen, O.; Rita, H.; Hanski, I. Consequences of forest fragmentation for polyporous fungi at two spatial scales. *Oikos* **2006**, *114*, 225–240. [CrossRef]
203. Linder, P.; Östlund, L. Structural changes in three mid-boreal Swedish forest landscapes, 1885–1996. *Biol. Conserv.* **1998**, *85*, 9–19. [CrossRef]
204. Fridman, J.; Walheim, M. Amount, structure, and dynamics of dead wood on managed forestland in Sweden. *For. Ecol. Manag.* **2000**, *131*, 23–36. [CrossRef]
205. Angelstam, P.; Mikusiński, G.; Fridman, J. Natural forest remnants and transport infrastructure: Does history matter for biodiversity conservation planning? *Ecol. Bull.* **2004**, *51*, 149–162.
206. Larsson, A. *Tillståndet i Skogen—Rödlistade Arter i ett Nordiskt Perspektiv*; ArtDatabanken Rapporterar 9; ArtDatabanken SLU: Uppsala, Sweden, 2011. (In Swedish)
207. Berglund, H.; Kuuluvainen, T. Representative boreal forest habitats in northern Europe, and a revised model for ecosystem management and biodiversity conservation. *AMBIO* **2021**, *50*, 1003–1017. [CrossRef]
208. Angelstam, P.; Andersson, L. To what extent should the area of forest reserves increase to conserve biodiversity? In *Kirjassa Skydd av Skogsmark. Behov och Kostnader. Bilagor, Bilaga 1997:98, 4, 75*; SOU: Stockholm, Sweden, 1997; Volume 4, p. 71. (In Swedish)
209. Convention on Biological Diversity. Kunming-Montreal Global biodiversity framework. In Proceedings of the Conference of the Parties to the Convention on Biological Diversity, Kunming, China, 17 December 2022; CBD: Motreal, QC, Canada; p. 14.
210. De Jong, J.; Larsson-Stern, M.; Liedholm, H. *Grönare Skog*; Skogsstyrelsen: Jönköping, Sweden, 1999. (In Swedish)
211. Persson, J. *Rikare Skog: 90-Talets Kunskaper om Naturvård och Ekologi*; Skogsstyrelsen: Jönköping, Sweden, 1990. (In Swedish)
212. Olsson, A.; Benner-Gårdö, M.; Flink, G. *Kulturmiljövård i Skogen*; Skogsstyrelsen: Jönköping, Sweden, 1992. (In Swedish)
213. Naturvårdsverket; Skogsstyrelsen. *Kompletterande Metoder vid Skydd av Värdefull Natur. Redovisning av Regeringsuppdrag*; Naturvårdsverket: Stockholm, Sweden, 2008. (In Swedish)
214. Norén, M. *Landskapsekologiska Kärnområden, LEKO. Redovisning av ett Projekt 1999–2003*; Meddelande 2; Skogsstyrelsen: Jönköping, Sweden, 2004. (In Swedish)
215. Särkkä, M. *Naturvärden att Hyra. En Granskning av den Finska Modellen för Skogsskydd*; Naturskyddsföreningen: Stockholm, Sweden, 2008. (In Swedish)

216. Miljödepartementet. *Uppdrag till Naturvårdsverket, Skogsstyrelsen och Länsstyrelsen i Skåne län om att Påbörja ett Samverkansprogram Med Markägare Med Kompletterande Metoder för Skydd av Natur*; Miljödepartementet: Stockholm, Sweden, 2009. (In Swedish)
217. Skogsstyrelsen. *Kometprogrammet—Anvisningar för Genomförande i de fem Kometområdena. Skogstyrelsen, Naturvårdsverket, Länsstyrelsen i Skåne, Skogsstyrelsen*; Undated "Skogens Pärlor"; Skogsstyrelsen: Jönköping, Sweden, 2012. (In Swedish)
218. Naturvårdsverket. Regionala landskapsstrategier—Ett rikt växt- och djurliv. In *Naturvårdsverkets Rapport 5855*; Naturvårdsverkets: Solna, Sweden, 2009. (In Swedish)
219. Jonegård, S. *Skogsstyrelsens Erfarenheter Kring Samarbetsnätverk i Landskapet: Rapport 9*; Skogsstyrelsen: Jönköping, Sweden, 2009. (In Swedish)
220. Sundström, G. *Målstyrningen Går åt Skogen-om Government och Governance i Svensk Skogspolitik: SCORE Rapportserie 2005:6*; SCORE: Stockholm, Sweden, 2005.
221. Hysing, E.; Olsson, J. Sustainability through Good Advice? Assessing the Governance of Swedish Forest Biodiversity. *Environ. Politics* **2005**, *14*, 510–526. [CrossRef]
222. Uliczka, H.; Angelstam, P.; Jansson, G.; Bro, A. Non-industrial private forest owners' knowledge of and attitudes towards nature conservation. *Scand. J. For. Res.* **2004**, *19*, 274–288. [CrossRef]
223. Nitare, J.; Norén, M. Nyckelbiotoper kartläggs i nytt projekt vid Skogsstyrelsen. *Sven. Bot. Tidskr.* **1992**, *86*, 219–226.
224. Nitare, J. *Projektplan, Nyckelbiotoper för Skogens Flora och Fauna*; Skogsstyrelsen: Stockholm, Sweden, 1991. (In Swedish)
225. Taylor, P.D.; Fahrig, L.; Henein, K.; Merriam, G. Connectivity Is a Vital Element of Landscape Structure. *Oikos* **1993**, *68*, 571–573. [CrossRef]
226. Taylor, P.; Fahrig, L.; With, K. Landscape connectivity: A return to the basics. In *Connectivity Conservation*; Crooks, K., Sanjayan, M., Eds.; Cambridge University Press: Cambridge, UK, 2006; pp. 29–43.
227. Fries, C.; Carlsson, M.; Dahlin, B.; Lämås, T.; Sallnäs, O. A review of conceptual landscape planning models for multiobjective forestry in Sweden. *Can. J. For. Res.* **1998**, *28*, 159–167. [CrossRef]
228. Sundberg, B.; Silversides, C. *Operational Efficiency in Forestry: Vol. 1: Analysis*; Springer Science & Business Media: Berlin/Heidelberg, Germany, 1988; Volume 29.
229. Dudley, N.; Parish, J. Closing the gap. Creating ecologically representative protected area systems: A guide to conducting the gap assessments of protected area systems for the convention on biological diversity. In *Technical Series No. 24*; Secretariat of the Convention on Biological Diversity: Montreal, QC, Canada, 2006.
230. Krever, V.; Stishov, M.; Onufrenya, I. *National Protected Areas of the Russian Federation: GAP Analysis and Perspective Framework*; WWF-Russia, and The Nature Conservancy, MAVA: Moscow, Russia, 2009; p. 80.
231. Lõhmus, A.; Kohv, K.; Palo, A.; Viilma, K. Loss of Old-Growth, and the Minimum Need for Strictly Protected Forests in Estonia. *Ecol. Bull.* **2004**, *51*, 401–411.
232. Liljelund, L.-E.; Pettersson, B.; Zackrisson, O. Skogsbruk och biologisk mångfald. *Sven. Bot. Tidskr.* **1992**, *86*, 227–232.
233. Angelstam, P.; Yamelynets, T.; Elbakidze, M.; Prots, B.; Manton, M. Gap analysis as a basis for strategic spatial planning of green infrastructure: A case study in the Ukrainian Carpathians. *Écoscience* **2017**, *24*, 41–58. [CrossRef]
234. Manton, M.; Makrickas, E.; Banaszuk, P.; Kołos, A.; Kamocki, A.; Grygoruk, M.; Stachowicz, M.; Jarašius, L.; Zableckis, N.; Sendžikaitė, J.; et al. Assessment and Spatial Planning for Peatland Conservation and Restoration: Europe's Trans-Border Neman River Basin as a Case Study. *Land* **2021**, *10*, 174. [CrossRef]
235. Burton, P.; Macdonald, S. The restoration imperative: Challenges objectives and approaches to restoring naturalness in forests. *Silva Fenn.* **2011**, *45*, 843–863. [CrossRef]
236. Lindborg, R.; Eriksson, O. Historical landscape connectivity affects present plant species diversity. *Ecology* **2004**, *85*, 1840–1845. [CrossRef]
237. Buse, J. "Ghosts of the past": Flightless saproxylic weevils (Coleoptera: Curculionidae) are relict species in ancient woodlands. *J. Insect Conserv.* **2012**, *16*, 93–102. [CrossRef]
238. Rompré, G.; Boucher, Y.; Bélanger, L.; Côté, S.; Robinson, W. Conserving biodiversity in managed forest landscapes: The use of critical thresholds for habitat. *For. Chron.* **2010**, *86*, 589–596. [CrossRef]
239. Mikusiński, G.; Angelstam, P. Occurrence of mammals and birds with different ecological characteristics in relation to forest cover in Europe: Do macroecological data make sense? *Ecol. Bull.* **2004**, *51*, 265–275.
240. Skogsstyrelsen. *Skogsstyrelsen Utvärdering av Skogspolitiken*; Skogsstyrelsen: Jönköping, Sweden, 2001. (In Swedish)
241. Appelqvist, T. *Naturvårdsbiologisk Forskning. Underlag för Områdesskydd i Skogslandskapet: Rapport 5452*; Naturvårdsverket: Solna, Sweden, 2005. (In Swedish)
242. Skogsstyrelsen. *Fördjupad Utvärdering av Levande Skogar*; Meddelande 4; Skogsstyrelsen: Jönköping, Sweden, 2007. (In Swedish)
243. Länsstyrelsen Östergötland. *Levande Eklandskap i Östergötland—Regional Landskapsstrategi 2008–2015*; Rapport 2007; Länsstyrelsen: Östergötland, Sweden, 2007. (In Swedish)
244. Wennberg, S.; Höjer, O. *Frekvensanalys av Skyddsvärd Natur. Rapport 5466*; Naturvårdsverket: Solna, Sweden, 2005.
245. Naturvårdsverket; Skogsstyrelsen. *Nationell Strategi för Formellt Skydd av Skog. (Beslut Naturvårdsverkets dnr 310-419-04, Skogsstyrelsens dnr 194/04-4.43)*; Naturvårdsverket & Skogsstyrelsen: Solna, Sweden, 2005.
246. Bergman, P.; Gustafsson, L. Ecoparks–Forest landscapes in Sweden with emphasis on biodiversity conservation and recreation. In *How to Balance Forestry and Biodiversity Conservation—A View Across Europe*; Krumm, F., Schuck, A., Rigling, A., Eds.; European Forest Institute, Swiss Federal Research Institute: Birmensdorf, Sweden, 2020; pp. 369–378.

247. Regeringens. *Förändrat Uppdrag för Sveaskog AB. Regeringens Proposition 2009/10:69*; Riksdagen: Stockholm, Sweden, 2009. (In Swedish)
248. Skogsstyrelsen. *Skogsvårdsorganisationens Utvärdering av Skogspolitiken. Meddelande 1:1998*; Skogsstyrelsen: Jönköping, Sweden, 1998; p. 103. (In Swedish)
249. Skogsstyrelsen. *Naturskydd och Miljöarbete. Meddelande 6:1998*; Skogsstyrelsen: Jönköping, Sweden, 1998. (In Swedish)
250. Skogsstyrelsen. *Skogsbrukets Frivilliga Avsättningar*; Meddelande 3; Skogsstyrelsen: Jönköping, Sweden, 2008. (In Swedish)
251. SCB. *Formellt Skyddad Skogsmark, Frivilliga Avsättningar, Hänsynsytor Samt Improduktiv Skogsmark 2021*; MI 41 2021A02; Statistics Sweden: Stockholm, Sweden, 2022. (In Swedish)
252. Naturvårdsverket. *Skogsreservat i Sverige*; Rapport 4707; Naturvårdsverket: Stockholm, Sweden, 1997. (In Swedish)
253. SCB. *Skyddad Natur 31 dec 2009. Sveriges Officiella Statistik*; Statistiska Meddelanden MI 41 SM 1001; SCB: Stockholm, Sweden, 2009. (In Swedish)
254. Root, T.L.; Price, J.T.; Hall, K.R.; Schneider, S.H.; Rosenzweig, C.; Pounds, J.A. Fingerprints of global warming on wild animals and plants. *Nature* **2003**, *421*, 57–60. [CrossRef]
255. Blicharska, M.; Angelstam, P.; Giessen, L.; Hilszczański, J.; Hermanowicz, E.; Holeksa, J.; Jacobsen, J.B.; Jaroszewicz, B.; Konczal, A.; Konieczny, A.; et al. Between biodiversity conservation and sustainable forest management—A multidisciplinary assessment of the emblematic Białowieża Forest case. *Biol. Conserv.* **2020**, *248*, 108614. [CrossRef]
256. Manton, M.; Angelstam, P. Defining Benchmarks for Restoration of Green Infrastructure: A Case Study Combining the Historical Range of Variability of Habitat and Species' Requirements. *Sustainability* **2018**, *10*, 326. [CrossRef]
257. Aune, K.; Jonsson, B.-G.; Moen, J. Isolation and edge effects among woodland key habitats in Sweden: Making fragmentation into forest policy? *Biol. Conserv.* **2005**, *124*, 89–95. [CrossRef]
258. Mikusiński, G.; Edenius, L. Assessment of spatial functionality of old forest in Sweden as habitat for virtual species. *Scand. J. For. Res.* **2006**, *21*, 73–83. [CrossRef]
259. Regeringens. *Svenska Miljömål—Ett Gemensamt Uppdrag*; Proposition 2004/05:150; Riksdagen: Stockholm, Sweden, 2004. (In Swedish)
260. Miljömålsrådet. *Miljömålrådets Uppföljning av Sveriges Miljömål*; Miljömålsrådet: Stockholm, Sweden, 2007. (In Swedish)
261. Statskontoret. *Skyddet av Levande Skogar*; Rapport 2007:14; Statskontoret: Stockholm, Sweden, 2007.
262. Ihse, M.; Oostra, S. *Regionala Landskapsstrategier—Ett Rikt Växt- och Djurliv. en Kunskapssammanställning—Fallstudier*; Rapport 5855; Naturvårdverket: Stockholm, Sweden, 2009. (In Swedish)
263. Naturvårdsverket. *Arbetssätt för Biologisk Mångfald och Andra Värden i ett Landskapsperspektiv*; Rapport 6342; Naturvårdsverket: Stockholm, Sweden, 2010. (In Swedish)
264. Sandström, C.; Hovik, S.; Falleth, E. *Omstridd Natur: Trender & Utmaningar i Nordisk Naturförvaltning*; Boréa: Umeå, Sweden, 2008. (In Swedish)
265. Arts, B.; Leroy, P. *Institutional Dynamics in Environmental Governance*; Springer: Berlin/Heidelberg, Germany, 2006.
266. Elbakidze, M.; Ražauskaitė, R.; Manton, M.; Angelstam, P.; Mozgeris, G.; Brūmelis, G.; Brazaitis, G.; Vogt, P. The role of forest certification for biodiversity conservation: Lithuania as a case study. *Eur. J. For. Res.* **2016**, *135*, 361–376. [CrossRef]
267. Angelstam, P.; Roberge, J.-M.; Axelsson, R.; Elbakidze, M.; Bergman, K.-O.; Dahlberg, A.; Degerman, E.; Eggers, S.; Esseen, P.-A.; Hjältén, J.; et al. Evidence-Based Knowledge Versus Negotiated Indicators for Assessment of Ecological Sustainability: The Swedish Forest Stewardship Council Standard as a Case Study. *AMBIO* **2013**, *42*, 229–240. [CrossRef]
268. Kuuluvainen, T.; Lindberg, H.; Vanha-Majamaa, I.; Keto-Tokoi, P.; Punttila, P. Low-level retention forestry, certification, and biodiversity: Case Finland. *Ecol. Process.* **2019**, *8*, 47. [CrossRef]
269. Vedung, E. Policy instruments: Typologies and theories. In *Carrots, Sticks, and Sermons: Policy Instruments and Their Evaluation*; Bemelmans-Videc, M.L., Rist, R.C., Vedung, E.O., Eds.; Transaction Publishers: New Brunswick, NJ, USA, 1998; Volume 5, pp. 21–58.
270. Fischer, A.P. Forest landscapes as social-ecological systems and implications for management. *Landsc. Urban Plan.* **2018**, *177*, 138–147. [CrossRef]
271. Fischer, K.; Stenius, T.; Holmgren, S. Swedish Forests in the Bioeconomy: Stories from the National Forest Program. *Soc. Nat. Resour.* **2020**, *33*, 896–913. [CrossRef]
272. SFS. *Svensk Författningssamling 429*; Riksdagen: Stockholm, Sweden, 1979. (In Swedish)
273. SFS. *Svensk Författningssamling 553*; Riksdagen: Stockholm, Sweden, 1993. (In Swedish)
274. SFS. *Svensk Författningssamling 921*; Riksdagen: Stockholm, Sweden, 2010. (In Swedish)
275. Ministry for Rural Affairs. *The Forest Kingdom—With Values for the World*; Action Plan; XGS Grafisk Service: Stockholm, Sweden, 2011.
276. Annerberg, R.; Ekelund, H. *Skogsbrukets Sektorsansvar för Miljön*; Unpublished Memorandum Dated 27 April 1992; Forestry Policy Review Committee: Stockholm, Sweden, 1992. (In Swedish)
277. Ingebro, P.-A.; Norén, M. *Nyckelbiotoper—Unika Skogsområden Med Höga Naturvärden*; Updated; Skogsstyrelsen: Jönköping, Sweden. (In Swedish)
278. KSLA. *The Swedish Forestry Model*; The Royal Swedish Academy of Agriculture and Forestry: Stockholm, Sweden, 2009.
279. Rudqvist, L. *Sveriges Sumpskogar: Resultat av Sumpskogsinventeringen 1990–1998*; Skogsstyrelsens Meddelande 1999:3; Skogsstyrelsen: Jönköping, Sweden, 1999. (In Swedish)

280. Skogsstyrelsen. *Nyckelbiotopsinventeringen 1993–1998: Slutrappor*; Skogsstyrelsens Meddelande 1:1999; Skogsstyrelsen: Jönköping, Sweden, 1999. (In Swedish)
281. Skogsstyrelsen. *Inventering av Nyckelbiotoper—Resultat till och Med 2003*; Skogsstyrelsens Meddelande 4:2004; Skogsstyrelsen: Jönköping, Sweden, 2004. (In Swedish)
282. Miljöbalken. *Environmental Code of 1998*; Miljöbalken: Stockholm, Sweden, 1998.
283. Svenska PEFC. *Kombinerat Tekniskt Dokument II Med Tillämpningskrav 1 April 2006—28 Februari 201*; Svenska PEFC: Uppsala, Sweden, 2006. (In Swedish)
284. Svenska PEFC. *Extension of the PEFT Endorsement Validity of the Swedish Forest Certification Scheme*; Svenska PEFC: Uppsala, Sweden, 2011.
285. Svenska FSC-rådet. *Svensk Skogsbruksstandard Enligt FSC Med SLIMF-Indikatorer*; V2-1 050510; Svenska FSC: Uppsala, Sweden, 2010. (In Swedish)
286. Svenska FSC-rådet. *Statistik och Fakta*; Svenska FSC-rådet: Uppsala, Sweden, 2011; Available online: http://www.fsc-sverige.org/statistik-och-fakta (accessed on 31 July 2011). (In Swedish)
287. Svenska PEFC. *Statistik 100930, Kvartal 3 2010*; Svenska PEFC: Uppsala, Sweden, 2010; Available online: http://www.pefc.se/ (accessed on 31 July 2011). (In Swedish)
288. Appelstrand, M. Miljömålet i skogsbruket: Styrning och frivillighet. In *Lund Studies in Sociology of Law, 26. Sociologiska Institutionen*; Lunds Universitet: Lund, Sweden, 2007.
289. Isacsson, G. *Miljöhänsyn Vid Föryngringsavverkning—Resultat Från Skogsstyrelsens Rikspolytaxinventering (R0/R1), Avverkningssäsongerna 1998/1999—2006/2007*; Memorandum Dated 8 May 2010; Skogsstyrelsen: Hässleholm, Sweden, 2010.
290. Skogsstyrelsen. *Skogs och Miljöpolitiska Mål—Brister, Orsaker och Förslag på Åtgärder*; Skogsstyrelsens Meddelande 2; Skogsstyrelsen: Jönköping, Sweden, 2011. (In Swedish)
291. Baltscheffsky, S. *Urskog mals till träflis*; Svenska Dagbladet: Stockholm, Sweden, 2011. (In Swedish)
292. Sahlin, M. *Cutting the Edge—The Loss of Natural Forests in Sweden*; Swedish Society for Nature Conservation: Stockholm, Sweden, 2010.
293. Karlsson, M.; Sahlin, M. *Skogen Skövlas Utan Ansvar*; Svenska Dagbladet: Stockholm, Sweden, 2010. (In Swedish)
294. Baltscheffsky, S. *Fler Förbud Mot Skogsavverkningar*; Svenska Dagbladet: Stockholm, Sweden, 2011. (In Swedish)
295. Bush, T. Biodiversity and sectoral responsibility in Swedish forestry policy 1988–1993. In *Examensarbete Nr. 68, Institutionen för Sydsvensk Skogsvetenskap*; Sveriges Lantbruksuniversitet: Alnarp, Sweden, 2005.
296. Lindkvist, A.; Kardell, Ö.; Nordlund, C. Intensive Forestry as Progress or Decay? An Analysis of the Debate about Forest Fertilization in Sweden, 1960–2010. *Forests* **2011**, *2*, 112–146. [CrossRef]
297. Strengbom, J.; Dahlberg, A.; Larsson, A.; Lindelöw, Å.; Sandström, J.; Widenfalk, O.; Gustafsson, L. Introducing Intensively Managed Spruce Plantations in Swedish Forest Landscapes will Impair Biodiversity Decline. *Forests* **2011**, *2*, 610–630. [CrossRef]
298. Laudon, H.; Sponseller, R.A.; Lucas, R.W.; Futter, M.N.; Egnell, G.; Bishop, K.; Ågren, A.; Ring, E.; Högberg, P. Consequences of More Intensive Forestry for the Sustainable Management of Forest Soils and Waters. *Forests* **2011**, *2*, 243–260. [CrossRef]
299. Beland Lindahl, K.; Westholm, E. Food, Paper, Wood, or Energy? Global Trends and Future Swedish Forest Use. *Forests* **2011**, *2*, 51–65. [CrossRef]
300. Sandström, C.; Lindkvist, A.; Öhman, K.; Nordström, E.-M. Governing Competing Demands for Forest Resources in Sweden. *Forests* **2011**, *2*, 218–242. [CrossRef]
301. Huntington, S.P. *The Clash of Civilizations and the Remaking of World Order*; Penguin Books India: New Delhi, India, 1996.
302. Wilhere, G.F. The How-Much-Is-Enough Myth. *Conserv. Biol.* **2008**, *22*, 514–517. [CrossRef] [PubMed]
303. Borgström, S.T.; Elmqvist, T.; Angelstam, P.; Alfsen-Norodom, C. Scale Mismatches in Management of Urban Landscapes. *Ecol. Soc.* **2006**, *11*, 16. [CrossRef]
304. Barbour, M. *Ecological Assessment of Aquatic Resources: Linking Science to Decision-Making*; SETAC Press: Pensacola, FL, USA; Brussels, Belgium, 2004.
305. Mansourian, S. Governance and forest landscape restoration: A framework to support decision-making. *J. Nat. Conserv.* **2017**, *37*, 21–30. [CrossRef]
306. Naturvårdsverket. *Förslag till Strategi för Naturvårdande Förvaltning av Skogar och Andra Trädbärande Marker i Nationalparker, Naturreservat och Natura 2000-Områden*, Remissversion 20100225; Naturvårdsverket: Stockholm, Sweden, 2010. (In Swedish)
307. Bengtsson, J.; Angelstam, P.; Elmqvist, T.; Emanuelsson, U.; Folke, C.; Ihse, M.; Moberg, F.; Nyström, M. Reserves, resilience and dynamic landscapes. *AMBIO* **2003**, *32*, 389–396. [CrossRef]
308. Savilaakso, S.; Johansson, A.; Häkkilä, M.; Uusitalo, A.; Sandgren, T.; Mönkkönen, M.; Puttonen, P. What are the effects of even-aged and uneven-aged forest management on boreal forest biodiversity in Fennoscandia and European Russia? A systematic review. *Environ. Evid.* **2021**, *10*, 1–38. [CrossRef]
309. Andersson, K.; Angelstam, P.; Elbakidze, M.; Axelsson, R.; Degerman, E. Green infrastructures and intensive forestry: Need and opportunity for spatial planning in a Swedish rural–urban gradient. *Scand. J. For. Res.* **2013**, *28*, 143–165. [CrossRef]
310. Dawson, L.; Elbakidze, M.; Angelstam, P.; Gordon, J. Governance and management dynamics of landscape restoration at multiple scales: Learning from successful environmental managers in Sweden. *J. Environ. Manag.* **2017**, *197*, 24–40. [CrossRef]

311. Tear, T.H.; Kareiva, P.; Angermeier, P.L.; Comer, P.; Czech, B.; Kautz, R.; Landon, L.; Mehlman, D.; Murphy, K.; Ruckelshaus, M.; et al. How Much Is Enough? The Recurrent Problem of Setting Measurable Objectives in Conservation. *BioScience* **2005**, *55*, 835–849. [CrossRef]
312. Lõhmus, A. Ecological Sustainability at the Forest Landscape Level: A Bird Assemblage Perspective. *Land* **2022**, *11*, 1965. [CrossRef]
313. Roche, P.K.; Campagne, C.S. From ecosystem integrity to ecosystem condition: A continuity of concepts supporting different aspects of ecosystem sustainability. *Curr. Opin. Environ. Sustain.* **2017**, *29*, 63–68. [CrossRef]
314. Degerman, E.; Sers, B.; Törnblom, J.; Angelstam, P. Large woody debris and Brown trout in small forest streams: Towards targets for assessment and management of riparian landscapes. *Ecol. Bull.* **2004**, *51*, 233–239.
315. Trigal, C.; Degerman, E. Multiple factors and thresholds explaining fish species distributions in lowland streams. *Glob. Ecol. Conserv.* **2015**, *4*, 589–601. [CrossRef]
316. Manton, M.; Ruffner, C.; Kibirkštis, G.; Brazaitis, G.; Marozas, V.; Pukienė, R.; Makrickiene, E.; Angelstam, P. Fire Occurrence in Hemi-Boreal Forests: Exploring Natural and Cultural Scots Pine Fire Regimes Using Dendrochronology in Lithuania. *Land* **2022**, *11*, 260. [CrossRef]
317. Hyvärinen, E.; Kouki, J.; Martikainen, P. Fire and Green-Tree Retention in Conservation of Red-Listed and Rare Deadwood-Dependent Beetles in Finnish Boreal Forests. *Conserv. Biol.* **2006**, *20*, 1710–1719. [CrossRef]
318. Johnstone, J.F.; Allen, C.D.; Franklin, J.F.; Frelich, L.E.; Harvey, B.J.; Higuera, P.E.; Mack, M.C.; Meentemeyer, R.K.; Metz, M.R.; Perry, G.L.; et al. Changing disturbance regimes, ecological memory, and forest resilience. *Front. Ecol. Environ.* **2016**, *14*, 369–378. [CrossRef]
319. Olsson, R. *Efter Johannesburg—Utmaningar för Forskarsamhället*; Miljövårdsberedningen Rapport 2003:1; Riksdag: Stockholm, Sweden, 2003. (In Swedish)
320. Berkes, F. Environmental governance for the anthropocene? Social-ecological systems, resilience, and collaborative learning. *Sustainability* **2017**, *9*, 1232. [CrossRef]
321. Liu, J.; Dietz, T.; Carpenter, S.R.; Alberti, M.; Folke, C.; Moran, E.; Pell, A.N.; Deadman, P.; Kratz, T.; Lubchenco, J.; et al. Complexity of coupled human and natural systems. *Science* **2007**, *317*, 1513–1516. [CrossRef]
322. Carlsson, J.; Lidestav, G.; Bjärstig, T.; Svensson, J.; Nordström, E.-M. Opportunites for Integrated Landscape Planning: The Broker, the Arena, the Tool. *Landsc. Online* **2017**, *55*, 1–20. [CrossRef]
323. Potapov, P.; Hansen, M.C.; Laestadius, L.; Turubanova, S.; Yaroshenko, A.; Thies, C.; Smith, W.; Zhuravleva, I.; Komarova, A.; Minnemeyer, S.; et al. The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013. *Sci. Adv.* **2017**, *3*, e1600821. [CrossRef]
324. Kettunen, M.; Terry, A.; Tucker, G.; Jones, A. *Guidance on the Maintenance of Landscape Features of Major Importance for Wild Flora and Fauna—Guidance on the Implementation of Article 3 of the Birds Directive (79/409/EEC) and Article 10 of the Habitats Directive (92/43/EEC)*; Institute for European Environmental Policy (IEEP): Brussels, Belgium, 2007; p. 114 pp. & Annexes.
325. Baldwin, R.F.; Powell, R.B.; Kellert, S.R. Habitat as Architecture: Integrating Conservation Planning and Human Health. *AMBIO* **2011**, *40*, 322–327. [CrossRef]
326. Costanza, R.; d'Agre, R.; De Groot, R.S.; Farber, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem, S.; O'Neill, R.V.; Paruelo, J.; et al. The value of the world's ecosystem services and natural capital. *Nature* **1997**, *385*, 253–260. [CrossRef]
327. Haines-Young, R.; Potschin, M. The links between biodiversity, ecosystem services and human well-being. *Ecosyst. Ecol. New Synth.* **2010**, *1*, 110–139.
328. Sandifer, P.A.; Sutton-Grier, A.E.; Ward, B.P. Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation. *Ecosyst. Serv.* **2015**, *12*, 1–15. [CrossRef]
329. Skärbäck, E. Landscape Planning to Promote Well Being: Studies and Examples from Sweden. *Environ. Pract.* **2007**, *9*, 206–217. [CrossRef]
330. Annerstedt, M.; Währborg, P. Nature-assisted therapy: Systematic review of controlled and observational studies. *Scand. J. Public Health* **2011**, *39*, 371–388. [CrossRef]
331. Parmesan, C.; Skevington, S.; Guégan, J.-F.; Jutro, P.; Kellert, S.; Mazumder, A.; Roué, M.; Sharma, M. Biodiversity and human health: The decision-making process. In *Biodiversity Change and Human Health: From Ecosystem Services to Spread of Disease*; Sala, O., Meyerson, L., Parmesan, C., Eds.; Island Press: Washington, DC, USA, 2009; pp. 61–81.
332. Rapport, D.; Daszak, P.; Froment, A.; Guégan, J.-F.; Lafferty, K.; Larigauderie, A.; Mazumder, A.; Winding, A. The impact of anthropogenic stress at global and regional scales on biodiversity and human health. In *Biodiversity Change and Human Health: From Ecosystem Services to Spread of Disease*; Sala, O., Meyerson, L., Parmesan, C., Eds.; Island Press: Washington, DC, USA, 2009; pp. 41–60.
333. Norman, J. *Living for the City—A New Agenda for Green Cities. Think Tank of the Year 2006/2007*; Policy Exchange: London, UK, 2006.
334. Knoops, K.T.B.; de Groot, L.C.P.G.M.; Kromhout, D.; Perrin, A.-E.; Moreiras-Varela, O.; Menotti, A.; van Staveren, W.A. Mediterranean Diet, Lifestyle Factors, and 10-Year Mortality in Elderly European Men and WomenThe HALE Project. *JAMA* **2004**, *292*, 1433–1439. [CrossRef]
335. Park, J.H.; Moon, J.H.; Kim, H.J.; Kong, M.H.; Oh, Y.H. Sedentary Lifestyle: Overview of Updated Evidence of Potential Health Risks. *Korean J. Fam. Med.* **2020**, *41*, 365–373. [CrossRef]
336. Nesse, R.; Williams, G. *Why We Get Sick: The New Science of Darwinian Medicine*; Vintage Books: New York, NY, USA, 1994.

337. Nilsson, K.; Sangster, M.; Gallis, C.; Hartig, T.; de Vries, S.; Seeland, K.; Schipperijn, J. *Forests, Trees and Human Health*; Springer: New York, NY, USA; Dordrecht, The Netherlands; Berlin/Heidelberg, Germany; London, UK, 2011.
338. De Vries, S.; Verheij, R.A.; Groenewegen, P.P.; Spreeuwenberg, P. Natural environments—Healthy environments? An exploratory analysis of the relationship between greenspace and health. *Environ. Plan. A* **2003**, *35*, 1717–1731. [CrossRef]
339. Walsh, R. Lifestyle and mental health. *Am. Psychol.* **2011**, *66*, 579. [CrossRef] [PubMed]
340. Skärbäck, E. Urban forests as compensation measures for infrastructure development. *Urban For. Urban Green.* **2007**, *6*, 279–285. [CrossRef]
341. de Jong, K.; Albin, M.; Skärbäck, E.; Grahn, P.; Wadbro, J.; Merlo, J.; Björk, J. Area-aggregated assessments of perceived environmental attributes may overcome single-source bias in studies of green environments and health: Results from a cross-sectional survey in southern Sweden. *Environ. Health* **2011**, *10*, 4. [CrossRef]
342. Angelstam, P.; Manton, M.; Stjernquist, I.; Gunnarsson, T.G.; Ottvall, R.; Rosenberg, M.; Thorup, O.; Wedholm, P.; Elts, J.; Gruberts, D. Barriers and bridges for sustaining functional habitat networks: A macroecological system analysis of wet grassland landscapes. *Ecol. Evol.* **2022**, *12*, e8801. [CrossRef]
343. Ottvall, R.; Edenius, L.; Elmberg, J.; Engström, H.; Green, M.; Holmqvist, N.; Lindström, Å.; Pärt, T.; Tjernberg, M. Population trends for Swedish breeding birds. *Ornis Svec.* **2009**, *19*, 117–192. [CrossRef]
344. Axelsson, R.; Angelstam, P. Uneven-aged forest management in boreal Sweden: Local forestry stakeholders' perceptions of different sustainability dimensions. *For. Int. J. For. Res.* **2011**, *84*, 567–579. [CrossRef]
345. Puettmann, K.J.; Wilson, S.M.; Baker, S.C.; Donoso, P.J.; Drössler, L.; Amente, G.; Harvey, B.D.; Knoke, T.; Lu, Y.; Nocentini, S.; et al. Silvicultural alternatives to conventional even-aged forest management—What limits global adoption? *For. Ecosyst.* **2015**, *2*, 8. [CrossRef]
346. Andersson, K. Geographic Information Systems as a Tool to Support Monitoring and Assessment of Landscape and Regional Sustainability. Ph.D. Thesis, Swedish University of Agricultural Sciences, Skinnskatteberg, Sweden, 2011.
347. Stjernquist, I.; Schlyter, P. Managing Forestry in a Sustainable Manner: The Importance of System Analysis. In *Transformation Literacy: Pathways to Regenerative Civilizations*; Springer International Publishing: Cham, Switzerland, 2022; pp. 145–158.
348. Aldea, J.; Bianchi, S.; Nilsson, U.; Hynynen, J.; Lee, D.; Holmström, E.; Huuskonen, S. Evaluation of growth models for mixed forests used in Swedish and Finnish decision support systems. *For. Ecol. Manag.* **2023**, *529*, 120721. [CrossRef]
349. Moilainen, A.; Wilson, K.; Possingham, H. *Spatial Conservation Prioritization: Quantitive Methods and Computational Tools*; Oxford University Press: Oxford, UK, 2009; p. 304.
350. Khoshkar, S.; Hammer, M.; Borgström, S.; Balfors, B. Ways Forward for Advancing Ecosystem Services in Municipal Planning—Experiences from Stockholm County. *Land* **2020**, *9*, 296. [CrossRef]
351. Hooimeijer, F.; Tummers, L. Integrating subsurface management into spatial planning in the Netherlands, Sweden and Flanders. *Proc. Inst. Civ. Eng. Urban Des. Plan.* **2017**, *170*, 161–172. [CrossRef]
352. Regeringens. *En enklare Plan-och Bygglag*; Proposition 2009/10:170; Riksdagen: Stockholm, Sweden, 2009.
353. Elbakidze, M.; Angelstam, P.; Sandström, C.; Axelsson, R. Multi-stakeholder collaboration in Russian and Swedish model forest initiatives: Adaptive governance toward sustainable forest management? *Ecol. Soc.* **2010**, *15*, 14. [CrossRef]
354. Dudley, N.; Schlaepfer, R.; Jackson, W.; Jeanrenaud, J.-P.; Stolton, S. *Forest Quality: Assessing Forests at a Landscape Scale*; Routledge: London, UK, 2012.
355. Axelsson, R.; Angelstam, P.; Elbakidze, M.; Stryamets, N.; Johansson, K.-E. Sustainable development and sustainability: Landscape approach as a practical interpretation of principles and implementation concepts. *J. Landsc. Ecol.* **2011**, *4*, 5–30. [CrossRef]
356. Noss, R.F. A Regional Landscape Approach to Maintain Diversity. *BioScience* **1983**, *33*, 700–706. [CrossRef]
357. Batisse, M. The biosphere reserve: A tool for environmental conservation and management. *Environ. Conserv.* **1982**, *9*, 101–111. [CrossRef]
358. UNESCO. *Biosphere Reserves: The Seville Strategy & the Statutory Framework of the World Network*; UNESCO: Paris, Italy, 1996.
359. Besseau, P.; Dansou, K.; Johnson, F. The International Model Forest Network (IMFN): Elements of Success. *For. Chron.* **2002**, *78*, 648–654. [CrossRef]
360. IMFN. *Model Forest Development Guide*; International Model Forest Network Secretariat: Ottawa, ON, Canada, 2008; p. 34.
361. Shaffer, M.; Stein, B. Safeguarding our precious heritage. In *Precious Heritage: The Status of Biodiversity in the United States*; Stein, B., Kutner, L., Adams, J., Eds.; Oxford University Press: New York, NY, USA, 2000; pp. 301–321.
362. Kirkpatrick, J.B. An iterative method for establishing priorities for the selection of nature reserves: An example from Tasmania. *Biol. Conserv.* **1983**, *25*, 127–134. [CrossRef]
363. Pressey, R.L.; Humphries, C.J.; Margules, C.R.; Vane-Wright, R.I.; Williams, P.H. Beyond opportunism: Key principles for systematic reserve selection. *Trends Ecol. Evol.* **1993**, *8*, 124–128. [CrossRef]
364. Gaston, K.J.; Pressey, R.L.; Margules, C.R. Persistence and vulnerability: Retaining biodiversity in the landscape and in protected areas. *J. Biosci.* **2002**, *27*, 361–384. [CrossRef]
365. Anon. Sverige klarar Nagoya-överenskommelsen. *Norra Skogsmagasinet* **2011**, *4*, 28. (In Swedish)
366. Convention on Biological Diversity. *Explanatory Guide on Target 11 of the Strategic Plan for Biodiversity*; Convention of Biological Diversity: Montreal, QC, Canada, 2011.
367. Jönsson, M.T.; Jonsson, B.G. Assessing coarse woody debris in Swedish woodland key habitats: Implications for conservation and management. *For. Ecol. Manag.* **2007**, *242*, 363–373. [CrossRef]

368. Jasinski, K.; Uliczka, H. *De Trädbevuxna Impedimentens Betydelse Som Livsmiljöer för Växt-och Djurarter*; Skogsstyrelsen: Jönköping, Sweden, 1998. (In Swedish)
369. Cederberg, B.; Ehnström, B.; Gärdenfors, U.; Hallingbäck, T.; Ingelög, T.; Tjernberg, M. *De Trädbärande Impedimentens Betydelse för Rödlistade Arter*; ArtDatabanken Rapporterar 1; ArtDatabanken, SLU: Uppsala, Sweden, 1997. (In Swedish)
370. Cederberg, B. *Skogsbrukets Effekter på Rödlistade Arter*; ArtDatabanken Rapporterar 4; ArtDatabanken, SLU: Uppsala, Sweden, 2001. (In Swedish)
371. Angelstam, P.; Roberge, J.-M.; Dönz-Breuss, M.; Burfield, I.J.; Ståhl, G. Monitoring forest biodiversity: From the policy level to the management unit. *Ecol. Bull.* **2004**, *51*, 295–304.
372. Lindenmayer, D.; Franklin, J.F. *Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach*; Island Press: London, UK, 2002.
373. Gibbons, M. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*; Sage: London, UK, 1994.
374. Turner, B.; Devisscher, T.; Chabaneix, N.; Woroniecki, S.; Messier, C.; Seddon, N. The Role of Nature-Based Solutions in Supporting Social-Ecological Resilience for Climate Change Adaptation. *Annu. Rev. Environ. Resour.* **2022**, *47*, 123–148. [CrossRef]
375. Seddon, N.; Smith, A.; Smith, P.; Key, I.; Chausson, A.; Girardin, C.; House, J.; Srivastava, S.; Turner, B. Getting the message right on nature-based solutions to climate change. *Glob. Chang. Biol.* **2021**, *27*, 1518–1546. [CrossRef] [PubMed]
376. Ludvig & Co. *Skogsbarometern 2022*; Ludvig & Co.: Stockholm, Sweden, 2022; p. 7. (In Swedish)
377. Richnau, G.; Angelstam, P.; Valasiuk, S.; Zahvoyska, L.; Axelsson, R.; Elbakidze, M.; Farley, J.; Jönsson, I.; Soloviy, I. Multifaceted value profiles of forest owner categories in South Sweden: The River Helge å catchment as a case study. *AMBIO* **2013**, *42*, 188–200. [CrossRef]
378. Hafmar, G. Alternativa Skötselmetoder i Trakthyggesbrukets Tidsålder—Om Attityder i Jämtland för Alternativa Skötselmetoder och Dess Potentiella Framtid. Master's Thesis, Dille Gård Yrkeshögskola, Krokom, Sweden, 2021.
379. Curtis, K.J. Creating the landscape, one stand at a time: The role of timber buyers in landscape-level planning in southern Sweden. In *Master Thesis Series in Environmental Studies and Sustainability Science*; Lund University: Lund, Sweden, 2020.
380. Guillén, L.A.; Wallin, I.; Brukas, V. Social capital in small-scale forestry: A local case study in Southern Sweden. *For. Policy Econ.* **2015**, *53*, 21–28. [CrossRef]
381. Hertog, I.M.; Brogaard, S.; Krause, T. Barriers to expanding continuous cover forestry in Sweden for delivering multiple ecosystem services. *Ecosyst. Serv.* **2022**, *53*, 101392. [CrossRef]
382. Daniels, S.E.; Walker, G.B. *Working through Environmental Conflict: The Collaborative Learning Approach*; Praeger: London, UK, 2001.
383. Angelstam, P.; Fedoriak, M.; Cruz, F.; Muñoz-Rojas, J.; Yamelynets, T.; Manton, M.; Washbourne, C.-L.; Dobrynin, D.; Izakovicova, Z.; Jansson, N.; et al. Meeting places and social capital supporting rural landscape stewardship: A Pan-European horizon scanning. *Ecol. Soc.* **2021**, *26*, 11. [CrossRef]
384. Svensson, L.; Nilsson, B. *Partnership: As a Strategy for Social Innovation and Sustainable Change*; Santérus Academic Press: Stockholm, Sweden, 2008.
385. Svensson, L.; Brulin, G.; Ellström, P.-E. Interactive research and ongoing evaluation as joint learning processes. In *Sustainable Development in Organizations*; Edward Elgar Publishing: Cheltenham, UK, 2015; pp. 346–362.
386. Lee, K.N. *Compass and Gyroscope*; Island Press: Washington, DC, USA, 1993.
387. Norton, B.G. *Sustainability: A Philosophy of Adaptive Ecosystem Management*; University of Chicago Press: Chicago, IL, USA, 2005.
388. Keen, M.; Brown, V.; Dyball, R. *Social Learning in Environmental Management: Towards a Sustainable Future*; James & James/Earthscan: London, UK, 2005.
389. Wals, A. *Social Learning towards a Sustainable World*; Academic Publishers: Wageningen, The Netherlands, 2009.
390. World Forestry Congress. Forest Development: A Vital Balance, Findings and Strategic Actions. Findings and Strategic Actions. Available online: http://foris.fao.org/meetings/download/_2009/xiii_th_world_forestry_congress/misc_documents/wfc_declaration.pdf (accessed on 16 March 2023).
391. Rockstrom, J.; Steffen, W.; Noone, K.; Persson, A.; Chapin, F.S.; Lambin, E.F.; Lenton, T.M.; Scheffer, M.; Folke, C.; Schellnhuber, H.J.; et al. A safe operating space for humanity. *Nature* **2009**, *461*, 472–475. [CrossRef]
392. Nordberg, M.; Angelstam, P.; Elbakidze, M.; Axelsson, R. From logging frontier towards sustainable forest management: Experiences from boreal regions of North-West Russia and North Sweden. *Scand. J. For. Res.* **2013**, *28*, 797–810. [CrossRef]
393. Himes, A.; Betts, M.; Messier, C.; Seymour, R. Perspectives: Thirty years of triad forestry, a critical clarification of theory and recommendations for implementation and testing. *For. Ecol. Manag.* **2022**, *510*, 120103. [CrossRef]
394. Schlyter, P.; Stjernquist, I.; Bäckstrand, K. Not seeing the forest for the trees? The environmental effectiveness of forest certification in Sweden. *For. Policy Econ.* **2009**, *11*, 375–382. [CrossRef]
395. Poteete, A.R.; Janssen, M.A.; Ostrom, E. *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*; Princeton University Press: Princeton, NJ, USA, 2010; p. 376.
396. Doppelt, B. *From Me to We: The Five Transformational Commitments Required to Rescue the Planet, Your Organization, and Your Life*; Greenleaf Publishing: Sheffield, UK, 2012.
397. Grundel, I.; Christenson, N.; Dahlström, M. Identifying interests and values in forest areas through collaborative processes and landscape resource analysis. *For. Policy Econ.* **2022**, *142*, 102801. [CrossRef]
398. Nowotny, H. The place of people in our knowledge. *Eur. Rev.* **1999**, *7*, 247–262. [CrossRef]

399. Wood, D.J.; Gray, B. Toward a Comprehensive Theory of Collaboration. *J. Appl. Behav. Sci.* **1991**, *27*, 139–162. [CrossRef]
400. Emerson, K.; Nabatchi, T.; Balogh, S. An Integrative Framework for Collaborative Governance. *J. Public Adm. Res. Theory* **2011**, *22*, 1–29. [CrossRef]
401. Keskitalo, E.C.H.; Lundmark, L. The Controversy Over Protected Areas and Forest-Sector Employment in Norrbotten, Sweden: Forest Stakeholder Perceptions and Statistics. *Soc. Nat. Resour.* **2009**, *23*, 146–164. [CrossRef]
402. Schultz, L.; Lundholm, C. Learning for resilience? Exploring learning opportunities in biosphere reserves. *Environ. Educ. Res.* **2010**, *16*, 645–663. [CrossRef]
403. Mirtl, M.; Orenstein, D.E.; Wildenberg, M.; Peterseil, J.; Frenzel, M. Development of LTSER Platforms in LTER-Europe: Challenges and Experiences in Implementing Place-Based Long-Term Socio-ecological Research in Selected Regions. In *Long Term Socio-Ecological Research: Studies in Society-Nature Interactions across Spatial and Temporal Scales*; Singh, J.S., Haberl, H., Chertow, M., Mirtl, M., Schmid, M., Eds.; Springer: Dordrecht, The Netherlands, 2013; pp. 409–442. [CrossRef]
404. Haberl, H.; Winiwarter, V.; Andersson, K.; Ayres, R.U.; Boone, C.; Castillo, A.; Cunfer, G.; Fischer-Kowalski, M.; Freudenburg, W.R.; Furman, E.; et al. From LTER to LTSER Conceptualizing the Socioeconomic Dimension of Long-term Socioecological Research. *Ecol. Soc.* **2006**, *11*, 13. [CrossRef]
405. Tress, B.; Tress, G.; Fry, G. Defining concepts and the process of knowledge production in integrative research. *Landsc. Res. Landsc. Plan. Asp. Integr. Educ. Appl.* **2005**, *12*, 13–26.
406. Cheng, A.; Fiero, J. Collaborative learning and the public's stewardship of its forests. In *The Deliberative Democracy Handbook: Strategies for Effective Civic Engagement in the 21st Century*; Gastil, J., Levine, P., Eds.; Jossey-Bass: San Francisco, CA, USA, 2005.
407. Hadorn, G.H.; Hoffmann-Riem, H.; Biber-Klemm, S.; Grossenbacher-Mansuy, W.; Joye, D.; Pohl, C.; Wiesmann, U.; Zemp, E. *Handbook of Transdisciplinary Research*; Springer: Berlin/Heidelberg, Germany, 2008; Volume 10.
408. Angelstam, P.; Elbakidze, M.; Axelsson, R.; Dixelius, M.; Tornblom, J. Knowledge production and learning for sustainable landscapes: Seven steps using social-ecological systems as laboratories. *AMBIO* **2013**, *42*, 116–128. [CrossRef] [PubMed]
409. Skytt, T.; Englund, G.; Jonsson, B.-G. Climate mitigation forestry—Temporal trade-offs. *Environ. Res. Lett.* **2021**, *16*, 114037. [CrossRef]
410. Sayer, J.; Sunderland, T.; Ghazoul, J.; Pfund, J.-L.; Sheil, D.; Meijaard, E.; Venter, M.; Boedhihartono, A.K.; Day, M.; Garcia, C.; et al. Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proc. Natl. Acad. Sci. USA* **2013**, *110*, 8349–8356. [CrossRef]
411. Nikolakis, W.; Innes, J.L. *The Wicked Problem of Forest Policy: A Multidisciplinary Approach to Sustainability in Forest Landscapes*; Cambridge University Press: Cambridge, UK, 2020.
412. Rittel, H.W.J.; Webber, M.M. Dilemmas in a general theory of planning. *Policy Sci.* **1973**, *4*, 155–169. [CrossRef]
413. Österblom, H.; Blasiak, R. Credibility at stake in Sweden. *Science* **2022**, *378*, 337. [CrossRef] [PubMed]
414. Chapron, G. Sweden threatens European biodiversity. *Science* **2022**, *378*, 364. [CrossRef]
415. Irslinger, R. *Scientist Letter on the Need for Climate Smart Forest Management*; European Commission President Ursula von der Leyen: Rottenburg, Germany, 2022; p. 35.
416. van der Spoel, D. *Open Letter to EU on Forestry, Letter ed.*; European Commission President Ursula von der Leyen, Uppsala University: Uppsala, Sweden, 2023; p. 27.
417. Eyvindson, K.; Repo, A.; Mönkkönen, M. Mitigating forest biodiversity and ecosystem service losses in the era of bio-based economy. *For. Policy Econ.* **2018**, *92*, 119–127. [CrossRef]
418. Messier, C.; Puettmann, K.; Chazdon, R.; Andersson, K.P.; Angers, V.A.; Brotons, L.; Filotas, E.; Tittler, R.; Parrott, L.; Levin, S.A. From Management to Stewardship: Viewing Forests As Complex Adaptive Systems in an Uncertain World. *Conserv. Lett.* **2015**, *8*, 368–377. [CrossRef]
419. Betts, M.G.; Phalan, B.T.; Wolf, C.; Baker, S.C.; Messier, C.; Puettmann, K.J.; Green, R.; Harris, S.H.; Edwards, D.P.; Lindenmayer, D.B.; et al. Producing wood at least cost to biodiversity: Integrating Triad and sharing–sparing approaches to inform forest landscape management. *Biol. Rev.* **2021**, *96*, 1301–1317. [CrossRef]
420. Seymour, R.S.; Hunter, M.L. *New Forestry in Eastern Spruce-Fir Forests: Principles and Applications to Maine*; College of Forest Resources, University of Maine: Orono, ME, USA, 1992; Volume 716.
421. Bollmann, K.; Braunisch, V. *To Integrate or to Segregate: Balancing Commodity Production and Biodiversity Conservation in European Forests*; European Forest Institute: Freiburg, Germany, 2013; p. 18.
422. Bollmann, K.; Kraus, D.; Paillet, Y.; Jonsson, B.; Gustafsson, L.; Mergner, U.; Krumm, F. A unifying framework for the conservation of biodiversity in multi-functional European forests. In *How to Balance Forestry and Biodiversity Conservation—A View across Europe*; Swiss Federal Institute for Forest, Snow and Landscape Research (WSL): Birmensdorf, Sweden, 2020; pp. 27–45.
423. Fedrowitz, K.; Koricheva, J.; Baker, S.C.; Lindenmayer, D.B.; Palik, B.; Rosenvald, R.; Beese, W.; Franklin, J.F.; Kouki, J.; Macdonald, E.; et al. REVIEW: Can retention forestry help conserve biodiversity? A meta-analysis. *J. Appl. Ecol.* **2014**, *51*, 1669–1679. [CrossRef]
424. Gustafsson, L.; Hannerz, M.; Koivula, M.; Shorohova, E.; Vanha-Majamaa, I.; Weslien, J. Research on retention forestry in Northern Europe. *Ecol. Process.* **2020**, *9*, 3. [CrossRef]
425. Thorn, S.; Seibold, S.; Leverkus, A.B.; Michler, T.; Müller, J.; Noss, R.F.; Stork, N.; Vogel, S.; Lindenmayer, D.B. The living dead: Acknowledging life after tree death to stop forest degradation. *Front. Ecol. Environ.* **2020**, *18*, 505–512. [CrossRef]

426. Pulla, P.; Schuck, A.; Verkerk, P.J.; Lasserre, B.; Marchetti, M.; Green, T. *Mapping the Distribution of Forest Ownership in Europe*; Technical Report 88; European Forest Institute: Joensuu, Finland, 2013.
427. Sabatini, F.M.; Burrascano, S.; Keeton, W.S.; Levers, C.; Lindner, M.; Pötzschner, F.; Verkerk, P.J.; Bauhus, J.; Buchwald, E.; Chaskovsky, O.; et al. Where are Europe's last primary forests? *Divers. Distrib.* **2018**, *24*, 1426–1439. [CrossRef]
428. Rosenvald, R.; Lõhmus, P.; Rannap, R.; Remm, L.; Rosenvald, K.; Runnel, K.; Lõhmus, A. Assessing long-term effectiveness of green-tree retention. *For. Ecol. Manag.* **2019**, *448*, 543–548. [CrossRef]
429. Jonsson, B.G.; Ekström, M.; Esseen, P.-A.; Grafström, A.; Ståhl, G.; Westerlund, B. Dead wood availability in managed Swedish forests—Policy outcomes and implications for biodiversity. *For. Ecol. Manag.* **2016**, *376*, 174–182. [CrossRef]
430. Nagel, T.A.; Firm, D.; Pisek, R.; Mihelic, T.; Hladnik, D.; de Groot, M.; Rozenbergar, D. Evaluating the influence of integrative forest management on old-growth habitat structures in a temperate forest region. *Biol. Conserv.* **2017**, *216*, 101–107. [CrossRef]
431. Virkkala, R.; Leikola, N.; Kujala, H.; Kivinen, S.; Hurskainen, P.; Kuusela, S.; Valkama, J.; Heikkinen, R.K. Developing fine-grained nationwide predictions of valuable forests using biodiversity indicator bird species. *Ecol. Appl.* **2022**, *32*, e2505. [CrossRef]
432. Rosenvald, R.; Lõhmus, A.; Kraut, A.; Remm, L. Bird communities in hemiboreal old-growth forests: The roles of food supply, stand structure, and site type. *For. Ecol. Manag.* **2011**, *262*, 1541–1550. [CrossRef]
433. Eggers, J.; Lundström, J.; Snäll, T.; Öhman, K. Balancing wood production and biodiversity in intensively managed boreal forest. *Scand. J. For. Res.* **2022**, *37*, 213–225. [CrossRef]
434. Côté, P.; Tittler, R.; Messier, C.; Kneeshaw, D.D.; Fall, A.; Fortin, M.-J. Comparing different forest zoning options for landscape-scale management of the boreal forest: Possible benefits of the TRIAD. *For. Ecol. Manag.* **2010**, *259*, 418–427. [CrossRef]
435. Pohjanmies, T.; Eyvindson, K.; Triviño, M.; Mönkkönen, M. More is more? Forest management allocation at different spatial scales to mitigate conflicts between ecosystem services. *Landsc. Ecol.* **2017**, *32*, 2337–2349. [CrossRef]
436. Bostedt, G.; de Jong, J.; Ekvall, H.; Hof, A.R.; Sjögren, J.; Zabel, A. An empirical model for forest landscape planning and its financial consequences for landowners. *Scand. J. For. Res.* **2021**, *36*, 626–638. [CrossRef]
437. Westholm, E.; Beland Lindahl, K.; Kraxner, F. *The Future Use of Nordic Forests: A Global Perspective*; Springer: Cham, Switzerland, 2015.
438. Aggestam, F.; Konczal, A.; Sotirov, M.; Wallin, I.; Paillet, Y.; Spinelli, R.; Lindner, M.; Derks, J.; Hanewinkel, M.; Winkel, G. Can nature conservation and wood production be reconciled in managed forests? A review of driving factors for integrated forest management in Europe. *J. Environ. Manag.* **2020**, *268*, 110670. [CrossRef]
439. Potterf, M.; Eyvindson, K.; Blattert, C.; Burgas, D.; Burner, R.; Stephan, J.G.; Mönkkönen, M. Interpreting wind damage risk–how multifunctional forest management impacts standing timber at risk of wind felling. *Eur. J. For. Res.* **2022**, *141*, 347–361. [CrossRef]
440. Eyvindson, K.; Duflot, R.; Triviño, M.; Blattert, C.; Potterf, M.; Mönkkönen, M. High boreal forest multifunctionality requires continuous cover forestry as a dominant management. *Land Use Policy* **2021**, *100*, 104918. [CrossRef]
441. SLU. *Forest Statistics 2020*; Swedish University of Agricultural Sciences (SLU): Umeå, Sweden, 2020.
442. Gardiner, B.A.; Quine, C.P. Management of forests to reduce the risk of abiotic damage—A review with particular reference to the effects of strong winds. *For. Ecol. Manag.* **2000**, *135*, 261–277. [CrossRef]
443. Gamfeldt, L.; Snäll, T.; Bagchi, R.; Jonsson, M.; Gustafsson, L.; Kjellander, P.; Ruiz-Jaen, M.C.; Fröberg, M.; Stendahl, J.; Philipson, C.D.; et al. Higher levels of multiple ecosystem services are found in forests with more tree species. *Nat. Commun.* **2013**, *4*, 1340. [CrossRef]
444. Felton, A.; Nilsson, U.; Sonesson, J.; Felton, A.M.; Roberge, J.-M.; Ranius, T.; Ahlström, M.; Bergh, J.; Björkman, C.; Boberg, J.; et al. Replacing monocultures with mixed-species stands: Ecosystem service implications of two production forest alternatives in Sweden. *AMBIO* **2016**, *45*, 124–139. [CrossRef]
445. Sousa-Silva, R.; Verbist, B.; Lomba, Â.; Valent, P.; Suškevičs, M.; Picard, O.; Hoogstra-Klein, M.A.; Cosofret, V.-C.; Bouriaud, L.; Ponette, Q.; et al. Adapting forest management to climate change in Europe: Linking perceptions to adaptive responses. *For. Policy Econ.* **2018**, *90*, 22–30. [CrossRef]
446. Gren, I.-M.; Aklilu, A.Z. Policy design for forest carbon sequestration: A review of the literature. *For. Policy Econ.* **2016**, *70*, 128–136. [CrossRef]
447. Stoltz, J.; Björk, J.; Grahn, P.; Mattisson, K.; Skärbäck, E. *Klassificering av Utemmiljöer i Kristianstad för Hälsa och Välbefinnande*; Sveriges Lantbruksuniversitet: Uppsala, Sweden, 2013.
448. Marselle, M.R.; Lindley, S.J.; Cook, P.A.; Bonn, A. Biodiversity and Health in the Urban Environment. *Curr. Environ. Health Rep.* **2021**, *8*, 146–156. [CrossRef] [PubMed]
449. So, H.W.; Lafortezza, R. Reviewing the impacts of eco-labelling of forest products on different dimensions of sustainability in Europe. *For. Policy Econ.* **2022**, *145*, 102851. [CrossRef]
450. Abrams, J.; Elbakidze, M. Adaptive governance in forest management. In *Handbook on Adaptive Governance*; Edward Elgar Publishing: Cheltenham, UK, 2023; pp. 127–142.
451. Barredo, J.I.; Brailescu, C.; Teller, A.; Sabatini, F.M.; Mauri, A.; Janouskova, K. *Mapping and Assessment of Primary and Old-Growth Forests in Europe*; Amt fur Veroffentlichungen der EU: Luxemburg, 2021.
452. Gustafsson, L.; Bauhus, J.; Asbeck, T.; Augustynczik, A.L.D.; Basile, M.; Frey, J.; Gutzat, F.; Hanewinkel, M.; Helbach, J.; Jonker, M.; et al. Retention as an integrated biodiversity conservation approach for continuous-cover forestry in Europe. *AMBIO* **2020**, *49*, 85–97. [CrossRef]

453. Häkkilä, M.; Johansson, A.; Sandgren, T.; Uusitalo, A.; Mönkkönen, M.; Puttonen, P.; Savilaakso, S. Are small protected habitat patches within boreal production forests effective in conserving species richness, abundance and community composition? A systematic review. *Environ. Evid.* **2021**, *10*, 2. [CrossRef]
454. Nilsson, M. Skydda lagom—En ESO-rapport om miljömålet Levande skogar. In *Rapport till Expertgruppen för Studier i Offentlig Ekonomi 2018:4*; Elanders Sverige AB: Stockholm, Sweden, 2018. (In Swedish)
455. SOU. *Enklare Skatteregler för Enskilda Näringsidkare*; 2000:50; Statens Offentliga Utredningar: Stockholm, Sweden, 2000. (In Swedish)
456. Messier, C.; Puettmann, K.J.; Coates, K.D. *Managing Forests as Complex Adaptive Systems: Building Resilience to the Challenge of Global Change*; Routledge: London, UK; New York, NY, USA, 2013.
457. Krumm, F.; Schuck, A.; Rigling, A. *How to Balance Forestry and Biodiversity Conservation. A View across Europe*; Birmensdorf; European Forest Institute (EFI): Barcelona, Spain, 2020.
458. Kraus, D.; Krumm, F. *Integrative Approaches as an Opportunity for the Conservation of Forest Biodiversity*; European Forest Institute: Joensuu, Finland, 2013.
459. Lawton, J.; Brotherton, P.; Brown, V.; Elphic, C.; Fitter, A.; Forshaw, J.; Haddow, R.; Hilbourne, S.; Leafe, R.; Mace, G.; et al. *Making Space for Nature: A Review of England's Wildlife Sites and Ecological Network*; DEFRA: London, UK, 2010.
460. Isaac, N.J.B.; Brotherton, P.N.M.; Bullock, J.M.; Gregory, R.D.; Boehning-Gaese, K.; Connor, B.; Crick, H.Q.P.; Freckleton, R.P.; Gill, J.A.; Hails, R.S.; et al. Defining and delivering resilient ecological networks: Nature conservation in England. *J. Appl. Ecol.* **2018**, *55*, 2537–2543. [CrossRef]
461. Hothorn, T.; Müller, J. Large-scale reduction of ungulate browsing by managed sport hunting. *For. Ecol. Manag.* **2010**, *260*, 1416–1423. [CrossRef]
462. Lie, M.H.; Josefsson, T.; Storaunet, K.O.; Ohlson, M. A refined view on the "Green lie": Forest structure and composition succeeding early twentieth century selective logging in SE Norway. *Scand. J. For. Res.* **2012**, *27*, 270–284. [CrossRef]
463. Stachowicz, M.; Manton, M.; Abramchuk, M.; Banaszuk, P.; Jarašius, L.; Kamocki, A.; Povilaitis, A.; Samerkhanova, A.; Schäfer, A.; Sendžikaitė, J.; et al. To store or to drain—To lose or to gain? Rewetting drained peatlands as a measure for increasing water storage in the transboundary Neman River Basin. *Sci. Total. Environ.* **2022**, *829*, 154560. [CrossRef]
464. Repo, A.; Eyvindson, K.; Halme, P.; Mönkkönen, M. Forest bioenergy harvesting changes carbon balance and risks biodiversity in boreal forest landscapes. *Can. J. For. Res.* **2020**, *50*, 1184–1193. [CrossRef]
465. Pörtner, H.-O.; Roberts, D.C.; Adams, H.; Adler, C.; Aldunce, P.; Ali, E.; Begum, R.A.; Betts, R.; Kerr, R.B.; Biesbroek, R. *Climate Change 2022: Impacts, Adaptation and Vulnerability*; IPCC: Geneva, Switzerland, 2022.
466. Colfer, C. *The Complex Forest: Communities, Uncertainty, and Adaptive Collaborative Management*; Routledge: London, UK, 2010.
467. Owuor, J.; Giessen, L.; Prior, L.; Cilio, D.; Bal, T.; Bernasconi, A.; Burns, J.; Chen, X.; Goldsmith, A.; Jiacheng, Z. *Trends in Forest-Related Employment and Tertiary Education: Insights from Selected Key Countries around the Globe*; European Forest Institute: Bonn, Germany, 2021.