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Landscape Planning—Paving the Way for Effective Conservation of Forest Biodiversity and a Diverse Forestry?*

Abstract: *Globally, intensive forestry has led to habitat degradation and fragmentation of the forest landscape. Taking Sweden as an example, this development is contradictory to international commitments, EU obligations, and to the fulfillment of the Parliament's environmental quality objective "Living Forests", which according to Naturvårdsverket (The Swedish Environmental Protection Agency) will not be achieved in 2020 as stipulated. One important reason for the implementation deficit is the fragmented forestry management. In a forest landscape, felling and other measures are conducted at different times on separate forest stands (often relatively small units) by different operators. Consequently, the authorities take case by case decisions on felling restrictions for conservation purposes. In contrast, conservation biology research indicates a need for a broad geographical and strategical approach in order to, in good time, select the most appropriate habitats for conservation and to provide for a functioning connectivity between different habitats. In line with the EU Commission, we argue that landscape forestry planning could be a useful instrument to achieve ecological functionality in a large area. Landscape planning may also contribute to the fulfilment of Sweden's climate and energy policy, by indicating forest areas with insignificant conservation values, where intensive forestry may be performed for biomass production etc.*

* *Forests* 2018, 9, 523, p. 1–15.

Forest owners should be involved in the planning and would, under certain circumstances, be entitled to compensation. As state resources for providing compensation are scarce, an alternative could be to introduce a tax-fund system within the forestry sector. Such a system may open for voluntary agreements between forest owners for the protection of habitats within a large area.

Keywords: *biodiversity; boreal forest; landscape planning; fragmentation; habitat protection; habitats directive; birds directive; Aichi targets; compensation; tax-fund*

1. Introduction

Biodiversity in forest ecosystems is under threat worldwide[1]. The global community has acknowledged the urgency of the problem and intentions and actions to conserve forest biodiversity have been multilaterally agreed upon through, e.g., the Aichi Biodiversity Targets, and the United Nations Millennium Development Goals.

A country like Sweden has for example, besides signing the international agreements mentioned above, since 1994 recognized the maintenance of forest biodiversity as an objective equally important to sustainable good yield[2], in Section 1 of the Forestry Act (1979:429). The biodiversity objective is further developed in different non-legal documents, such as the environmental quality objective "Sustainable Forests", adopted by the Swedish parliament in 1999[3]. This decision recognizes, inter alia, that forests should "offer unique habitats for a variety of animal and plant species". The Swedish Environmental Protection Agency (SEPA) evaluated the implementation of the objective in 2017[4]. The report highlights,

[1] Betts, M.; Wolf, C.; Ripple, W.J.; Phalan, B.; Millers, K.A.; Duarte, A.; Butchart, S.H.M.; Levi, T. Global forest loss disproportionately erodes biodiversity in intact landscapes. *Nature 2017*, *547*, 441–444. [CrossRef] [PubMed]

[2] Prop. 1992/93:226, Om en ny Skogspolitik, p. 27. Government bill on a New Forest Policy. Available online: https://data.riksdagen.se/fil/A0AE3402-7DB4-4E92-8B13-A24F1FD077EF (accessed on 28 August 2018).

[3] 1998/99:MJU6, Miljöpolitiken, and rskr. 1998/99:183. The Parliamentary Committee on Environmental and Agricultural Affairs Report, The Environmental Policy, and the Formal Parliamentary Decision rskr. 1998/99:183. Available online: https://www.riksdagen.se/sv/dokument-lagar/arende/betankande/miljopolitiken_GM01MJU6 (accessed on 28 August 2018).

[4] Naturvårdsverket. *Rapport 6749 Miljömålen – Årlig Uppföljning av Sveriges Nationella Miljömål—The Environmental Objectives–Yearly Monitoring of the Swedish National En-*

inter alia, a shortage of old forests with maintained forest continuity, multi-layered forests, untouched moist and wet forest environments as well as access to dead wood. Many forest species are adversely affected and biological diversity continues to be at risk. However, a positive observation is that the amount of dead wood and the number of remaining green trees after final felling has begun to increase (see also[5]). Still, SEPA concludes that the environmental quality objective cannot be achieved within the stipulated 2020 deadline given existing and approved legal instruments and voluntary protection arrangements. According to SEPA, it is not possible to predict the future of forest biodiversity.

To achieve the international and Swedish objectives for biodiversity, a number of legal administrative tools are available for the Swedish administration, most of them based upon the Environmental Code (1998:808) or the Forestry Act. The government may generally, directly in legislation, protect species, including their breeding sites and resting places, according to the Species Protection Ordinance (2007:845), and has done so to a considerable extent. Another approach is to protect a specific geographical area, e.g., a nature reserve or a biotope protection area. The Forest Agency is legally empowered to restrict or prohibit, in individual cases, activities within forestry (e.g., felling) if valuable biodiversity is threatened. Complementary to the coercive tools, taxes or other economic incentives may be used to stimulate conservation, and voluntary agreements may be entered between the state and the forest owner or between different forest owners[6]. Certification of forests is also a voluntary instrument.

The choice of conservation alternative depends on several factors. As most forests in Sweden are privately owned, protecting areas in the form of, for example, nature reserves can be very expensive and is in practice often not possible. Furthermore, restrictions to protect biodiversity are often in conflict with forest landowners' interests and with the public interest to achieve a high timber production, which is further emphasized by the importance of the forest as a key renewable energy resource.

vironmental Objectives; Naturvårdsverket: Bromma, Sweden, 2017; pp. 199–200. ISBN 978-91-620-6749-6.

[5] 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]

[6] Widman, U. Shared responsibility for forest protection? *For. Policy Econ. 2015, 50*, 220–227. [CrossRef]

Lindahl et al.[7] argue that the equal weighting of production and environmental objectives in the Forestry Act together with a 'more of everything' approach have stimulated rather than resolved such goal conflicts. The difficulty of coordinating conservation alongside production at a spatial scale that is meaningful for conservation is further complicated by the "freedom with responsibility" governance principle in the Swedish forestry sector. This principle essentially devolves the responsibility to balance the conflicting goals to the private sector[8]. Devolving conservation decisions which require concerted action at a large spatial scale to private forest owners has not proven widely successful in the Swedish case.

In order for conservation measures to be both cost efficient and proportionate (with regard to opposite interests), decisions on measures should be based upon adequate information on the specific ecological conditions in a large area. Such information may indicate that a forest area should be legally protected, but it may also show that other less far-reaching instruments may be used, e.g., voluntary instruments, to ensure connectivity between different habitats. In this paper, we argue that landscape planning is an instrument that could provide useful ecological information for future decisions on forest management and, depending on the content and legal status of the plan, guide or even govern such decisions. The plan can support both production and conservation objectives in the landscape. More specifically, we argue that forest landscape planning could provide for stricter conservation requirements in some areas, while more intensive forest production may be conducted in other areas (e.g., for biomass production as a climate change mitigation measure). If this variety of conservation requirements is accepted, we also need to consider how landowners that take more responsibility for nature conservation than others could be economically compensated, thereby promoting horizontal equity.

This work is a first presentation of the work conducted within the multi-scientific research programme "Landscape Planning for Forest Biodiversity and A Diverse Forestry", with the objective to introduce relevant issues for forest landscape planning from the perspective of conser-

[7] Lindahl, K.B.; Sténs, A.; Sandström, C.; Johansson, J.; Lidskog, R.; Ranius, T.; Roberge, J.-M. The Swedish forestry model: More of everything? *For. Policy Econ. 2017, 77*, 44–55. [CrossRef]

[8] Löfmarck, E.; Uggla, Y.; Lidskog, R. Freedom with what? Interpretations of "responsibility" in Swedish forestry practice. *For. Policy Econ. 2017, 75*, 34–40. [CrossRef]

vation biology, environmental law, and forest economics. Although our geographical focus is Sweden, many of the issues we raise apply to forest landscape planning in general.

2. Biodiversity in Swedish Forests

Most of Sweden's forest (about 70%) is boreal coniferous forest dominated by Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* (L.) H. Karst.), and Silver birch (*Betula pendula* Roth). Most of the remainder is hemiboreal forest in which generally a greater variety of deciduous species occur such as aspen (*Populus tremula* L.) and alder (*Alnus* spp.). Many vertebrate and invertebrate species are (partly) dependent on forest ecosystems, such as the moose (*Alces alces* (Linnaeus, 1758)), several red-listed woodpecker species like the white-backed woodpecker (*Dendrocopos leucotos* (Bechstein, 1803)), lesser spotted woodpecker (*Dendrocopos minor* (Linnaeus, 1758)), and the black woodpecker (*Dryocopus martius* (Linnaeus, 1758)), large predators like the lynx (*Lynx lynx* (Linnaeus, 1758)) and the golden eagle (*Aquila chrysaetos* (Linnaeus, 1758)), and numerous deadwood associated (saproxylic) species.

Globally, intensive forestry has led to habitat degradation and fragmentation, resulting in a severely threatening situation for many forest organisms[9]. Sweden, providing ten percent of the saw timber, pulp, and paper that is traded on the global market, while holding merely one percent of the world's commercial forest area[10], is no exception. Today, the main management operations include clear-felling, soil preparation, planting or natural regeneration, and thinning. The long-term trend in Swedish forests since the introduction of mechanized forestry in the 1950's and 1960's[11] is that the forest stands are becoming younger, denser, increasingly dominated by monocultures of coniferous species, less affected by

[9] Betts, M.; Wolf, C.; Ripple, W.J.; Phalan, B.; Millers, K.A.; Duarte, A.; Butchart, S.H.M.; Levi, T. Global forest loss disproportionately erodes biodiversity in intact landscapes. *Nature 2017, 547*, 441–444. [CrossRef] [PubMed]

[10] KSLA. *Forests and Forestry in Sweden*; Royal Swedish Academy of Agriculture and Forestry: Stockholm, Sweden, 2015; p. 2. Available online: https://www.skogsstyrelsen.se/globalassets/in-english/forests-and-forestry-in-sweden_2015.pdf (accessed on 28 August 2018).

[11] 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]

natural fire outbreaks, largely void of dead wood (although there is a trend that suggests that levels of dead wood have recently been increasing)[12], and create a landscape that is becoming more fragmented[13, 14]. Such changes have led to a decline in species that are associated with sun-exposed conditions, deciduous broad-leaved trees, and dead wood, such as saproxylic species, but also their predators such as woodpeckers[15]. At present, close to 2300 species that count forests as an important habitat are red-listed in Sweden[16].

Of Sweden's productive forest area, which is defined as having a volume increment of ≥1 m3 ha−1 year−1, 4% is formally protected and classified as, for example, nature reserve, biotope protection area, or Natura 2000 area[17], although the restrictions and protection vary from area to area. In addition, according to statistics published in 2017, 5.2% of the productive forest area is voluntarily set aside by forest owners through private agreements, 6% of this is protected area in forests adjacent to the mountains[18]. This means that more than 90% of the productive forest land lacks formal or informal protection of any kind (except the general protection of species, see Section 4).

In a European comparison, Sweden in sum has the second largest amount of protected forest area with no active intervention, surpassed

[12] 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]

[13] Siitonen, J. Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example. *Ecol. Bull. 2001, 49*, 11–41.

[14] Bernes, C. *Biodiversity in Sweden. Monitor 22*; Swedish Environmental Protection Agency: Stockholm, Sweden, 2011; p. 280. ISBN 978-91-620-1291-5.

[15] Berg, A.; Ehnstrom, B.; Gustafsson, L.; Hallingback, T.; Jonsell, M.; Weslien, J. Threatened Plant, Animal, and Fungus Species in Swedish Forests: Distribution and Habitat Associations. *Conserv. Biol. 1994, 8*, 718–731. [CrossRef]

[16] Sandström, J.; Bjelke, U.; Carlberg, T.; Sundberg, S. *Tillstånd och Trender för Arter och Deras Livsmiljöer-Rödlistade Arter i Sverige 2015*; Artdatabanken Rapporterar 17; Artdatabanken, SLU: Uppsala, Sweden, 2015.

[17] Sveriges Officiella Statistik. *Skyddad Natur. 2018, p. 3. Official Statistics of Sweden. Protected Nature*. Available online: https://www.scb.se/contentassets/e419dfae78ef4162a2b4b2c4bd4ef4e4/mi0603_2017a01_ sm_mi41sm1801.pdf (accessed on 28 August 2018).

[18] Skogsstyrelsen. Avrapportering av Regeringsuppdrag om Frivilliga Avsättningar. [The Forest Agency Reporting from a Governmental Assignment Concerning Voluntary Setting Aside of Land]; 2017/4. 2017. Available online: https://www.skogsstyrelsen.se/globalassets/aga-skog/skydda-skog/om-regeringsuppdraget-frivilliga-avsattningar.pdf (accessed on 28 August 2018).

only by Finland. Strict forest protection without intervention is more common in the Nordic and Baltic countries, while Southern European, Central and Northwestern countries prefer to implement strategies with active management for biodiversity[19].

Figure 1 compares Sweden's forest cover and share of protected area to the other Nordic countries, as well as selected countries from Central, Southern, and Eastern Europe. The share of protected areas has increased in all of these countries since the Millennium shift. Sorting the countries by total forest cover shows that protected area shares tend to be higher in countries with smaller total forest cover.

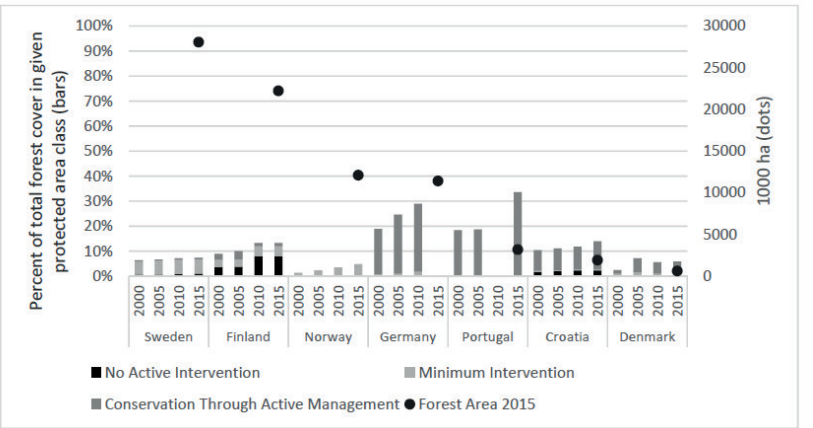

Figure 1. Trends in protected area shares. Protected area categories correspond to MCPFE (Ministerial Conference on the Protection of Forests in Europe) Classes 1.1, 1.2, and 1.3 for the management objective "biodiversity conservation". Data source: FOREST EUROPE/UNECE/FAO 2016[20].

Still, safeguarding biodiversity by formally protecting areas (e.g., as nature reserves) is not going to work without functionally connected areas

[19] FOREST EUROPE. *State of Europe's Forests 2015*; FOREST EUROPE: Zvolen, Slovakia, 2015.

[20] Forest Europe. Database: Protected Forests (Indicator 4.9.) by Land Use Category, MCPFE Class, Country and Year. 2016. Available online: http://w3.unece.org/PXWeb2015/pxweb/en/STAT/STAT__26-TMSTAT1_____040-TM15_BD1/110_en_TM15_4_9_r.px/?rxid=0a46486c–5a6e–40af-b1c6-7abc3c7b0e91 (accessed on 28 August 2018).

of high-quality habitat within the unprotected land. This is increasingly acknowledged today in conservation literature[21, 22]. As is explained below (Section 5), landscape planning may serve as an important instrument to achieve the needed connectivity.

3. Sweden Is Legally Obliged to Protect Forest Biodiversity

The insufficient biodiversity in Swedish forests is also problematic with regard to Sweden's international and EU obligations. Sweden is a party of the Convention on Biological Diversity (CBD). The CBD parties adopted a strategic plan in Nagoya 2010 including the so-called "Aichi targets", with the overall objective to effectively "halt the loss of biodiversity" and thereby "ensure that by 2020 ecosystems are resilient and continue to provide essential services" (COP 10 Decision X/2, Annex, 12). Aichi target 5 relates to forests: "By 2020, the rate of loss of all-natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced."

Complying with the Nagoya decision is politically relevant, but the decision has no legal status. The Convention is formally legally binding for the parties, but the articles are not precise and leave much discretion to the parties with regard to their implementation on a national level. However, as the EU is one of the parties of the CBD, the preconditions for legal enforcement become fundamentally different for Sweden and other EU member states. To implement Aichi target 5, the EU Parliament adopted a separate, more detailed strategy in 2011, including forestry management planning[23]. As the EU, in contrast to the CBD, provides an arsenal of effective legal instruments for implementation of the political strategy, Swedish forest management is directly impacted. The core EU legislation in this context is the Council Directive 92/43/

[21] Lindenmayer, D.B.; Cunningham, S.A. Six principles for managing forests as ecologically sustainable ecosystems. *Landsc. Ecol. 2013, 28*, 1099–1110. [CrossRef]

[22] Lindenmayer, D.B.; Fischer, J. Tackling the habitat fragmentation panchreston. *Trends Ecol. Evol. 2007, 22*, 127–132. [CrossRef] [PubMed]

[23] European Parliament resolution of 20 April 2012, On Our Life Insurance, Our Natural Capital: An EU Biodiversity Strategy to 2020 (2011/2307(INI), Item 75. Available online: http://ec.europa.eu/environment/ nature/biodiversity/comm2006/pdf/EP_resolution_april2012.pdf (accessed on 28 August 2018).

EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive) and Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Birds Directive). The two nature directives establish two complementary systems for the conservation of nature; the Nature 2000-network and the strict protection scheme for certain listed species and habitats. Accordingly, all EU member states are obliged to protect specific areas within the EU ecological network Natura 2000 (for a cross-country comparison of the Natura 2000 implementation process, see Weiss et al.[24]). Currently, forest ecosystems and agro-ecosystems take up the largest shares of national protected areas and Natura 2000 areas in Europe; respectively 31% and 28% in national protected areas and 46% and 38% in Natura 2000 areas[25].

The provisions on species protection prohibit—generally—the killing, disturbance of, and damage to many species (including, e.g., eggs and nests). The Habitats Directive also generally prohibits the "deterioration or destruction of breeding sites or resting places" for a number of species listed as "strictly protected". Due to this general legal protection, Sweden, like all other member states, is obliged to protect forest biodiversity *also outside* the formally protected areas. The EU Commission supervises the compliance with EU legislation, and can eventually bring the state before the European Court of Justice. A number of such infringement cases in the past have concerned the violation of the Birds or Habitats directives[26].

[24] Weiss, G.; Sotirov, M.; Sarvašová, Z. Implementation of Natura 2000 in forests. In *Natura 2000 and Forests: Assessing the State of Implementation and Effectiveness*; Sotirov, M., Ed.; European Forest Institute: Joensuu, Finland, 2017.

[25] European Environment Agency (EEA). Protected Areas in Europe—An Overview. Available online: https://www.eea.europa.eu/publications/protected-areas-in-europe-2012 (accessed on 28 August 2018).

[26] Langlet, D.; Mahmoudi, S. *EU Environmental Law and Policy*, 1 st ed.; Oxford University Press: Oxford, UK, 2016; pp. 351–362. ISBN 978-0-19-875393-3 (pbk).

4. Current Legal Preconditions in Sweden for Biodiversity Conservation in Unprotected Forest Areas

As mentioned in the introduction, in Sweden the Forestry Act and the Environmental Code include different legal instruments for the conservation of forest biodiversity. The "base" is in regulations under the Forest Act, including certain general, relatively lenient, conservation restrictions. The Environmental Code provides for more far-reaching requirements; through the protection of areas; the Forest Agency's power to impose additional requirements in individual cases; and the general protection of species under the Species Protection Ordinance.

The application of legal conservation instruments restricts, more or less, landowners' right to make use of forest land, e.g., to carry out felling (used as an example in the following). With the exception of requirements under the Species Protection Ordinance, the landowner is entitled to compensation if restrictions "considerably obstruct ongoing land use on the relevant part of the property" (Chapter 2, Section 15 of the Constitution and Chapter 31, Section 4 of the Environmental Code). This is a rather complicated norm[27, 28]. In short, guidelines in the preparatory works indicate that 10% of the value of the relevant forest area (basically determined by the age of the trees in this area) is what the landowner should be able to tolerate at most[29]. In practice, the percentage is sometimes lowered to 5% or 2% of the relevant forest area, depending on the economic value of the forest[30]; the higher the economic value, the lower

[27] Forsberg, M. Landskapsplanering för naturvård och virkesproduktion—Särskilt med koppling till ersättningsrätten. *Nord. Environ. Law J.* **2018**, *1*, 89–92.

[28] Forsberg, M. *Skogen som Iivsmiljö: En Rättsvetenskaplig Studie om Skyddet för Biologisk Mångfald—The Forest as Habitat. A Legal Scientific Study on the Protection of Biodiversity*; Uppsala Universitet: Uppsala, Sweden, 2012; pp. 134–147. ISBN 978-91-506-2297-3.

[29] 1986/87:BoU1 om en ny Plan- och Bygglag m.m. [The Parliamentary Committee on Housing Affairs Report Concerning a New Plan- and Building Act]. p. 150. Available online: https://data.riksdagen.se/fil/ 5FA7AFDE-2814-4977-BB52-5381919C332C (accessed on 28 August 2018).

[30] Skogsstyrelsen. Skogsstyrelsens Tillämpning av Toleransnivå vid Olika Nettovärden på Skogsobjektet—The Swedish Forest Agency's Application of Tolerance Level at Different Net Values of Forests. 2018. Available online: https://www.skogsstyrelsen.se/globalassets/lag-och-tillsyn/ skogsvardslagen/intrangsbegransningskurvan.pdf (accessed on 28 August 2018).

the percentage. However, in addition, conservation restrictions should in no case amount to a value that is more than trivial ("bagatellartat") in absolute monetary terms ("absoluta tal"). This extra protection of the property right applies, in particular, where the timber value in the relevant forest area is very high[31]. It is not possible to determine precisely where the limit is in absolute monetary terms, but two cases from the Kammarrätten (Administrative Court of Appeal) give some guidance[32]. In the first case (Kammarrätten i Göteborg 5238-07), a restriction in felling amounting to 300,000 Swedish crowns was regarded as more than trivial in absolute monetary terms (ca. 4.5% of the total timber value notified for felling). In the other case (Kammarrätten i Jönköping 2928-10), the amount of 199,000 Swedish crowns was considered trivial in absolute monetary terms (ca. 3% of the total timber value notified for felling).

Although there are different legal instruments available, some of them formally providing for far-reaching restrictions, it is in practice sometimes difficult to achieve effective conservation of forest biodiversity. One reason is the lack of financial resources needed in order to pay landowners entitled to compensation, according to the legal norm just mentioned. This compensation amounts to 125% of the loss according to the Swedish Expropriation Act (1972:719, Chapter 4, Section 2). If the state lacks economic resources to pay, and fails to enter into an agreement with the landowner, the authorities are in practice forced to allow felling despite the destruction of valuable habitats.

Another reason for ineffective protection is the lack of time and administrative resources of the Forest Agency, which must react within six weeks to a submitted felling notification in order to impose conservation requirements. The Agency receives a great number of notifications, e.g., 61,942 for regeneration fellings in the year 2017[33], but often lacks sufficient information on the ecological situation in the area notified regard-

[31] 1986/87:BoU1 om en ny Plan- och Bygglag m.m. [The Parliamentary Committee on Housing Affairs Report Concerning a New Plan- and Building Act]. p. 150. Available online: https://data.riksdagen.se/fil/ 5FA7AFDE-2814-4977-BB52-5381919C332C (accessed on 28 August 2018).

[32] Skogsstyrelsen. Miljöhänsyn som ska tas Enligt Skogsvårdslagen: Required Measures for Environmental Protection according to the Forestry Act. Available online: https://www.skogsstyrelsen.se/lag-och-tillsyn/ skogsvardslagen/miljohansyn-som-maste-tas/ (accessed on 28 August 2018).

[33] Statistiska Centralbyrån. *Statistiska Meddelanden*; JO0314 SM 1801; Statistiska Centralbyrån: Stockholm, Sweden, 2018.

ing felling and the surrounding ecosystem, concerning, inter alia, the occurrence of listed species and habitats and connecting corridors between habitats (the obligation on the landowner to provide such information is very lenient). The risk is obvious that notified felling "slips through" even though stricter conservation measures would have been motivated in the individual cases.

A third reason for ineffective biodiversity control can be summarized with the word fragmentation[34]. Felling is often conducted within relatively small land units, by different operators and at different times. Decisions on biodiversity conservation in connection with felling normally relate to these specific areas and occasions. This fragmented forestry protection has implications for the many forest species that require contiguous forests, larger than average single forest stands. Fragmentation of old-growth forest is considered to be an important factor contributing to the decline of a number of forest-associated species in Fennoscandia[35]. The capercaillie (*Tetrao urogallus* (Linnaeus, 1758)) is an example of a forest species that requires large areas of mature or even pristine forest habitat[36, 37]. As a consequence, it is not surprising that capercaillies are quite sensitive to landscape-level habitat alteration[38]. It has been suggested that at large spatial scales, more effort needs to be focused towards preservation of the overall forest cover, especially around functioning capercaillie breeding sites[39, 40, 41]. Another example is the white-backed woodpecker

[34] Fahrig, L. Effects of Habitat Fragmentation on Biodiversity. *Annu. Rev. Ecol. Evol. Syst. 2003, 34*, 487–515. [CrossRef]

[35] Kouki, J.; Löfman, S.; Martikainen, P.; Rouvinen, S.; Uotila, A. Forest fragmentation in Fennoscandia: Linking habitat requirements of wood-associated threatened species to landscape and habitat changes. *Scand. J. For. Res. 2001, 16*, 27–37. [CrossRef]

[36] Gjerde, I.; Wegge, P. Spacing Pattern, Habitat Use and Survival of Capercaillie in a Fragmented Winter Habitat. *Ornis Scand. 1989, 20*, 219. [CrossRef]

[37] Swenson, J.E.; Angelstam, P. Habitat separation by sympatric forest grouse in Fennoscandia in relation to boreal forest succession. *Can. J. Zool. 1993, 71*, 1303–1310. [CrossRef]

[38] Storch, I. Annual Home Ranges and Spacing Patterns of Capercaillie in Central Europe. *J. Wildl. Manag. 1995, 59*, 392. [CrossRef]

[39] Lindén, H.; Pasanen, J. Capercaillie leks are threatened by forest fragmentation. *Suomen Riista 1987, 34*, 66–76.

[40] Helle, P.; Helle, T.; Lindén, H. Capercaillie (Tetrao urogallus) Lekking sites in fragmented Finnish forest landscape. *Scand. J. For. Res. 1994, 9*, 386–396. [CrossRef]

[41] Lindén, H.; Danilov, P.I.; Gromtsev, A.N.; Helle, P.; Ivanter, E.V.; Kurhinen, J. Large-scale forest corridors to connect the taiga fauna to Fennoscandia. *Wildl. Biol. 2000, 6*, 179–188. [CrossRef]

(*Dendrocopos leucotos*), which requires relatively large patches of deciduous dominated forests with plenty of dead wood[42, 43, 44]. Since it is currently critically endangered in Sweden[45, 46], a large-scale restoration project was set up in the early 2000s to benefit the species[47]. However, it is shown that the effectiveness of the project could have benefitted from improved landscape planning, since in some areas sites dedicated for restoration were too few, small, or located too far from one another[48]. Restoration of forest ecosystems and allowing natural disturbances to promote unevenly aged forests with several successional stages and large amounts of coarse woody debris may be effective strategies that could potentially benefit several forest-associated species[49].

How does the legal control outside protected areas respond to situations as described above? Implementing the EU Nature Directives, Section 4 of the Swedish Species Protection Ordinance prohibits the damaging of breeding sites (and also resting places) for birds and certain other species. Following the EU Commission guidelines, this does not entail a protection of every single habitat. Instead, the "ecological functionality"

[42] Angelstam, P.K.; Bütler, R.; Lazdinis, M.; Mikusinski, 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.

[43] Aulén, G. *Ecology and Distribution History of the White-Backed Woodpecker Dendrocopos leucotos in Sweden*; Swedish University of Agricultural Sciences: Uppsala, Sweden, 1988; ISBN 91-576-3340-1.

[44] Carlson, A. The effect of habitat loss on a deciduous forest specialist species: The White-backed Woodpecker (*Dendrocopos leucotos*). *For. Ecol. Manag. 2000, 131*, 215–221. [CrossRef]

[45] Stighäll, K. *Dendrocopos leucotos*; Artdatabanken: Uppsala, Sweden, 2010.

[46] Artdatabanken. Available online: http://artfakta.artdatabanken.se/taxon/100046 (accessed on 28 August 2018).

[47] Naturvårdsverket. *Åtgärdsprogram för Bevarande av Vitryggig Hackspett (Dendrocopos leucotos) och dess Livsmiljöer. Action Plan for the Conservation of the Swedish Population of White-backed Woodpecker (Dendrocopos leucotos)*; Naturvårdsverket: Stockholm, Sweden, 2005.

[48] Hof, A.R.; Hjältén, J. Are we restoring enough? Simulating impacts of restoration efforts on the suitability of forest landscapes for a locally critically endangered umbrella species. *Restor. Ecol. 2017, 5*, 207. [CrossRef]

[49] Kouki, J.; Löfman, S.; Martikainen, P.; Rouvinen, S.; Uotila, A. Forest fragmentation in Fennoscandia: Linking habitat requirements of wood-associated threatened species to landscape and habitat changes. *Scand. J. For. Res. 2001, 16*, 27–37. [CrossRef]

of breeding sites must be safeguarded[50], which sometimes paves the way for a selection among several habitats for conservation (it is in practice sometimes complicated to determine the number of needed breeding sites, due to the lack of ecological data). However, in a fragmented forestry management and control, this selection may become random. The Swedish Forest Agency must allow the destruction of breeding sites in its case by case assessment of felling notifications until the remaining breeding sites are so few that the ecological functionality in the region is threatened. Then, in contrast, the Forest Agency is obliged to halt the next felling to comply with the Species Protection Ordinance (and the Habitats Directive). This "first come, first served" approach counteracts a strategic conservation approach and a prioritizing of the most valuable conservation objects.

Although the international obligations and framework conditions are identical for all EU member countries, national implementation of forest conservation policies can differ substantially between them. To put the Swedish example in perspective relative to other selected EU member countries we briefly describe forest conservation governance in four of the countries presented in Figure 1 that represent different regions of the EU: Germany, Portugal, Croatia, and Finland. In Germany, the federal law on forests provides general provisions at a national level, but the German "Länder" are responsible for the more detailed design of forest policies[51]. Moreover, biodiversity conservation in forests is addressed in various programs and strategies at different levels of governance. Portugal focuses on conservation through active sustainable forest management rather than the Scandinavian model of conservation through zero or minimal intervention. This is deemed necessary to cope with the high risk of forest fires and threats related to harmful biotic agents[52]. Croatia has more protected forest areas with no intervention than Portugal. However, approximately three-quarters of the forest area is State-owned and 18% forms part of

[50] Directorate-General for Environment. Guidance Document on the Strict Protection of Animal Species of Community Interest under the Habitats Directive 92/43/EEC. Available online: http://ec.europa.eu/ environment/nature/conservation/species/guidance/pdf/guidance_en.pdf (accessed on 28 August 2018).

[51] Weber, N. Participation or involvement? Development of forest strategies on national and sub-national level in Germany. *For. Policy Econ. 2018, 89*, 98–106. [CrossRef]

[52] European Commission. The EU Environmental Implementation Review Country Report—Portugal. COM (2017) 63 Final. Available online: http://ec.europa.eu/environment/eir/pdf/report_pt_en.pdf (accessed on 28 August 2018).

the national system of protected areas[53]. Forest owners are entitled to full compensation if the use of forest resources is prohibited for the sake of conserving a certain habitat or species[54]. In Finland, the preconditions for forestry are widely similar to Swedish conditions, as is the management system. To a large extent, conservation measures are conducted on a voluntary basis with only a minimum set of legal requirements, such as the protection of habitats of special importance[55, 56]. As many other EU Member States, Finland is struggling to implement the requirements in the EU Nature Directives. About 80% of the habitats protected by the Habitats Directive do not have a favourable conservation status[57], and although the wording of the Finnish legislation corresponds to the EU protection of breeding sites and resting places of listed species, such protection can be questioned in practice[58]. Landscape planning of forest management has been suggested as a tool for more sustainable forestry[59]. The existing landscape approaches in Finland, such as Regional Forest Programmes, are often general in nature and of less practical meaning in the concrete management[60].

5. Forest Landscape Planning

5.1 Background

Due to the problems described in Section 4, the chief question to be addressed in this part is if landscape planning can contribute to a more effective conservation of forest biodiversity. We will also discuss the plan-

[53] Lovric´, M.; Lovric´, N.; Schraml, U.; Winkel, G. Implementing Natura 2000 in Croatian forests: An interplay of science, values and interests. *J. Nat. Conserv. 2018, 43*, 46–66. [CrossRef]

[54] Lovric´, M.; Lovric´, N. Integration of Nature Protection in Forest Policy in Croatian; INTEGRATE Country Report. 2013. Available online: http://www.eficent.efi.int/files/attachments/eficent/projects/croatia.pdf (accessed on 28 August 2018).

[55] Pappila, M. Forestry and no net loss principle. The possibilities and need to implement NNL in forest management in Finland. *Nord. Environ. Law J. 2018, 1*, 60–74.

[56] Peltola, T.; Tuomisaari, J. Re-inventing forestry expertise: Strategies for coping with biodiversity protection in Finland. *For. Policy Econ. 2016, 62*, 11–18. [CrossRef]

[57] Pappila, M. Forestry and no net loss principle. The possibilities and need to implement NNL in forest management in Finland. *Nord. Environ. Law J. 2018, 1*, 60–74.

[58] Op. cit.

[59] Op. cit.

[60] Op. cit.

ning instrument as a tool to provide for more variation in forest production.

Forest planning is not a new policy instrument. It is already used in several countries (e.g., France and the USA). At EU level, the Parliament sees forest planning as an important policy tool in the strategy to implement the Nagoya decision. With reference to the Aichi target 5 (supra, Section 3), the Parliament calls upon the Member States to "adopt and implement forest management plans taking account of appropriate public consultation, including effective measures for the conservation and recovery of protected species and habitats and related ecosystem services"[61]. The Parliament views forest planning as one of the preventive tools to avoid conflicts with the strict protection of species in the Habitats Directive[62].

In Sweden, the obligation to adopt a forest management plan was abolished in 1994. Although many forest owners adopt such plans on a voluntary basis, the Swedish Government has stressed that the lack of planning in Swedish forests, and thereby the lack of knowledge, prevents the enforcement of environmental objectives and production goals[63]. With a few exceptions for larger forest companies, the management and conservation of Swedish forests are not planned from a landscape perspective.

While landscape planning is a challenge at the national level, creating a consistent management network across Europe is even more so. Related to Natura 2000 sites, Greenwood et al. argue that a key challenge in the future will be to develop ways to manage these sites across countries as a functioning ecological network[64].

[61] European Parliament resolution of 20 April 2012, On Our Life Insurance, Our Natural Capital: An EU Biodiversity Strategy to 2020 (2011/2307(INI), Item 75. Available online: http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/EP_resolution_april2012.pdf (accessed on 28 August 2018).

[62] Directorate-General for Environment. Guidance Document on the Strict Protection of Animal Species of Community Interest under the Habitats Directive 92/43/EEC. Available online: http://ec.europa.eu/environment/nature/conservation/species/guidance/pdf/guidance_en.pdf (accessed on 28 August 2018).

[63] En Skogspolitik i takt med Tiden. Prop. 2007/08:108. Government Bill, An Updated Forest Policy. Available online: https://www.regeringen.se/rattsliga-dokument/proposition/2008/03/prop.-200708108/ (accessed on 28 August 2018).

[64] Greenwood, S.; Jump, A.; Sotirov, M.; Marchetti, M.; Mikusinski, G.; Bastrup-Birk, A.; Brotons, L.; Hermoso, V.; Parviainen, J. Effectiveness of Natura 2000 in forests in

5.2 A System for Landscape Planning—Discussion

How should a landscape planning be performed and what should it contain? We assume in the following that forest planning, for ecological reasons, includes a relatively large geographical area with several forest stands.

Firstly, the planning would necessitate a prior assessment of the distribution and suitability of habitats and of important forest characteristics (e.g., deadwood levels, stem density, the presence of gaps) within the area. The focus could be to create a landscape in which species of conservation importance (SCI), e.g., rare or red-listed species[65, 66] will survive with viable populations. By using a number of SCI with known habitat requirements as landscape value indicators, it is possible to identify which kind of habitats and substrates are important to conserve or develop, such as specific types of dead wood, forest age, tree composition etc. Data on habitat quality is available on different web-pages (e.g., http://skogskarta.slu.se/ and http://mdp.vic-metria.nu/ miljodataportalen/) or through different national (authorities and universities) and regional (county administrations) surveys. Thus, it is possible to match habitat requirements with habitat availability on a landscape level and in this way identify which areas should be prioritized for conservation and which have the least priority. However, for landscape planning, not only stand quality is important, but also the juxtaposition of the stand in the landscape. The connectivity between stands, habitat area, availability of stepping stones etc., are important factors for long-term sustainability, and these factors should also be included when prioritizing stands for conservation or management. Ideally, not only present qualities of the landscape, but also former qualities should be included by conducting a gap analysis. This analysis is important in order to understand potential extinction debts and for producing guidelines on restoration requirements. However, this final step is very time consuming and not always possible, at least not if landscape planning will be performed on larger scales. There are several free conservation planning tools available to aid planners in making edu-

EU-28. In *Natura 2000 and Forests: Assessing the State of Implementation and Effectiveness*; Sotirov, M., Ed.; European Forest Institute: Joensuu, Finland, 2017.

[65] Hallingbäck, T. *Naturvårdsarter—Species of Conservation Interest*; Artdatabanken SLU: Uppsala, Sweden, 2013.

[66] De Jong, J.; Dahlberg, A. Impact on species of conservation interest of forest harvesting for bioenergy purposes. *For. Ecol. Manag. 2017, 383*, 37–48. [CrossRef]

cated decisions in landscape planning (e.g., ZONATION (https://www.helsinki.fi/en/researchgroups/metapopulation-research-centre/software), and MARXAN (http://marxan.org/)).

By providing the ecological information necessary in order to select areas for conservation, the plan can, at an early stage, prevent the negative effects of a "first come first served" approach (see Section 4). The plan can pave the way for early decisions that promote ecological functionality of breeding sites. Such a preventive approach is recommended by the EU Commission[67]. However, whether ecological functionality is actually achieved by the planning depends on various factors, such as whether the plan is legally binding or not (see below).

Furthermore, the assessment can indicate that some of the areas lack significant conservation values and potentials. The plan may indicate that such areas should be used for more intensive forestry, e.g., in order to provide for biofuel harvesting, which can be one part of the fulfilment of Sweden's climate and energy policies. For such areas, the general nature conservation requirements, stipulated in the Swedish forestry legislation, may seem unnecessary. It may also be regarded as rational to make exemptions from some other restrictions in the forest legislation, e.g., regarding fertilization or the use of exotic tree species (cf. the Triad model, [57]). Such legal derogations would indicate a substantial shift in Swedish forest policy and require political decisions. Given such a political position, a forest landscape plan would be the core implementation instrument to use in order to select those forest stands, lacking significant conservation values, which can be relieved from certain legal restrictions. The present state forestry control, including the system of felling notifications, would be inadequate in this respect[68].

Several legal and governance issues are related to landscape planning and different options are possible. It is for instance necessary to discuss if there should be one single overarching master plan or a system with several planning levels instead, e.g., a master plan followed by different, detailed operation plans for particular forest stands. The legal status of a

[67] Directorate-General for Environment. Guidance Document on the Strict Protection of Animal Species of Community Interest under the Habitats Directive 92/43/EEC. Available online: http://ec.europa.eu/environment/nature/conservation/species/guidance/pdf/guidance_en.pdf (accessed on 28 August 2018).

[68] Michanek, G.; Pettersson, M. *Rättsliga Förutsättningar för Intensivodling av Skog: Faktaunderlag till MINT-Utredningen*; Sveriges Lantbruksuniversitet: Uppsala, Sweden, 2009; p. 42.

landscape plan is also crucial. If the plan includes legally binding restrictions for landowners, it would be effective in relation to the conservation objective, but the planning process would probably be relatively long, not least as affected landowners would have the right to appeal to the planning decision and to claim for economic compensation. It would also be complicated to afterwards change a plan where the obligations are "settled". If the plan instead has the status of a guideline, or is binding merely for authorities in their subsequent decision making, the planning process should be faster and the content of the plan could afterwards more easily adapt to new knowledge on the ecological situation etc. Where a plan is not legally binding for landowners, these persons' rights to appeal and compensation would be triggered first when a conservation authority—on the basis of the plan—takes a decision in an individual case, e.g., if the Forest Agency decides to establish a "biotope protection area" for a particular habitat.

Yet another important issue is how to develop a legal framework for participation in the planning process, involving authorities, landowners and the public, including environmental organisations. In order for the planning system to be regarded as legitimate and to provide for adequate ecological information on the particular forest stands, the law should set up certain minimum requirements to guarantee dissemination of information, consultation with involved parties, public meetings etc. There are several legal statutes that may serve as models for public participation provisions, e.g., the Plan and Building Act (2010:900).

6. Tax-Fund System

6.1 Background

A landscape forestry planning with stricter conservation requirements than stipulated in the forestry legislation may directly or indirectly trigger the constitutional right to compensation for forest owners (see above, Section 4). It is reasonable to assume that the constitutional protection of ownership is politically established and will not be significantly altered for a long time. It is also very likely that state resources for compensating landowners from time to time will be scarce in the future, as they have been in the past. Voluntary measures have been and can be successful, but they cannot assure a sufficiently strong, long-term protection, nor that priority is given to the most valuable objects from a conservation point

of view. If the above assumptions are correct, an alternative form of financing is necessary[69] to ensure the necessary conservation. The fact that state financial resources for conservation are limited makes economic efficiency all the more important.

One could argue that forest owners should have a collective corporate social responsibility for the landscape they manage, which includes striving to achieve national biodiversity objectives and complying with EU legislation. The Swedish hydropower sector is a case in point. The sector has recently agreed to carry the costs for the review and environmental updating of old permits for numerous installations within the entire sector (including compensation to operators). The commitment is one part of a proposed new water management policy with the purpose to fulfill Sweden's obligations according to the EU Water Framework Directive[70].

For such a change in the code of conduct, where the forest sector takes a collective responsibility, landscape policies need to be readily available to divide the burden of conservation among forest owners. A tax-fund system, building on the concept of common but differentiated responsibility among forest landowners, could serve as a solution[71]. In a tax-fund system, all forest owners in the landscape periodically make a monetary contribution (e.g., a tax or fee) that is collected in a fund. The proceeds are then used to compensate forest owners that must comply with restrictions that considerably restrict their ongoing land use. Both the collection and redistribution of the monetary contributions can be designed in many ways, each with different advantages and challenges.

Croatia is the only EU country that, to the best of our knowledge, has piloted a tax-fund system related to forests. This Green-Tax is prescribed in the Croatian Law of Forests. It raises a fee on revenues of all economic activities by legal and physical persons in Croatia. The state forest com-

[69] Michanek, G. Artskyddet, politiken och juridiken: Species protection, politics and law. In *Särtryck ur Boken Bertil Bengtsson 90 år*; Blomstrand, S., Mattsson, D., Skarhed, A., Eds.; Digitala Vetenskapliga Arkivet: Uppsala, Sweden, 2016; pp. 383–397.

[70] Prop. 2017/18:243, Vattenmiljö och Vattenkraft. [Government Bill, Water Environment and Hydro power]. p. 74. Available online: https://data.riksdagen.se/fil/FC5D5C9C-440D-459B-A15E-7610DEE5C910 (accessed on 28 August 2018).

[71] Zabel, A.; Bostedt, G.; Ekvall, H. Policies for forest landscape management—A conceptual approach with an empirical application for Swedish conditions. *For. Policy Econ. 2018, 86*, 13–21. [CrossRef]

pany receives the proceeds to support the provision of generally beneficial functions of the forest, which, inter alia, includes forest conservation[72].

6.2 Collection of Funds

The collection of funds among forest owners in the landscape can be achieved through a tax or fee, as in the Croatian example, which itself needs to be carefully designed, taking into account its regulatory steering power. For example, harvest taxes, such as a yield tax levied on harvest revenue or a unit tax levied on the volume of harvested timber, are known to create incentives for delaying harvests. By contrast, a timber tax levied on the value of trees creates incentives to harvest earlier. Lump-sum taxes such as a site productivity tax based on the yield potential have no effect on the timing of harvests[73, 74].

6.3 Distribution of Funds

The choice of the distribution method depends on the relative weight given to different criteria such as implementing a predefined conservation plan, achieving maximum connectivity between forest habitats set aside, or targeting specific species such as the already mentioned capercaillie and white-backed woodpecker.

If an ecological landscape plan exists that defines which forest habitats have highest priority, the fund can be used to compensate forest owners for considerable obstruction of their ongoing land use, as discussed above. However, such a heavy-handed top-down approach is unlikely to be appreciated among landowners. Where legally possible to choose between different conservation alternatives, bottom-up approaches can be an interesting option, allowing interested forest owners to jointly submit a proposal for forest conservation activities to protect habitats. Experiences with such approaches have been gained in Australia and Germany where farmers voluntarily form land stewardship groups that propose

[72] Lovric´, M.; Lovric´, N. Integration of Nature Protection in Forest Policy in Croatian; INTEGRATE Country Report. 2013. Available online: http://www.eficent.efi.int/files/attachments/eficent/projects/croatia.pdf (accessed on 28 August 2018).

[73] Amacher, G.S.; Ollikainen, M.; Koskela, E. *Economics of Forest Resources*; MIT Press: Cambridge, MA, USA, 2009.

[74] Englin, J.E.; Klan, M.S. Optimal taxation: Timber and externalities. *J. Environ. Econ. Manag. 1990, 18*, 263–275. [CrossRef]

biodiversity conservation actions[75]. If funded, farmers collaborate in implementing the conservation actions. This approach can be transferred to the forest context where, as discussed above, conservation measures implemented across adjoining estates are often more effective than measures implemented at the single estate level. Although based on voluntary solutions, a bottom-up approach could function as an important part of a preventive management model implementing, for example, EU requirements on ecological functionality.

When connectivity between set aside sites is given high priority, agglomeration bonus payments can be offered as an incentive to set aside contiguous forest areas[76, 77]. An agglomeration bonus is an incentive payment that is offered to forest owners who protect habitats on plots adjacent to their neighbours' conservation sites.

If the intention is to reward the actual occurrence of certain species, results-based payments can be an interesting policy option to top-up an area-based payment. Results-based payments are issued contingent on the abundance of the species in question. However, results-based payments require monitoring of the species in question, which can come at considerable costs. Furthermore, successful recovery of the species may be hampered by other factors not directly related to the forest characteristics in the set-aside area itself, e.g., when numbers of species are generally low or the species is not very mobile. Sweden has pioneered this approach for carnivore conservation in the reindeer herding area, with payments based on the annual number of carnivore offspring in defined areas[78].

In situations without a clear ranking of priorities for conservation sites, a reverse-auction can help achieve a cost-efficient solution. In a reverse-auction, forest owners place a bid containing a description of the conservation actions they propose to implement on their estate together

[75] Prager, K.; Vanclay, F. Landcare in Australia and Germany: Comparing structures and policies for community engagement in natural resource management. *Ecol. Manag. Restor. 2010, 11*, 187–193. [CrossRef]

[76] Parkhurst, G.M.; Shogren, J.F. Spatial incentives to coordinate contiguous habitat. *Ecol. Econ. 2007, 64*, 344–355. [CrossRef]

[77] Bell, A.; Parkhurst, G.; Droppelmann, K.; Benton, T.G. Scaling up pro-environmental agricultural practice using agglomeration payments: Proof of concept from an agent-based model. *Ecol. Econ. 2016, 126*, 32–41. [CrossRef]

[78] Zabel, A.; Bostedt, G.; Engel, S. Performance Payments for Groups: The Case of Carnivore Conservation in Northern Sweden. *Environ. Resource Econ. 2014*, *59*, 613–631. [CrossRef]

with the monetary amount they request. Policymakers can then choose and finance bids that offer the best ratio between conservation improvement and cost. The reversed auction approach was piloted in Finland and later tested in Sweden[79, 80].

These are just a few examples of how the collection and distribution of funds could be designed. Which combination is optimal will depend on the goals, specific regional context, and existing policy mix.

This is also relevant should landscape planning of private land be introduced, when the plan directly (if in itself legally binding) or indirectly (if guiding subsequent decisions on restrictions) limits felling and other forestry measures.

7. Conclusions

Conservation biology research indicates a need for a broad geographical approach to select the most appropriate habitats for conservation and to provide for a functioning connectivity between different habitats. Functional connectivity includes a more dynamic conservation strategy, by not only conserving but also developing and restoring conservation values in managed forests based on historical land use and species occurrence. The present fragmented forestry in Sweden, conducted on a great number of privately owned real estates, counteracts such an overall ecological consideration. In line with the EU Commission, we argue that landscape forestry planning could be a useful remedy in this respect. By indicating, in good time, how best to achieve ecological functionality in a large area, the planning would counteract future conflicts between felling etc., and the strict prohibitions in the Species Protection Ordinance. On a broader scale, the planning should promote the achievement of international, EU, and Swedish political objectives for biodiversity. The planning may promote a more differentiated forestry; it may, inter alia, contribute to the fulfilment of Sweden's climate and energy policy, by indicating forest areas with insignificant conservation values, where intensive forestry may be performed for biomass production etc., possibly exempted from today's legal requirements on nature conservation, etc.

[79] Parviainen, J. Cultural heritage and biodiversity in the present forest management of the boreal zone in Scandinavia. *J. For. Res. 2017, 20*, 445–452. [CrossRef]

[80] Primmer, E. Institutional constraints on conservation auction: Organizational mandate, competencies and practices. *Land Use Policy 2017, 63*, 621–631. [CrossRef]

The planning may serve as a base for both legal administrative enforcement and voluntary agreements.

Implications for management of a forest landscape based on such planning may demand that some areas, particularly valuable for biodiversity, be (permanently) set-aside from forest management for species conservation purposes. Other areas that could provide connectivity between areas valuable for biodiversity may need to be restored or may require short-term human interventions. One can think of increasing levels of dead wood and removing coniferous trees in favour of deciduous trees. However, harvest levels may increase in those areas not identified as valuable for biodiversity or that could serve as a corridor or stepping stones between areas that are valuable for biodiversity.

To provide for accurate ecological information and for legitimacy reasons, the assessments and decisions related to the landscape planning should include public participation. This also obviously includes the forest owners. Furthermore, in order to solve the problem of insufficient state resources for compensating forest owners that are legally entitled to compensation, due to conservation requirements in the plan, we raised the question if a tax-fund system could be an appropriate complementary alternative. There are several alternatives regarding how to design the collection of taxes and the distribution from the fund. Where legally possible, such a system should open for voluntary agreements between forest owners on how to protect habitats within a large area.

Author Contributions: Although all authors were involved in the structuring and writing of the entire article, they have more specifically contributed as follows. Main editor and coordination: G.M.; Ecology and forest biology: A.R.H., J.d.J. and J.R.; Law and policy: M.F. and G.M.; Economics and policy: G.B., H.E. and A.Z.

Funding: This research was funded by Naturvårdsverket (the Swedish Environmental Protection Agency), grant number DNR 15/243.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.