

Wolves are Mobile, While Fruit Trees are not! How Characteristics of Resources and Supranational Regulatory Frameworks Shape the Provision of Biodiversity and Ecosystem Services in Germany

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ABSTRACT

This paper scrutinizes determinants of regional-level institutions regulating the provision of biodiversity and ecosystem services. Two cases of maintaining ecosystem services, provided by quite different resource systems, are compared: the protection of wolves and the management of a high nature value agroforestry system, scattered fruit tree meadows. Taking an abductive approach, we suggest that the distinct characteristics of resources – in particular the mobility of resource units – and differences in the overarching European regulatory framework – the obligation to protect wolves versus voluntary compensation payments to maintain scattered fruit tree meadows – largely explain the existing institutional structures at regional level. Cost-effectiveness considerations concerning the transaction costs of governance seem to act as determinants for the design and implementation of regional institutions. Livestock depredated by wolves is protected by a liability rule and hierarchical governance structures. In turn, maintenance of scattered fruit trees is subject to a property rule and voluntary long-term agreements. Copyright © 2012 John Wiley & Sons, Ltd and ERP Environment

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Introduction

WHAT DETERMINES THE DESIGN AND PERFORMANCE OF INSTITUTIONS THAT REGULATE THE PROVISION OF biodiversity and ecosystem services? From an institutional economics perspective, we propose that characteristics of natural resources (roughly equated with the biophysical problem structure) and supranational policy frameworks (here, EU regulations and their respective national transpositions) jointly shape governance structures and property rights to regulate concrete transactions at the regional level.

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We partly relate this argument to Williamson's discrete alignment hypothesis, which holds that actors choose those institutions that minimize transaction costs, given the particular characteristics of the transaction to be regulated (Williamson, 1998; Bougherara *et al.*, 2005). To illustrate our argument, we have selected two examples of biodiversity and ecosystem service provision with distinct legal and political features at the supranational, national and regional levels, yet having a similar *general* regulatory, administrative and political context, namely that of two German federal states (*Länder*). We look at wolf management in the state of Saxony (Upper Lusatia) and the maintenance of a high nature value agroforestry system, scattered fruit tree meadows, in the state of Baden-Württemberg, making comparisons on the analytical level in terms of specific abstract categories, such as the effect of transaction characteristics on institutional set-up.

Our work is related to the literature on common pool resource (CPR) management, as biodiversity and the ecosystem services in question have the characteristic of being rival in consumption, and exclusion from them is difficult. Many studies have elaborated on how institutional settings and policy measures change ecosystems at the landscape scale (e.g. Ryszkowski, 2002; Berger *et al.*, 2006). Yet, few authors have addressed the ways in which properties of natural resources shape the provision of ecosystem services (Agrawal, 2002). There are notable exceptions, however. Wade (1988), Ostrom (1990) and Balland and Platteau (1996) consider – among other aspects – the size of a resource system and the clarity of its boundaries to humans to be important. Concerning wildlife, Moseley (1999) shows that extensive movement makes wildlife less suited to local management, as large home ranges often limit the predictability of resource availability (Naughton-Treves and Sanderson, 1995, quoted by Agrawal, 2002, p. 56) and make human–carnivore conflicts (food and space) more unpredictable (Treves and Karanth, 2003). Schlager *et al.* (1994) conclude that high resource mobility and storage difficulties make the implementation of institutions to overcome CPR dilemmas more difficult, as they reduce reliability and increase costs of information involved. Meanwhile, another study emphasizes the role of different types of irreversibility in resource management (Theesfeld, 2009). Evidently then, several authors have concluded that physical characteristics of resources – which shape the characteristics of transactions – do affect the ways in which CPR provision and consumption problems are resolved (e.g. Agrawal, 2001; Theesfeld, 2004). Still, large research gaps remain to be filled.

The objective of the present study is to add to this literature. Since it is difficult to 'empirically prove' direct causal links between a specific resource characteristic and observed institutional structures, we have formulated an abductive analysis that is rooted in pragmatism and provides data- and theory-informed 'reasons [...] for particular actions' (Bromley, 2008, p. 2), from which we offer explanations. Abductive research investigates the plausibility of specific explanations arrived at through inference. These explanatory hypotheses are then maintained until other explanations are formulated that scientists agree to be more convincing. In a further abductive step, the plausibility of assumptions under which explanations are generated is also examined. This process continues until reasons are found outside the domain for which a specific set of assumptions holds (Bromley, 2008, pp. 2–3). Thus, for example, underlying cognitive and psychological causes of human behaviour need to be established in order to be able to maintain assumptions about human behaviour, or political processes need to be understood in order to explain the ways economic activities are regulated. In this paper, we wonder if – and to what extent – cost-effectiveness considerations can be presumed to be guiding the way governance of nature-related transactions is organized in cases where regional governance aims to implement specific supranational policy objectives. Thus, we examine whether striving for cost-effectiveness on the part of the regional government provides sufficient – or plausible – explanation for the governance structures that we observe empirically at the regional level (see Figure 1). However, we neither examine the quantitative details of the applied cost-effectiveness calculations nor investigate empirically whether such economic thinking was indeed at the core of the political debate when the regional policies under scrutiny were being designed. These points are beyond the scope of this article, and we leave them open for future research.

Although processes through which supranational legislative requirements are politically and legally formulated are obviously important (see, e.g., Hiedanpää and Bromley, 2011), we consider supranational policies as given, focusing solely on their effects on policies and subsequently induced (re-)distribution of resource-specific property rights at subnational such as specifically regional levels. In the cases examined here, regional policies have emerged because of societal re-evaluation of cost and benefit streams originating, among other reasons, from changes in the intensity of threats to ecosystem services provided by scattered fruit tree meadows and increased levels of threat to livestock from wolves.

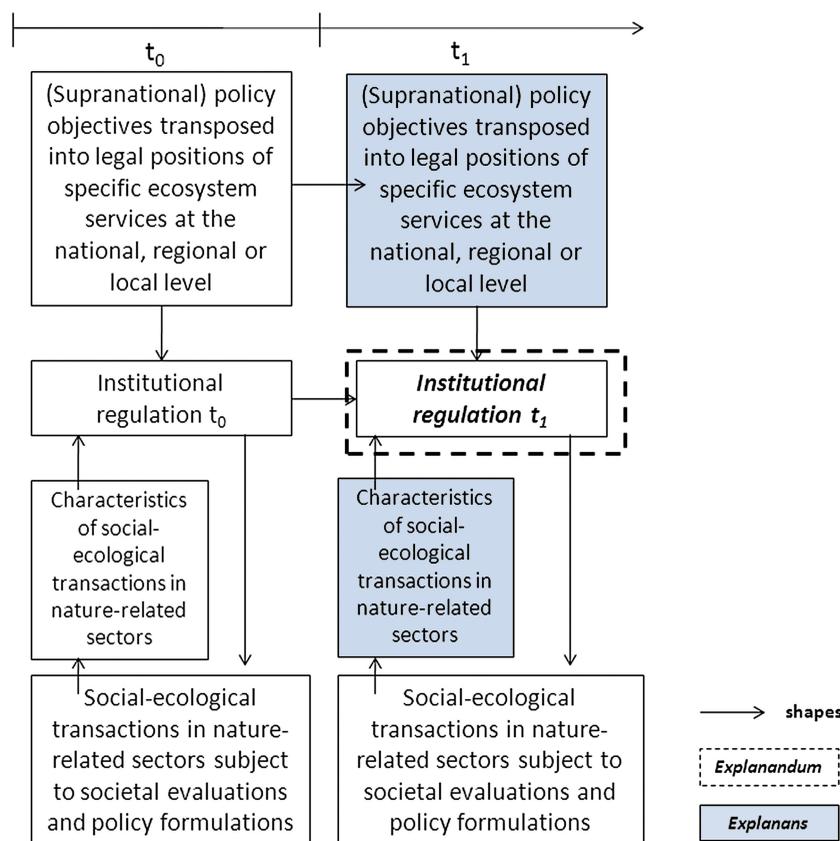
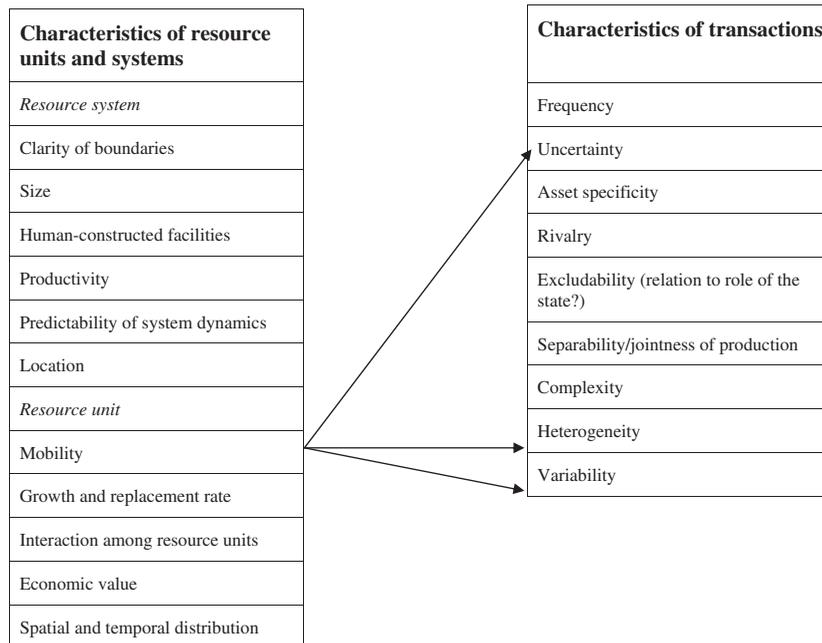


Figure 1. Logic of explanation used for this paper (focus of analysis on t_1)

In what follows, we first introduce our analytical perspective and empirical approach. Second, we present the empirical cases. Third, we apply our analytical lens to the empirical cases and make comparisons. Finally, we summarize our argument and provide brief recommendations for further work.

The Eco-Institutional Study of Social Regulation

This paper is framed around the concept of biodiversity and ecosystem service provision (MA, 2005) and considers social–ecological transactions in nature-related sectors to be basic units of analysis (Hagedorn, 2008). We understand ecosystems as providers of several interdependent services through multiple, interdependent transactions (Thiel, 2010). Social–ecological transactions in nature-related sectors entail interrelated changes in utility of two actors mediated by the non-human, biophysical system, subject to intentional action (agency) by at least one actor. We also presume that the state, on behalf of its citizens, can enter into such transactions (cf. Bougherara *et al.*, 2005). Such deliberate actions by an actor may, however, not only induce the intended and desired transaction with the targeted transacting partner(s); rather, mediated by the biophysical system, the same activity may also cause unintended transactions with other transacting partners. Whether a transaction is desired or not depends on evaluations by the transacting partners or society as a whole of cost and benefit streams related to it – and, thus, to the ecosystem services provided thereby. In many cases, these transactions exhibit characteristics of public goods, such as no or low rivalry and no or limited excludability. For the analysis of nature-related transactions, however, other transaction characteristics also need to be considered, including heterogeneity, variability, frequency, asset specificity, separability, jointness of production, and complexity (Hagedorn *et al.*, 2002). These shape ecosystem services and are, in turn, shaped by characteristics of resource systems and resource units, for example mobility



Source: own compilation, based on Agrawal, 2002; Ostrom, 2007; Hagedorn *et al.*, 2002; Williamson, 1998.¹

Figure 2. Definition and interrelation of resources and transaction characteristics

of resource units or clarity of boundaries (cf. Ostrom, 2007; see Figure 2). Transaction properties are specific to the social and ecological systems in question and are hinged on the interdependence between actors as mediated by non-human nature (Paavola and Adger, 2005). In our empirical cases, physical transactions are prompted – at least indirectly – by specific policies.

New Institutional Economics considers transaction costs – meaning the costs of actors informing themselves about options as well as the costs of negotiating, agreeing, monitoring, enforcing and adapting institutions (Dahlmann, 1979) – to be determined by transaction characteristics. Transaction costs matter, as information is costly and actors are assumed to be boundedly rational and acting opportunistically when given an opportunity for rent-seeking. Under these conditions, institutions are supposed to provide certainty concerning the behaviour of transacting partners and help in reducing transaction costs. In the context of social–ecological interactions, we view institutions as

sets of interrelated rules governing given aspects of social life which are acknowledged (or sanctioned) by all or some members of society. They regulate relationships among individuals and between the social and ecological systems, i.e. rights and duties as well as costs and benefits of actions [...]. They therefore [...] link social and ecological systems (Gatzweiler and Hagedorn, 2002, p. 3).

Thus, institutions entail property rights and governance structures. Property rights provide actors with

a claim to a benefit stream that some higher body – usually the state – will agree to protect through the assignment of duty to others who may covet, or somehow interfere with, the benefit stream. Rights have no meaning without correlated duties (Bromley, 1992, p. 2).

From a policy perspective, property rights are the outcome of politics, which decide on the ‘incidence of costs and benefits’ concerning, for example, biodiversity conservation and comprise several symmetrical legal correlates (Bromley, 1991, p. 22). We base our investigation on a static framework where a *right* for A implies a *duty* for B

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and where the state has an active, enforcing role. Alternatively, A has a *privilege* of no interference and B, therefore, has *no right* to interfere, giving the enforcing higher authority a passive role. Through the definition of property rights, coercive units play an important role in resolving environmental conflicts. Governance structures sanction property rights (Williamson, 1985) and may entail property regimes (e.g. state, private), entitlement structures and other structures, such as knowledge systems, management plans, dispute-settlement arrangements and monitoring infrastructures (Hagedorn, 2002). Bromley (1991) qualifies the analysis of governance structures by proposing that they differ in the ways in which they back up property rights to specific components of nature and with respect to the levels and distribution of situation-specific transaction costs. Property rights that are protected by a *property rule* are safeguarded against unwanted (and proscribed) incursions of either a physical or economic nature. Thus, a property right has to be acquired by the interfering actor *before* interference can legitimately take place. Having a right that is protected by a *liability rule* assures that ‘the party committing that act [of interference] is [ex post] liable for damages’ (Bromley, 1991, p. 49).

Based on this theoretical toolbox, our analytical strategy is as follows. First, for each case we describe the two dimensions of the *explanans*:

- a the focal transactions singled out for analysis, their characteristics, the resource units at stake that provide for specific (ecosystem) services or benefits and for biodiversity conservation, as well as the transacting partners;
- b the relevant supranational policies and pre-existing regional institutional structures concerning biodiversity conservation and ecosystem service provision.¹

We limit this description to those features that we believe are relevant for the *explanandum*, that is, the changes in property rights and governance structures at the regional level that have been developed to socially regulate the transactions under scrutiny. Second, we ask whether, and if so how, property rights and governance structures at the regional level reflect the differing characteristics of the resources and transactions in question and the distinct features of the relevant supranational policies related to them.

The subsequent description and analysis of the two case studies is empirically based on the scientific literature on ecological, economic, social and political aspects of the management of wolves and scattered fruit tree meadows; international, national and regional legal documents; regional planning materials and publications of regional state authorities and agencies.

Wolf Management in Upper Lusatia

In 2000, for the first time in almost 100 years, wild wolves were born in the Eastern part of Germany, in Upper Lusatia. Only nine years later, seven wolf packs comprising around 35–50 wolves were roaming across an area of ca. 2500 km². This area is mainly situated in the state of Saxony, but also stretches into the neighbouring state of Brandenburg (Kluth and Reinhardt, 2009). Wolf habitats range over large territories – often over hundreds of kilometres; they are top-predators that naturally occur at relatively low densities. Therefore, management of wolves cannot be easily organized within confined protected areas, as their respective habitats usually cross administrative and political borders (Gehring and Potter, 2005).

The natural migration of wild wolves into Upper Lusatia has been having substantial effects on biodiversity and ecosystem services in the regional landscape and beyond. Wolves have considerable impact on the provisioning services of cultural landscapes, as they prey on wild game, but they simultaneously provide a regulating service, as they kill weak and ill wild game, stabilising respective populations. At the landscape level, wolves also provide cultural services; they contribute to the touristic value of a region, encourage scientific research activities and may be important for the cultural identity of local people (Balzer, 2010). However, wolves also prey upon livestock, such as sheep and goats, as they usually choose targets that are easiest to attack. Unlike wild game, livestock have a low

¹It should be noted that the respective supranational legislation may have enabled – or at least substantially fostered – the transaction under scrutiny in the first place. However, we do not regard the transactions investigated as *direct* outcomes of the implementation of the respective supranational policies.

ability to escape such attacks. Both commercial and non-commercial livestock holders can be affected in the process. Wolves are also a source of human fears of the wild (Kaczensky, 2006). Conflicts with wolves have been reported from other European countries, too (Bisi *et al.*, 2007; Ratamäki, 2008).

Most of the benefits derived from the maintenance of wolf populations, such as enriched biodiversity and touristic attractiveness, have an effect on higher spatial scales of society. Potential costs, in contrast, fall disproportionately on rural communities within the range of wolf populations. Thus, wolves are directly and indirectly affecting human well-being in a number of contradictory ways. We focus here on conflicts caused by preying upon livestock, which is at the core of acceptance problems of wolf conservation and has resulted in elaborated forms of social regulation.

Focal Transaction and its Characteristics (Explanans I)

In investigating wolf management, consideration must be given to what we call the wolf–livestock nexus, that is, the fact that wolf protection comes at the cost of unintended conflicts with animal husbandry, due to their biophysical interrelation.² Currently, the institutional structure of this nexus at the regional level is in accordance with the politically dominant aim of wolf protection, as the national state – on behalf of the ‘supranational state’ and those that hold an interest in the existence of wolves – transacts with those that contribute to wolf maintenance, such as hunters that refrain from culling them. As wolf populations grow, numbers of livestock (principally sheep) potentially diminish. Livestock owners, therefore, have an incentive to cull wolves in order to prevent damage being done to their livestock. Alternatively, they can actively avoid wolf attacks on livestock by non-lethal prevention measures, such as fencing, for which they need to make significant investments. The state – acting on behalf of its constituents and/or due to supranational legislation – has been intervening in this setting by providing incentives not to harm wolf populations. Thus, it has reformulated property rights and governance structures in ways favouring wolf protection, primarily in restricting the actions of hunters and livestock owners by banning the killing of wolves. The intended transactions between the state and those interested in wolf protection, on the one hand, and everyone who contributes to, or suffers from, wolf protection, on the other, are the outcome of this change in institutional structures. Furthermore, because of its biophysical embeddedness, restraint on hunting implies transactions between hunters (and sometimes even livestock owners) who refrain from culling wolves and livestock owners who suffer from preying upon livestock. Consequently, the state has become indirectly involved in unintended transactions between hunters who facilitate thriving wolf populations and livestock owners who suffer from losses of livestock due to increasing wolf populations. In the following, we focus on the way the regional state in question is seeking to regulate this unintended nature-related transaction (see Figure 3).

Wolf attacks on livestock reduce the number in the respective flocks of sheep or goats. There is strong rivalry in consumption, but the number of livestock killed per incident can be considered to be moderate. Since 2002, wolves in the Saxony part of Upper Lusatia have preyed upon over 200 heads of livestock in 50 incidents. In almost all incidents, the respective flocks were not (sufficiently) protected against wolves (SMUL, 2009). Naturally, such transactions can be considered irreversible.

While the effects of the attacks are local, the likelihood of these unintended transactions (wolves attacking livestock) occurring at a particular time and place, as well as the overall frequency of attacks, is extremely difficult to predict, as wolves are very mobile and their habitats may shift over time. The quantitative impact (damage) of attacks depends on the availability of wild game, the size of the respective wolf pack and the amount of livestock in the region (Kluth and Reinhardt, 2009). In this sense, we consider the transaction to be complex and interdependent with other natural resources and human activities, adding to its variability, heterogeneity and uncertainty.

Income losses due to wolf attacks can be avoided by investment in protective measures, such as electric fencing of herding areas, and acquisition and training of special herd-protection dogs. That is, wolves can be excluded from preying upon livestock; such protective measures also have moderate asset specificity (e.g., fencing material and dogs may be re-used) (SMUL, 2009).

²In order to more comprehensively capture the properties of the transaction, we have needed to look at the distinct characteristics of both strongly interrelated resource units – wolves and sheep – within the natural resource system under scrutiny.

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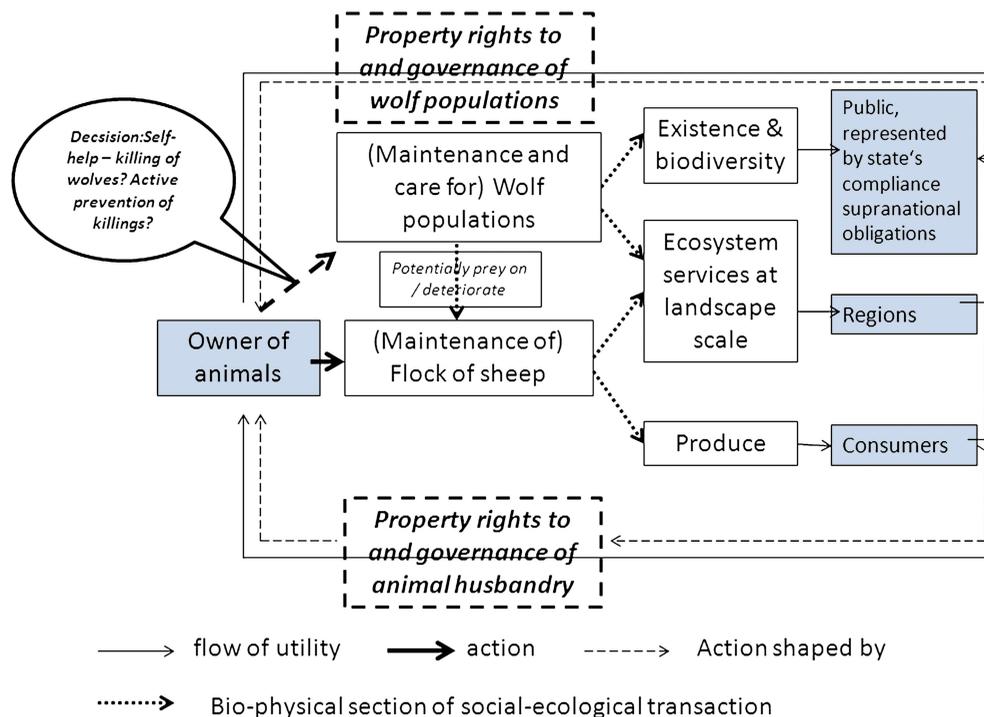


Figure 3. The interlinked transactions concerning wolf protection and sheep preyed upon

Supranational and National Regulatory Framework (Explanans II)

While migration of wolves into Upper Lusatia is a natural phenomenon, the persistence of wolf-pack settlement and increase in their number – that is, maintenance of this particular feature of biodiversity in the region – are predominantly facilitated by state activities. Most important is the strict prohibition on killing or harming wolves, with the exception of cases where human lives are in immediate danger or their presence has significant societal economic consequences (EC, 1992, Annexes II and IV). Further, translocation of individual wolves or wolf packs is forbidden. The strict protection of wolves induced by the Habitats Directive is based on the assessment that wolves are critically endangered in most member states of the EU. Although wolves are fairly well adapted to strongly human-dominated European landscapes, fear and narrow economic interests have often resulted in massive intentional killings of wolves by humans, posing a constant threat to wolf-population viability (see, e.g., Treves and Karanth, 2003, p. 1492).

In order to allow wolf packs to thrive they are now left to self-regulation, which in turn affects the likelihood of attacks on livestock. Nevertheless, the state has banned the hunting of wolves, even to prevent attacks on livestock. Sanctions for noncompliance are severe and may include prison sentences, making this protection measure relatively effective.

Institutional Structures at the Regional Level (Explanandum)

In order to cater to the maintenance of wolves while seeking to avoid or mitigate undesired effects, state authorities at the regional level have changed the institutional structures into which killing of wolves and holding of livestock are embedded. Here, overall biodiversity conservation as an underlying motivation for supranational wolf protection was a major driving force for the way in which property rights and governance structures addressing animal husbandry were modified when wolves resettled in Upper Lusatia. These changes address incentives associated with livestock-owner options to either accept the killing of livestock by wolves, to cull wolves or to prevent livestock killings through fences or other prevention measures.

In order to avoid consequences such as economically motivated poaching of wolves by livestock owners and to increase social acceptance of wolf protection, ex post compensation schemes for damages as well as support schemes for ex ante protective measures have been introduced by state and semi-state authorities as well as by

private organizations (regarding other countries, see Treves *et al.*, 2009). The Nature Protection Law of Saxony financially compensates for losses incurred by commercial and non-commercial holders of preyed upon livestock, subject to two conditions. First, within the so-called wolf area (i.e. the area presumably covered by wolf packs) plus an additional buffer zone of 30 km, livestock holders have to implement protective measures (e.g. herd protection dogs and/or suitable fences). Outside the wolf area, *all* damage to livestock by wolves is compensated for – irrespective of protective measures. To account for the roaming of wolves, the officially defined wolf area is extended once a wolf pack settles in an area outside the currently demarcated territory. Owners of livestock need to undertake preventive measures within one year after such an extension. In Saxony, commercial livestock holders can apply for financial assistance up to 60% of the costs of preventive measures under a Support Directive for ‘Natural Heritage’ (SMUL, 2009).

As a second condition for receiving compensation payments, livestock holders have to report each incident to the district authorities within 24 hours for evaluators to assess compensation eligibility (SMUL, 2009). In addition to the described policies – and in order to research suitable wolf habitat conditions and behaviour so as to improve their habitat and increase their acceptance among the general public – a *wolf management system* was established by the state of Saxony in 2009 (SMUL, 2009). Other environmental, non-governmental organizations complement the wolf management in Saxony by providing financial support and technical advice, including the Society for the Protection of Wolves (GzSdW), the *Freundeskreis Wölfe in der Lausitz e.V.*, the *Naturschutzbund Deutschland* (NABU) and the International Fund for Animal Welfare (IFAW). Further, volunteer ‘wolf protectors’ (*Wolfsschützer*) gather data on wolf sightings in the region (SMUL, 2009).

Maintenance of Scattered Fruit Tree Meadows in the Swabian Alb

Scattered fruit trees (*Streuoibst*) represent a land-use system composed of open stands of standard fruit trees within gardens, meadows, or crop fields. The most common fruit trees are apple, pear, plum and sweet cherry, planted at a density of 20–100 stems per ha. Generally, trees have a minimum stem height of 160 cm to allow for sound utilization of the ground below tree canopies. They can cover whole valley slopes, form greenbelts around villages or alleys, or occur as individual trees or tree groups (Eichhorn *et al.*, 2006; Plieninger, 2012). Such trees occupy land that has at some point been converted to meadows. Below these fruit trees, fodder grasses, cereals, root crops, vegetables and berries are grown. In Germany, the last large-scale planting activities of scattered fruit tree meadows took place during and after the Second World War. In Europe, this type of meadow is spread across 11 countries: concentrated in a belt stretching through Northern France, Southern Germany and Switzerland to Poland (Herzog, 1998, 2000). Recently, scattered fruit tree meadows have increasingly come under threat. In the state of Baden-Württemberg, scattered fruit tree meadows currently cover around 7.1% of the agricultural surface (an estimated 116 000 ha), but since the 1950s their area has heavily declined. From 18 million scattered fruit trees in 1965, only 9.3 million remained by 2009 (MLR, 2009). The forelands of the Swabian Alb Mountain Ranges (a UNESCO Biosphere Reserve) still harbour the largest contiguous landscape of this type in Europe, with about 6000 ha of grassland and 600 000 scattered fruit trees (see Figure 4).

The area covered by scattered fruit trees across Europe is declining because of replacement by more intensive forms of agriculture, facilitated by land consolidation projects (Vos and Klijn, 2000). Further, their location at the edge of settlements makes them vulnerable to land conversion. Third, many plantations have been abandoned due to lack of profitability. Many remaining scattered fruit trees are neglected or are held by part-time farmers and hobby land users, who often cannot adequately care for them (Weller, 2006).

The decline of scattered fruit tree plantations has provoked deep societal concern regarding the valuable biodiversity and ecosystem services they provide (Weller, 2006; Herzog, 1998, 2000). Their role in producing fruit has declined, but they still provide provisioning services, such as regionally produced fruits, and are reservoir of manifold genetic varieties. They fulfil important services of recreation, scenic values and regional identity and provide critical regulating ecosystem services, such as improving local climate, buffering groundwater pollution or controlling surface runoff and soil erosion. Only recently has the contribution of trees in agricultural landscapes to mitigation of and adaptation to climate change been acknowledged (Plieninger, 2011).

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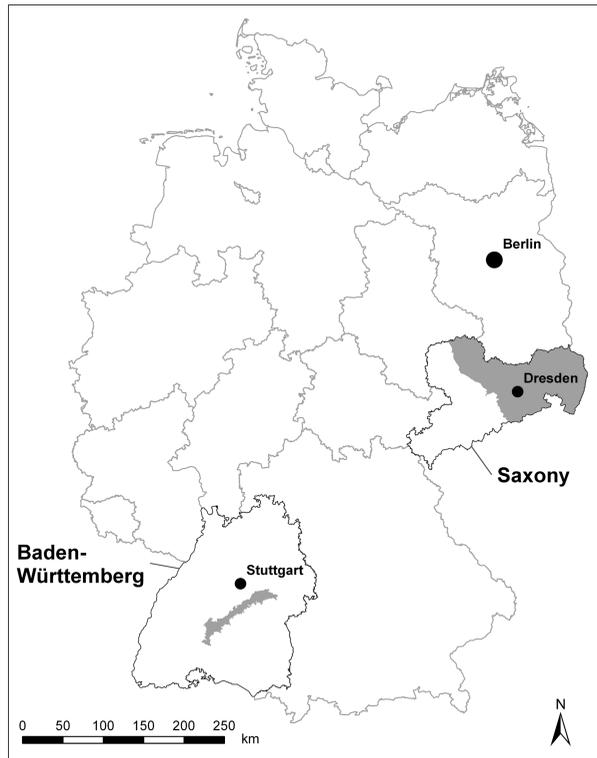


Figure 4. Overview of case study areas (light grey)

Focal Transaction, its Characteristics, and Supranational and National Regulatory Framework (Explanans I and II)

In the case of the maintenance of scattered fruit tree meadows, we have studied transactions involving the resource unit ‘scattered fruit tree meadow’, from which farmers draw a service (benefit) in terms of specific products – while incurring opportunity costs of higher-valued land uses – and from which regional populations and tourists enjoy ecosystem services at the landscape scale. Deliberate activities by farmers (planting trees, maintaining trees and meadows, harvesting) induce these transactions through the biophysical fruit tree meadow system.

The corresponding agricultural practices of farmers are not physically linked to ecosystem services that impinge on the private property rights of ‘third party’ actors in a similarly negative and unintended way as wolf protection does in the case of livestock. Thus, in this case we are dealing with an intended nature-related transaction between the state, on behalf of its citizens, and land owners that produce a specific set of ecosystem services (see Figure 5).

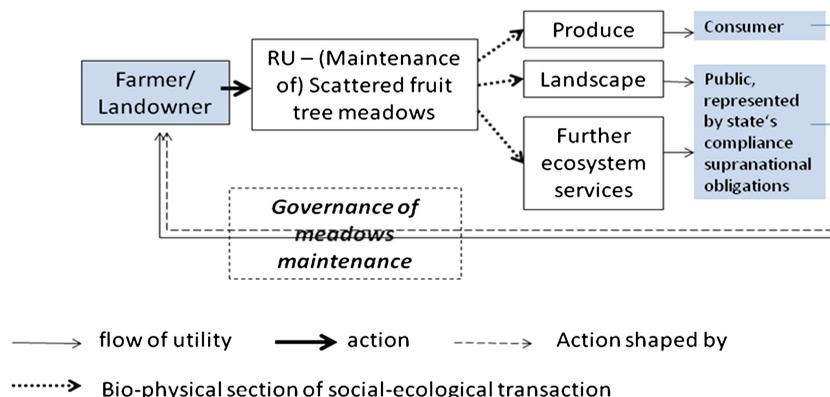


Figure 5. Transactions providing ecosystem services from scattered fruit tree meadows

Specifically, we are interested in knowing how the state regulates the maintenance of scattered fruit tree meadows. Policies in this regard often entail information and training campaigns to promote bird-friendly tree cutting and payments for the revitalization of scattered fruit trees on private and communal lands.

Management and preservation of scattered fruit tree meadows is connected with multiple transactions, ranging from production of fruit to the ‘production’ of scenic values in the area. Thus, most goods and services are produced jointly and cannot be regulated separately. In the following, we focus on the ‘production’ of the resource unit ‘scattered fruit tree meadow’. Given alternative ways of using the land, the transaction we focus on is at the heart of policies to maintain scattered fruit tree meadows. Usually, it is not possible to exclude people from benefiting from the aesthetic value of meadows, and services provided are non-rival in consumption, making the service provided a public good. In contrast, the production of a concrete scattered fruit tree meadow covers a particular piece of land, making it rival with respect to alternative land uses, site specific and immobile. If not restricted by land-use zoning requirements, landowners may choose to convert their land to a different use or apply different production methods. Further, scattered fruit tree meadows are low-intensity systems that need to be maintained through regular, extensive and moderately frequent human intervention, including intensive orcharding practices characterized by moderate knowledge and capital (machinery) specificity. Although production depends on stochastic climatic events, the related natural cause–effect relationships are regular, continuous and well known, making their maintenance a non-heterogeneous, non-variable transaction of regular but moderate frequency. Its effects are reversible, yet reconversion to a different land use is only possible in the medium term.

Unlike the wolf case, the supranational state does not oblige national or regional states in any way to maintain scattered fruit tree meadows. However, the EU co-finances maintenance measures in the context of the Rural Development Programs of the member states and Life+ Projects (Schleyer and Plieninger, 2011). Since the specific design of measures and premiums paid are defined at the regional level, such supranational provisions can be conceived of as framework regulations.

Institutional Structures at the Regional Level (Explanandum)

Preservation of typical scattered fruit tree areas is supported by the Agri-Environmental Program of Baden-Württemberg (MEKA III). Another EU co-financed scheme, the Life+ Project, was started in 2009 with the aim of protecting birds in scattered fruit tree habitats. Our working assumption is that regional, national and supranational entities represent the interests of those constituents that value benefits from corresponding ecosystem services.

In the Swabian Alb, scattered fruit tree plantations are predominantly under private, small-scale ownership. To support the maintenance of these plantations, several programmes have been designed by non-governmental organizations, such as *Naturschutzbund Deutschland* (NABU), and local to national public authorities and incentive-based approaches promote conservation. In many areas, apple juice from scattered fruit trees is marketed at a premium to compensate for maintenance efforts.

One of the most prominent schemes to support scattered fruit tree ecosystems in the Swabian Alb is the PLENUM project, which aims to preserve and develop nature and the environment; though initiated at the state level in 1993, it did not get under way in the Swabian Alb until 2001. Within the PLENUM project area, between 7500 t and 45 000 t of fruits can be harvested per year, and scattered fruit trees have been preserved by developing particular apple juice brands – supplemented at a later date by other fruit juice and liquor brands. For these products, producers obtain an additional premium for adhering to specific production practices.

Similarities and Differences in Characteristics of Transactions and Supranational Regulatory Frameworks

In this section, we first summarize the similarities and differences of transaction characteristics and supranational regulatory frameworks from the cases presented. Second, we explain for each case our argument concerning how they have determined the institutional structures of the corresponding transactions.

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In both transactions, non-rival and non-excludable ecosystem services, such as biodiversity and landscape amenities and aesthetics, are provided at multiple spatial scales. These services are generated, among other ways, by landowners and livestock holders (by adhering to specific production methods). With respect to the latter, refraining from poaching wolves as well as investments in non-lethal prevention methods are seen as ways to foster the maintenance of wolf populations. To different degrees these services are jointly produced along with other (partly private) goods and services and share features of complex interdependence with other natural resources. Both transactions involve asset-specific investments in knowledge, materials and sites. In both cases, maintenance of ecosystem services is provided at the landscape scale, in terms of recreational values, and even at the global or national scales, when we consider biodiversity.

Substantial differences in the characteristics of these transactions result from the resource-unit characteristics of either mobility (of wolves and, to some extent, livestock) or stationarity (of scattered fruit tree meadows). The mobility of the wolf resource unit determines the variable, heterogeneous and uncertain character of the biodiversity and ecosystem services provided by the transaction under scrutiny, which poses problems for actually excluding wolves from the 'consumption' of livestock. In contrast, the stationarity of scattered fruit tree meadows results in relatively low variability, heterogeneity and uncertainty of cost and benefit streams emerging from the transactions associated with them. Further, while individual preying upon livestock is irreversible, maintenance of scattered fruit tree meadows is not an irreversible condition. Different economic types of resource are provided in each case. Preying upon sheep, as well as maintenance of scattered fruit tree meadows, has the characteristic of being rival. Nevertheless, in the case of unintended preying upon (unprotected) livestock, exclusion is possible, while in the case of implementing specific fruit tree management practices (providing habitats) exclusion from many of the intended benefits is not possible. Preying upon livestock can then be said to have the characteristics of a private (undesired) good, whereas fruit tree meadows show features of a common pool resource.

Further, the two cases differ concerning the contingent positions of ecosystem services at stake in overarching European (supranational) regulatory frameworks and their reflection in particular national legislation. The national and regional states are obliged by supranational legislation to maintain wolf populations, whereas support for the maintenance of scattered fruit tree meadows is voluntary.

Wolf Management

In principle, owners of livestock have a right to have their animals' lives (property) unviolated, a right which the state at all levels has the duty to respect and uphold. This right becomes contested when livestock provides prey for wolves that are under the protection of the state. Further, livestock owners have the right to have their animals grazing on their own or perhaps even on others' private lands. In many areas of the case study region, they have traditionally been granted what Schlager and Ostrom (1992, p. 250) call 'access and withdrawal rights' on public lands, making them 'authorized users'. Meanwhile, various state levels are obliged by 'superior' EU regulations to secure the integrity of and habitat for wolves. With the advent of wolves in Upper Lusatia, this puts the regional state into the dilemma of not being able to fulfil its supranational obligations while, at the same time, guaranteeing unviolated property rights of individuals to livestock. In fact, the foreseeable depredation of livestock may lead to backlashes that further aggravate infringements of rights and duties of the parties involved. In other European countries, deteriorating acceptance of preying upon livestock has already led to attempts to illegally kill protected wolves (Salvatori and Linnell, 2005). At the regional level, the state principally reacts to this contradiction between property rights and its obligation to protect the wolf in two ways.

- (a) The regional state modifies property rights of livestock owners in order to fulfil its obligations vis-à-vis various supranational legislations. This results de facto in a situation where the regional state holds a quasi-privilege regarding the unviolated existence of wolves, derived from supranational obligations, the correlate being that individuals, that is livestock owners and others, have no right to interfere. Hiedanpää and Bromley (2011, 107) call this phenomenon 'inverse high-grading':

[I]nternational environmental authorities [...] declare that one or more constituents of a particular natural environment are so significant that special efforts must be mounted to prevent *any* human exploitation of those particular attributes of a local environment [emphasis in original].

- (b) The regional state modifies governance and entitlement structures to ensure the enforcement of property rights. First, the state is obliged to sustain the economic wellbeing (i.e. adequate income) of its citizens (*Verfassung des Freistaates Sachsen*, 1992, Art. 7[1]). Second, in order to avoid discontent among parts of the local population, potential backlashes in local and regional elections, and illegal vigilante actions, Saxony and other German states are aiming to increase acceptance of protective wolf management through compensation for costs incurred. Further, vigilante actions need to be avoided, as they threaten to undermine the recovery of the wolf population, which would backfire with respect to Germany's European obligations and potentially result in EU sanctions. Within the wolf area in Saxony, however, these compensation payments are conditioned upon the duty to implement non-lethal protective measures and the obligation to immediately notify authorities of damage to livestock by wolves.

Property rights to livestock are secured by a liability rule, that is, an ex post entitlement to compensation of losses incurred during the exercise of their access rights. Reasons for this include the high cost-effectiveness of the way in which such an entitlement structure secures property rights for the described transactions. Given the interrelated properties of transactions associated with depredation of livestock (high levels of variability, heterogeneity and uncertainty), ex ante agreements on buying-off potentially depredated livestock (as implied by a property rule) cannot be established. First, such ex ante purchases of rights to kill cannot be allocated in a fair fashion if compensations are to be equally distributed among all livestock owners in a specified area. Second, precisely targeted lump sums are not feasible, given the unpredictability of the transaction. Reasons for this are the uncertainties of wolf behaviour and uncertain distribution of damage (number of animals preyed upon and frequency of attacks). Damage done to livestock is assessed best after depredation has taken place, providing for a liability rule. To further minimize transaction and overall costs of the regulation and to overcome the risk of moral hazard (cf. Zabel and Holm-Müller, 2008), the state has added two conditions. First, a livestock owner's right to compensation depends on notification of damage within 24 hours after a killing. Consequently, livestock owners are burdened with the transaction costs of reporting depredations by wolves. The regional state is thereby able to distribute the costs of monitoring via this precondition for obtaining compensation, since these compensation payments in principle favour livestock owners.

The second condition for the liability rule exploits the fact that the likelihood of livestock being preyed upon can be excluded, or drastically reduced, by fencing. This addresses the trade-off between ex post compensation for incurred damages and asset-specific investments into preventive measures. We further argue that the regional state co-finances protective measures because it considers such contributions to ex ante prevention of depredations to be cheaper (i.e. more cost-effective) than relying entirely on an ex post compensation policy in the area where depredations are most likely. This policy also fosters acceptance of wolf populations by livestock owners. However, where the distance from the designated wolf area is greater than 30 km, the likelihood of killings and amounts necessary for ex post compensations are too low to justify compulsory ex ante protective measures. Requiring protective measures outside the wolf area would probably reduce overall acceptance by livestock owners and disproportionately burden state budgets if preventive measures were co-financed there as well.

Within the 30 km range of the designated wolf area, imposition of prevention costs expropriates livestock owners from the property right to unviolated livestock. The state has made a distributional decision in order to resolve the contradiction between its obligation to simultaneously protect the wolf and individuals' property right to unviolated livestock. The solution found reflects the power of the involved actors. Individuals cannot change the way in which property rights are distributed, but rather need to rely on the regional state for their enforcement. In contrast, the state can change property rights and entitlements, but it cannot change its supranational obligations after they have been put in force. Nevertheless, one could argue that the regional state buys unconditioned rights to livestock from property holders and pays by compensating 60% of the investment costs for installing protection measures. Outside the designated wolf area, independent from prevention measures, property rights to livestock are maintained, but for compensation to be paid the notification condition still applies.

How Characteristics of Transactions and Regulations Shape Institutions

The overall modification of property rights undertaken by the regional state has substantially improved the welfare position of livestock owners – who otherwise would have had no right to be compensated. Previously, in cases of depredation of livestock no compensation could be expected, as wolves could not be made responsible and the regional state did not deliberately infringe individuals' property rights. In contrast, detection of individuals poaching wolves results in penalties. Thus, individuals are better off accepting an alteration of their property rights that includes a policy of compensation for damages incurred. This has to do with their inability to escape the regional states' property right modifications as well as with the absence of deliberate and accountable human action behind depredation by wolves.

Maintenance of Scattered Fruit Tree Meadows

The case of scattered fruit tree meadow maintenance is less complex, therefore requiring less extensive explanation. Here, individuals hold the right to use their land at will within the overall legal framework. The state has the duty to respect this right, which is often subject to individual ownership (Bromley, 1992). However, through incentives such as price premiums on selected scattered fruit tree products, the regional state or individual consumers may buy the management right from individual landowners by compensating them for the opportunity costs of maintaining scattered fruit tree meadows.

Property rights to land are secured by a property rule that requires that a specific property (here, the land management right) be purchased before costs are incurred by landowners. For reasons of cost-effectiveness, this makes sense on two accounts: (1) opportunity costs for scattered fruit tree meadow maintenance are relatively certain because of high transaction occurrence predictability (low uncertainty, variability and heterogeneity) and the associated cost and benefit streams, which significantly lowers the transaction costs of determining benefits foregone and costs incurred; (2) opportunity costs for scattered fruit tree maintenance are unavoidably carried by individual landowners. There are two primary reasons for the way in which maintenance of scattered fruit tree meadows is governed. First, maintenance of scattered fruit tree meadows is not prescribed by European, national or regional legislations: presumably because such legislation would not be agreeable politically. As opposed to the wolf case, neither landowners nor the regional state have the (presumably politically legitimized) ability or external obligation to impose changes in property rights on transacting partners. Second, medium-term irreversibility of changes in land use practices requires asset specific investments beyond opportunity costs, such as specific investments in preservation activities. Jointly with other transaction characteristics, such as low uncertainty, heterogeneity and variability, this results in hybrid, bilateral and voluntary medium- to long-term agreements between landowners and those interested in the biodiversity conservation and ecosystem services provided by scattered fruit tree meadows. Here, the regional state or private non-governmental organizations act on behalf of their constituents and establish contracts with landowners that determine, for example, appropriate ways for scattered fruit tree meadows to be managed in order to qualify for the right to market produce under a specific quality label that generates extra revenue. Such medium- to long-term commitments are intended to reduce opportunistic behaviour by those paying for and those actually carrying out scattered fruit tree meadow maintenance, as they insure that asset-specific investments made by landowners pay off over time. The meeting of requirements for these specific practices needs to be monitored regularly. However, because of lack of data we cannot conclusively analyse the distributional incidence of monitoring costs in this regard. We do observe that, in the context of distributing monitoring costs of changes in land-use practices, the regional state is disadvantaged in negotiations, as owners of scattered fruit tree meadows adhere to such practices voluntarily.

Conclusions

In this paper we have presented 'reasons to believe' (Bromley, 2008, p. 2) that the way in which institutions at the regional level have been reshaped in the two selected German cases reflects the respective characteristics of the transactions at stake and supranational (EU) regulatory frameworks concerning biodiversity and ecosystem service provision. We have deliberately left out the politics of rule making and have instead focused on the way in which

requirements for institutional change were implemented and on the determinants for the specific institutional changes that were introduced. We have come to the conclusion that, in representing its citizens, each regional state has applied a cost-effectiveness calculus concerning the way in which it should implement policy objectives and shape corresponding institutions. In both cases, this has included acceptance of changes in environmental management, implying costs for either owners of livestock or scattered fruit tree meadows. Similarly, biodiversity, as a (global) public good, as well as specific local and regional ecosystem services, are provided in both cases at the expense of individuals holding property rights to land or livestock. A multitude of transactions is connected with the respective environmental management measures. We have emphasized two focal transactions related to state policy objectives to protect biodiversity. At the national and regional levels, states are obliged to protect wolves due to EU legislation. We argue that they therefore enjoy what could be called a position of 'quasi-privilege' with regard to interference with wolves, leaving domestic livestock owners with reduced rights. In contrast, owners of scattered fruit tree meadows enjoy a property right to land within the scope of overarching legislation that has to be respected by the state and the rest of society. These different legal positions in conjunction with differences in heterogeneity, variability and uncertainty of transactions – all of which can be related to the extreme mobility of wolf packs and the stationarity of scattered fruit tree meadows – help to explain the ways in which policies enhancing (the acceptance of) biodiversity and ecosystem service provision are regulated at the regional level. In order to resolve the contradictions in property rights that emerged following the arrival of the wolf and to comply with its supranational obligations, property rights concerning livestock were shaped at the regional level towards protection via a liability rule in order to compensate livestock owner losses and increase their acceptance of wolf protection. Reactions to wolf conservation in the case study area as well as all over Europe suggest that this course of action has had political reasons and serves to prevent EU sanctions by avoiding potential wolf poaching. Nevertheless, compensation is conditioned in order to overcome moral hazard problems and to induce adequate levels of livestock protection so as to reduce overall depredations. In this context, the state is able to impose certain costs upon owners of livestock as a condition for possible compensation when needed. On the other hand, scattered fruit tree meadow maintenance is subject to a property rule as well as to voluntary and medium- to long-term agreements, which are justified by medium-term irreversibility and asset-specific investments. These two specific entitlement regimes can be explained via transaction-cost considerations and trade-offs between stochastic compensation costs and prevention (in the case of livestock being preyed upon). However, taking an abductive approach, we can only suggest the argument that differences in transaction characteristics and overarching legal positions at the EU level lead regional states – on behalf of their constituents – to implement governance structures that secure respective property rights in cost-effective ways.

For us, this has been a surprising result, not least because, conventionally, outcomes of policymaking processes are only rather loosely associated with cost-effectiveness. Instead, particularistic interests or bureaucrats' aspirations are usually put into focus when policy outcomes are explained. Indeed, at first sight, neither bureaucrats nor policymakers have a genuine incentive to devise cost-effective policies. Consequently, the result of our study begs the question of how cost-effectiveness reasoning enters policy implementation or whether, in fact, it actually emerges from some orientations among bureaucrats or politicians that have not been investigated by the case studies presented here. In line with abductive reasoning, a further programme of empirical studies addressing other cases and European countries would need to be developed in order to verify and generalize our claim. Furthermore, in-depth qualitative empirical work – including qualitative supplementation of the cases analysed here – may paint a much more complex picture of the actual reasons for regulating biodiversity and ecosystem service provision in specific ways that *our* empirical approach was unable to disclose.

For the broader study of environmental governance, our paper has shown that a systematic account of characteristics of social–ecological transactions can help to better understand local governance and institutional responses. Further, a differentiated approach to the analysis of transaction characteristics allows for the formulation of 'plausible' conclusions with respect to the relevance of cost-effectiveness of policy measures and governance responses via their respective impacts on transaction costs. However, as we have also shown, transaction characteristics shape governance jointly with relevant institutional settings within the overall political and administrative domain.

In closing, we want to suggest that further work on the linkages between concrete transaction characteristics and observed governance and institutional solutions is necessary. Wolves and scattered fruit tree meadows are, therefore, seen by us as no more than telling examples for a broader research agenda.

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