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# **Characteristics of resources and the provision of biodiversity and ecosystem services in Germany: the cases of fruit tree meadows and wolf protection**

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## Abstract

Work on common pool resources has paid scant attention to the role of properties of natural resources for the way their provision is governed. This paper scrutinizes determinants of institutions that regulate the provision of biodiversity and ecosystem services. Two cases of maintaining ecosystem services are compared (protection of wolves and management of scattered fruit tree meadows). Distinct characteristics of resources (mobility) and differences in the overarching European regulatory framework explain their different institutional embeddedness. Cost-effectiveness considerations seem to be paramount in the design of institutions. In the case of wolf protection, the state uses its power to modify property rights in order to increase acceptance of wolf management. This is essential for political reasons as well as to prevent EU sanctions. On the other hand, scattered fruit tree maintenance is subject to voluntary, long-term agreements, justified by medium-term irreversibility and asset specific investments.

**Keywords:** Institutions, Governance, Wolf Management, Scattered fruit trees

## 1. Introduction

What determines the design and performance of institutions that regulate the provision of ecosystem services? Addressing this question Ostrom (1986, quoted in Bromley 1991, p. 33) states that “(1) *the nature of the resource itself*; (2) *the supply-demand conditions [...]* (3) *the characteristics of the users [...]*; and (4) *the characteristics of the legal and political environment*” need to be considered. This paper aims to undertake one step towards detailing the answer to this question. We compare the cases of safeguarding of wolf populations and maintaining scattered fruit trees in Germany and argue that causes of the way they are regulated are (a) in particular differences in mobility of the resource and (b) differences in the legal and political environment stemming from the overarching European regulatory framework. We understand regulations implying changes of institutions. They are the outcome of politics which decide on the “*incidence of costs and benefits*” of ecosystem services (Bromley 1991, p. 22). 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 ... [and therefore] ... link social and ecological systems*” (Gatzweiler and Hagedorn 2002, p. 3; see also Berkes and Folke 1998). Institutional economics considers transaction costs, i.e. the costs of actors informing themselves about options, negotiating, agreeing, monitoring, enforcing, and adapting institutions (Dahlmann 1979). Transaction costs matter as information is costly and actors are assumed to be boundedly rational and act opportunistically when they are given the opportunity for rent-seeking. Under these circumstances institutions provide certainty concerning the behaviour of transacting partners. Transaction costs result from the consequent need to establish and maintain institutions which constrain and structure human interaction (e.g. North 1990).

Our argument and findings support the discrete alignment hypothesis (Williamson 1985, 1998), where “*transactions are aligned with governance structures*” (Williamson 2000, p. 595, Bougherara et al. 2005). In order to allow for comparison, we select two instances of biodiversity and ecosystem services conservation within a rather similar regulatory and political context, namely that of two German *Länder*. We consider biodiversity a common pool resource (CPR) as it is rival in consumption because of conflicts with other land uses, but from which it is difficult to exclude.

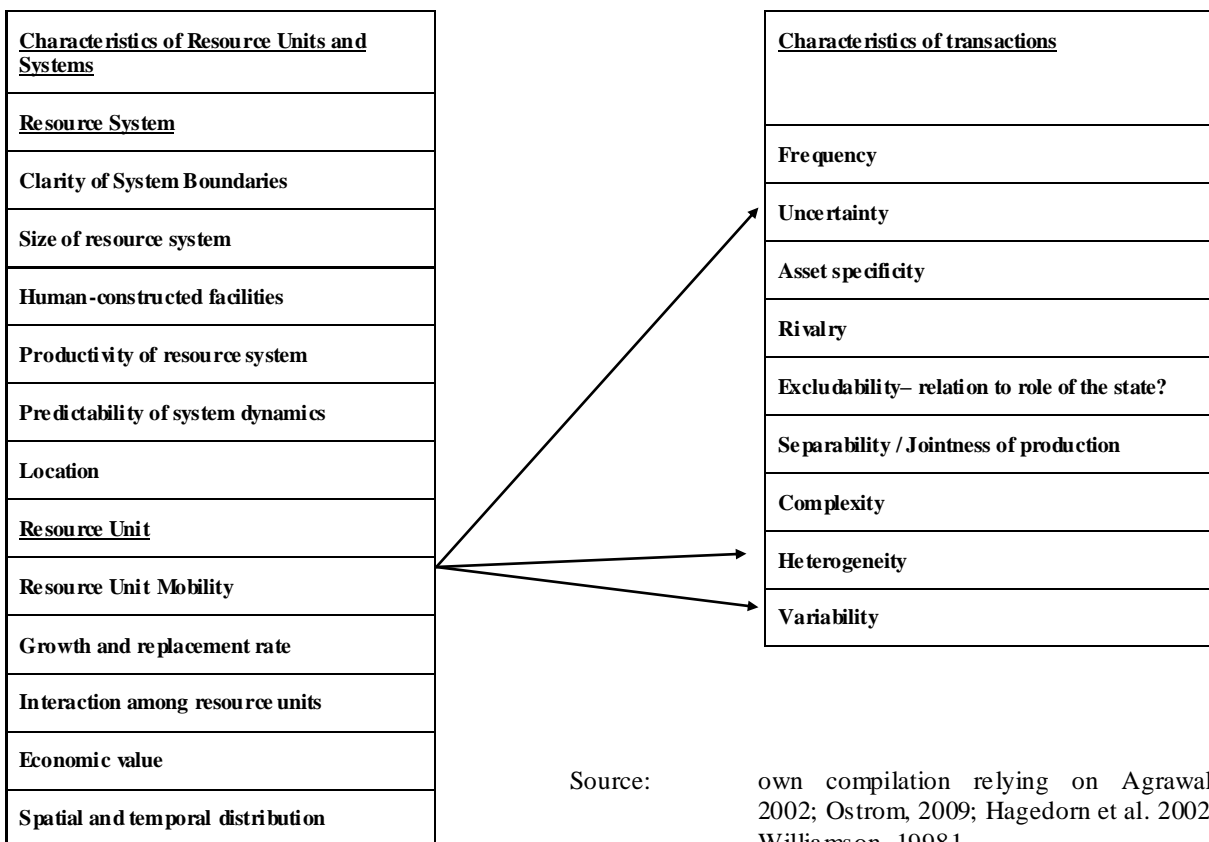
We develop the argument that physical characteristics of transactions affect the way problems of provision and consumption of CPE are resolved. First, we introduce our analytical perspective on the way ecosystem services are socially regulated. Second, we present our two

empirical cases. Third, we apply our analytical lens to the empirical cases and make comparisons. Finally, we summarize our argument and provide a brief outlook.

## 2. An eco-institutional perspective on social regulation

The paper is framed around the concept of ecosystem services delivery and considers social-ecological transactions in nature-related sectors as the basic unit of analysis. Such “[p]hysical transactions not only include direct transfers from one or many others, but the transfers may be indirect... intended or unintended, targeted or non-targeted, predictable or unpredictable. [...] Such properties of transactions are likely to play a greater role if they are related to natural systems than in the case of man-made systems” (Hagedorn 2008: 362). In this paper, transactions and their characteristics are the *explanans* concerning the way they are institutionally structured. For analytical purposes we single out individual transactions that contribute to the principal services that policies aim at. Transactions have specific characteristics determined by the temporally and spatially specific properties of the social and ecological systems they are embedded in. These socially constructed characteristics describe the interdependence between actors as mediated by non-human nature (Paavola and Adger 2005, Young 2002). As such, interrelated characteristics of transactions are shaped by resource characteristics. Specifically, we use a list of distinct resource characteristics (Resource Unit (RU) and Resource System (RS)) that research has thus far identified as significant in shaping Social-Ecological Systems’ (SES) performance Ostrom (2007) and Ostrom et al. (2007). Figure 1 relates the mentioned characteristics of resources to characteristics of transactions.

Figure 1: Interrelation of characteristics of resources and characteristics of transactions



First, we ask how property rights, as subgroup of institutions (Hagedorn 2008), are shaped by characteristics of resources. Through the definition of property rights coercive units – often the state – play an important role in resolving – often local – environmental conflicts. Second, we ask how governance structures deal with varying characteristics of resources. Governance

structures – as description of the coercive units (Bromley 1992) – monitor and sanction (or not) property rights. The *explanandum* of this paper are the institutional settings including property rights, property regimes, and governance structures (or authority systems (Bromley 1992)) in which the respective social-ecological transactions take place. Property rights are defined as “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 [...]. Property is not an object but is rather a social relation that defines the property holder with respect to something of value (the benefit stream) against all others” (Bromley 1992, p.2). Bromley (1991) highlights four essential symmetrical legal correlates defining property rights in which the state or any other higher authority either takes an *active enforcing role* (static: a right for A is *duty* for B; dynamic: *power* for A to change rights of B are B’s *liability*) or a *passive role* (static: where A has *privilege* of no interference and B therefore has *no right* to interfere; dynamic: where A has *immunity* of interference by B which therefore has *no power*).

Governance structures sanction property rights (Williamson 1985). They refer to the way the “unit of coercion” (Bromley 1991, p. 3), i.e. a higher authority or the state, enforcing property rights is organised. Governance structures entail several aspects: property regimes, entitlements, and other structures such as knowledge systems, management plans, dispute settlement arrangements, and monitoring infrastructures (Hagedorn 2002). Vatn (2005, p. 254) defines property regimes as “*structure of rights and duties characterising relationships between individuals with respect to specific good or benefit streams*”. They differ from property rights and may entail state, private (both of relevance below), common, or no property (open access) (Bromley 1992). They differ in rights and duties for property holders, and in the incentives concerning maintenance and improvement of the resource and transaction costs which origin from monitoring and enforcement (Schlager and Ostrom 1992). As another way for detailing the analysis of governance structures Bromley (1991) proposes to look at different *entitlement structures*. They differ in the way they back up property rights to specific components of nature and in situation-specific transaction costs (Hagedorn et al., 2002). Property rights that are protected by a *property rule* are protected against unwanted (and proscribed) incursions of either physical or economic nature. Thus, the property right has to be acquired by the interfering actor before interference can legitimately take place. To have a right that is protected by a *liability rule* is to rest assured that “*the party committing that act is [ex-post] liable for damages...*” (Bromley 1991, p. 49). Finally, if a right is protected by an inalienability rule interference with it is inadmissible under all circumstances and no compensation is required (Bromley 1991, p.46).

The subsequent description and analysis of the two case studies is empirically based on scientific literature as well as regional planning materials and other documentations.

### **3. Presentation of the case studies**

#### **3.1 Case study: wolf management in Upper Lusatia**

Wolves have been listed among the priority species to be protected under the European Flora-Fauna-Habitats (FFH) Directive. Nevertheless, wolves are adaptable to the strongly human-dominated European landscapes. Their 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 organised within confined protected areas, as their respective habitats usually cross administrative and political borders (Gehring and Potter 2005).

The natural migration of wild wolves in Upper Lusatia has substantial effects on biodiversity and ecosystem services in the regional landscape and beyond. Most of the benefits derived from the maintenance of wolf populations, such as enriched biodiversity and touristic attractiveness are experienced at higher scales of society. Potential conflicts and costs fall

disproportionally on rural communities within the range of the wolves. Thus, wolves are affecting human well-being directly and indirectly in many ways. In this study, we focus on the conflicts and transactions caused by the depredation of domestic animals. Livestock depredation is among the principal causes of conflict and at the core of problems of acceptance of wolf conservation and has resulted in elaborated forms of social regulation.

#### *Characteristics of transactions*

Wolf attacks on domestic animals reduce the number of the respective flock of sheep or goat. Clearly, there is a strong rivalry in consumption. Since wolves kill only as much prey as they need to feed their pack the number of domestic animals killed per incident can be considered as rather moderate. Naturally, this transaction can be considered as irreversible (SMUL 2009). While the effects of the attacks are local, the likelihood of this 'transaction' (attack) to occur at a particular time and place as well as the overall frequency of attacks is extremely difficult to predict. This is due to the fact that a wolf pack covers a very large area of about 250 km<sup>2</sup> (Kluth and Reinhardt 2009). Further, wolf habitats may also shift over time. Thus, unlike the herded animals, wolves are very mobile. Similar to the quantitative impact (damage) of such an attack, also the temporal and spatial occurrence depends, among others, on the availability of wild games, the size of the respective wolf pack, the protective measures, and the number of herds of domestic animals in the region. In this sense, the transaction can also be regarded as complex and as interdependent with other natural resources and human activities.

Income losses due to wolf attacks can be avoided by investments in protective measures, such as electric fencing of the herding area. That is, wolves can be excluded from the consumption of the domestic animal resources. Protective measures have moderate asset specificity as for example fencing material can be disassembled. Yet, time and labour to build the fence at a particular location or to train a herd protection dog, can be considered as sunk costs (SMUL 2009).

#### *Social regulation structuring the transactions*

While migration of wolves into Upper Lusatia is a natural phenomenon, the persistence of the settlement and the increase in the number of wolf packs, i.e. the maintenance of this particular feature of biodiversity in the region, is predominantly facilitated by state activities. Based on several international legal provisions, the German national state and the *Land* Saxony have implemented formal rules to protect wolves and to undertake measures to enable their populations to grow. Most important is the strict prohibition to kill wolves, or translocate them. In contrast recovery of populations is the predominant policy objective. Sanctions for defection are quite severe. Since 2002, wolves in the Saxony part of Upper Lusatia have depredated over 200 domestic animals in 50 incidents. In almost all incidents the respective herds were not (sufficiently) protected against wolves (SMUL 2009). However, as Gehring and Potter (2005) remark: "*Failure to effectively reduce or prevent carnivore-human conflict (e.g., wolf-human conflict) can lead to an erosion of social tolerance for carnivores [...]*". Thus, in order to reduce the economic motivation of holders of domestic animals to kill wolves illegally on the hand and to increase social acceptance of wolves' protection on the other, ex-post compensation schemes for damages and protective measures have been introduced by the authorities and private organisations.

In Saxony, subject to two conditions, the Nature Protection Law of Saxony provides for the financial compensation of commercial and non-commercial holders of domestic animals for the income losses incurred by the attacks of wolves. Conditions hold that holders of domestic animals have to implement protective measures (e.g., herd protection dogs and/or suitable fences). Otherwise, holders of domestic animals would only have limited incentives to invest in protective measure. These compulsory measures only apply to the so-called wolf area (i.e. the area presumably and knowingly covered by wolf packs) plus an additional buffer zone of

30 km. Outside this territory, *all* damage to domestic animals by wolves qualifies for compensation. The borders of the wolf areas are dynamic. Once a wolf pack settles in an area outside the current 'official' wolf area, the 'official' wolf area is extended accordingly. Commercial holders of domestic animals in the wolf area can apply for financial assistance in the amount of 60% of the costs incurred. As a second condition, holders of domestic animals have to report animals killed to the district authorities within 24 hours in order to receive the compensation.

In addition in order to improve the habitat conditions for the wolf and to increase the acceptance of wolves in the general public, a *wolf management system* was established. It focuses on scientific research (including monitoring), advice for state agencies and stakeholders, public relations and practical measures to increase the acceptance of wolves. Other private organisations complement the wolf management. Further, there are many honorary 'wolf protectors' (*Wolfsschützer*) gathering information on wolf packs in the region (SMUL 2009).

### **3.2 Case study: maintenance of scattered fruit tree meadows in the Swabian Alb**

Scattered fruit trees (*Streuobst*) represent a land use system composed of open stands of standard fruit trees within gardens, meadows, or crop fields. In many German regions scattered fruit tree meadows were introduced in a systematic form as a land use innovation in the 18th and 19th centuries, mainly with the aims of improving the profitability of agriculture and provisioning the population with food. First established on gardens and crop fields, these lands were later converted to meadows. Important uses of land below the fruit trees were the growing of fodder grasses, cereals, root crops, vegetables, and berries. The share of the agricultural area planted with scattered fruit trees is particularly high in hilly areas, where the topography limits the potential of more intensive forms of land use. Recently, scattered fruit tree meadows have come increasingly under threat. In the case presented here we address the core transaction of changes in private land use practices that cater for the maintenance of scattered fruit trees.

In the *Land* Baden-Württemberg, scattered fruit tree meadows cover around 7.1% of the agricultural surface (an estimated 116,000 ha). Since the 1950s their area has heavily declined. Despite drastic decline, the forelands of the Schwäbische Alb Mountain Ranges (a UNESCO Biosphere Reserve) still harbour the largest contiguous landscape of this type in Europe.

The area covered by scattered fruit trees is declining because of several trends that shaped European landscapes in past decades (Vos and Klijn 2000). First, many scattered fruit tree orchards were systematically replaced by more intensive forms of agriculture and horticulture. Second, scattered fruit tree plantations often concentrate at the edge of villages and cities which made them vulnerable to land conversion for urbanisation and infrastructure development. Third, many scattered fruit tree plantations have been partly or fully abandoned due to lack of profitability. Therefore, many remaining scattered fruit trees are overaged, lack regeneration, and are overly neglected. Most of the remaining scattered fruit tree plantations have shifted from professional pomiculture to part-time farmers and hobby land users (Weller 2006).

The decline of scattered fruit tree plantations has provoked deep societal concern as biodiversity and ecosystem services they provide have become highly appreciated (Weller 2006; Herzog 2000). The importance to produce fruit has declined, but scattered fruit tree meadows continue to deliver provisioning services such as regionally produced fruits and act as a reservoir of manifold genetic varieties. As a visual component of cultural landscapes, they fulfil important services of recreation, scenic values, and regional identity. They provide

critical regulating ecosystem services, e.g., by improving the local climate, buffering groundwater pollution or controlling surface-runoff and soil erosion.

#### *Characteristics of transactions*

Management and preservation of scattered fruit tree meadows is connected with multiple transactions. Most goods and services provided by scattered fruit tree meadows are produced jointly. For example, an intensive use of fertilisers or pesticides to allow for higher grassland yields is likely to reduce the suitability of the meadows as habitats for some species.

In the following, we focus on the ‘production’ of the resource unit ‘scattered fruit tree meadow as a visual feature of the regional cultural landscape’ that may be enjoyed by both local residents and tourists. Support of biodiversity and ecosystem services is inherent. 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 the meadows. Further, enjoyment of the landscape and biodiversity are non-rival in consumption making the service provided by our focus transaction a public good. In contrast, the production of a concrete scattered fruit tree meadow covers a particular piece of land. Thus, there is rivalry with respect to alternative land uses, and the resource unit is both site specific and immobile. If not restricted by land use zoning requirements, land owners may choose to convert the land into a different use or apply different production methods. Management of scattered fruit trees comprises intensive orcharding practices, such as grafting and several pruning technique, and there is some moderate knowledge and usually also capital (machinery) specificity. These management practices have to be carried out regularly, yet only with a moderate frequency. Further, we consider the natural cause-effect-relationships are rather regular, continuous, and well-known in ecosystems of scattered fruit tree meadows. In addition to rivalry in production and non-excludability, and required asset specific investments we therefore consider the maintenance of scattered fruit tree meadows as a non-heterogeneous, non-variable transaction of regular but moderate frequency. Its effects are reversible, yet reconversion from a different land use is only possible in the medium term.

#### *Social regulation structuring the transactions*

In the Swabian Alb, scattered fruit tree plantations are predominantly in private, small-scale ownership. Non-governmental organisations such as Naturschutzbund Deutschland (NABU) were among the first who called for the conservation of scattered fruit tree meadows. In more recent years, subsidised schemes for the protection of *Streuobst* have been developed. Several incentive-based approaches promote conservation through sustainable use of fruit products. In many areas, apple juice from scattered fruit trees is commercialized with an additional premium to compensate for management of scattered fruit tree meadows.

One of the most prominent schemes to support scattered fruit tree ecosystems in the Swabian Alb is the PLENUM-project. It aims to preserve and develop nature and environment and, while initiated at *Länder* level in 1993, it practically started in the Swabian Alb in 2001. Yet, in years with particularly high yields many fruits are not used at all (left on the ground) due to unfavourable cost-benefit-relations. Within the PLENUM-project, scattered fruit trees have been preserved by developing particular apple juice brands and liquor brands. For these products only fruits are used that come from plots where among other things the trees are managed in an environmentally friendly way and where grassland beneath the trees is used extensively. Producers get an additional premium for adhering to mentioned production practices.

#### **4. Comparing and explaining differences in institutional structure**

In this section we use our ‘analytical toolkit’ introduced in section two to compare characteristics of transactions and the way in which they are institutionally structured and make an attempt at explaining the differences observed.

The services that the two transactions that we focus upon imply show some similar characteristics. Non-rival and non-excludable ecosystem services are provided at several spatial scales and for various actors. These services are ‘produced’, among others, by owners of land (by adhering to specific production methods) and holders of domestic animals (by providing prey and/ or investing in prevention measures). These services are jointly produced with other services and share features of complex interdependence with other natural resources. Both transactions involve asset specific investments in knowledge, materials, and sites.

Yet, apart from these commonalities there are substantial differences in the characteristics of the two transactions resulting from the resource characteristic of either mobility or immobility (or stationarity). We argue that – to a large extent – they account for the differences in how the transactions are socially regulated by institutions and governance structures. First, individual deprecations of either wolves or domestic animals are irreversible. In contrast, maintenance of scattered fruit tree meadows is not. Different types of resources are provided in each case. Adhering to prescribed management practices subtracts welfare from owners of meadows and animals, making both provisions rival. In the case of depredation of (unprotected) domestic animals by wolves, exclusion from this disservice is possible, while in the case of implementing specific fruit tree growing practices (providing habitat) exclusion is not possible. Thus, to start with, providing prey for wolves or protection from wolves through fencing is a private good, while scattered fruit tree meadows at the scale of landscapes are a local common pool resource. Together with the contingent position of wolf protection and maintenance of scattered fruit trees in overarching European legislations, as we argue below, this results in different conditions on entitlements securing property rights. Finally, decisive in explaining differences in regulation are also other differences in characteristics of the resources. The mobility of wolves results in the specific characteristics of this transaction being variable, heterogeneous, and uncertain. Stationarity of scattered fruit tree meadows, in turn, results in relative low variability, heterogeneity, and uncertainty of potential costs and benefits streams emerging from this transaction.

In the following we turn to the regulations that emerged from this setting and explain the corresponding differences. More precisely, we need to explain why depredation of domestic animals by wolves is governed by hierarchical administrative mechanisms and ‘on the spot compensations’ and why changes in land use practices in scattered fruit tree areas are governed by (medium-term) hybrid governance structures, such as voluntary agreements.

Further, we need to explain the spatial differentiation of rights and duties associated with property rights to domesticated animals and land and the respective entitlements backing up property rights (property rule for property rights in land vs. liability rule for property in domestic animals). Explanation is provided by cost-effectiveness and distributional considerations in regard to transaction costs associated with respective institutions. Institutions are the administrative ways to implement public policies which have previously been socially elaborated and agreed subject to the rules of politics, which are not under scrutiny here. We start our comparison and explanation of differences focussing on institutions structuring the depredation of domestic animals, followed by the case of scattered fruit tree meadows.

Table 1: Comparison of properties of transactions and their regulation

	<b>Wolves</b>	<b>Difference</b>	<b>Scattered fruit tree meadows</b>
<b>Description of transaction</b>	Provision of ecosystem services Use change; accept losses for providing of biodiversity and landscape Accept deterioration of property rights to animals, as acceptance of depredation of domestic animals		Provision of ecosystem services Use change, accept losses for providing for biodiversity and landscape Accept limitations on property rights to land
<b>Functions involved<sup>1</sup></b>	Habitat, recreational, cultural		Habitat, recreational, cultural, production
<b>Scale of service provision</b>	Local to global public goods		Local to global public goods
<b><i>Explanans - Properties of transactions</i></b>			
Rivalry	Strong rivalry (living or dead animal)		Strong rivalry (to piece of land)
Excludability	Yes	<b>x</b>	No
Frequency	Moderate/ irregular	<b>x</b>	Moderate/ regular
Asset specificity	Yes – concerning exclusion technology/ certain sunk costs		Yes - material and knowledge/ certain sunk costs
Heterogeneity	High	<b>x</b>	No, as <i>relative</i> regularity across space applies to all
Jointness	Not so pronounced		Highly pronounced
Variability	High	<b>x</b>	Low, but transaction with great regularity
Reversibility	No, up to a threshold - substitutable at landscape scale	<b>x</b>	Yes, in medium term
Complex	Yes		Yes
Changes in cost/ scale	Yes, local		Yes, local for land owners
Changes in benefits/ scale	Individual, local to global		Individual, local to global
Who produces	Local animal owners		Local land owners
De jure property rights	Privilege of state property to wolves, no right for owners of domesticated animals	<b>x</b>	Land owner has rights/ state has to respect
<b><i>Explanandum – Institutional organisation of transactions</i></b>			
De jure property regime at stake	Wolves are state property Domestic animal holders have right to have animals grazing/ state needs to respect this	<b>x</b>	Private property, protected by a property rule
Difference de facto and de jure property rights	No		No
Governance structure	Hierarchical	<b>x</b>	Hybrid - voluntary long term agreements
Entitlement structure	Protected by a liability rule, conditioned by obligation to prevent within 30 km distance of wolf area and obligation to report within 24 hours		Protected by a property rule

Source: own compilation relying on Agrawal, 2002; Ostrom, 2009; Hagedorn et al. 2002; Williamson, 1998<sup>2</sup>

Wolf protection is codified ‘European societal’ legislations. Thus, the national and ‘regional’ state on behalf of the EU and its citizens holds *privilege* with regards to wolf populations which implies *no power* as a correlate for all other actors. This right is protected by an entitlement structure of inalienability. Practically, implementing this right conflicts with local access rights. It interferes with privilege that private owners of domestic animals hold over their animals independent from the property rights to the land on which these animals graze. . Importantly though, this *may not* preclude the state’s privilege concerning wolves, as the state in this regard is bound by higher level regulations. In this situation lower levels of government use their ‘dynamic’ powers and modify property rights in order to mitigate the local consequences of higher level legal provisions. They turn ‘privilege’ given to state

<sup>1</sup> Based on the classification by de Groot (2002).

<sup>2</sup> The table illustrates that characteristics of resource units and systems are not equivalent to relational characteristics of transactions and that indeed the difference should be maintained. Similar complex interrelations between the two types of categories could be described for other characteristics of resources. Definitions of characteristics of resources and transactions can be drawn from the literature indicated. They vary in relation to the specific author consulted.

property in wolves – and its correlate of no rights for owners of domestic animals – into a situation where animal holders are given rights which reconstitute benefit streams derived from holding their animals in cases of infringement of animal owner privilege over their animals by state protected wolves. These rights are secured by a liability rule, i.e. an ex-post entitlement to compensation of losses incurred. These modifications are handed down in a hierarchical way. Thus, owners of domestic animals cannot opt out (power / liability correlates). Two rationales seem to underlie this modification of property rights: 1) as codified in the constitution the state needs to sustain economic wellbeing of its citizens, despite the fact that it is not the state that kills domestic animals but the wolf, in whose existence it only holds privilege. 2) In order to avoid both, backlashes in local and regional elections and self-help actions (e.g., illegal killing of wolves) by those (actually or potentially) suffering from the presence of wolves, the federal government and the German *Länder* aim to increase acceptance of protective wolf management. Mentioned ‘self-help’ could backfire on Germany and the *Land* Saxony and result in EU sanctions.

We argue that cost-effectiveness considerations have been driving the selection of entitlements to secure the described problem of lack of human agency (responsibility) behind the actions of wolves. Cost-effectiveness is determined by characteristics of transactions. The overarching aim was to promote acceptance of wolf conservation. Damage done to domestic animals is assessed at lowest cost and in a fair manner after the depredation took place. However given the interrelated properties of transactions of depredation of domestic animals (variability, heterogeneity, uncertainty) *ex-ante* agreements on buying-off those animals which may be killed by wolves in the future cannot be established. First, such ex-ante purchases of rights to kill cannot be allocated in a fair fashion if compensations were equally distributed among all owners of domestic animals in a specified area. Second, more targeted lump sums are not feasible given the unpredictability of the transaction with respect to time, place, extent, and concerned human transaction partner (owner of the killed animal). Such compensation under a property rule entitlement would presumably be ineffective in increasing acceptance of wolf conservation. For organising the ex-ante purchase of property rights in a fair and targeted manner, compensating actual damages would be very costly considering paramount uncertainties of wolves’ behaviour and uncertain distribution of damages (number of animals depredated and frequency of attacks). To further minimize transaction and overall costs of the regulation, the state complemented the entitlements for ‘damaged’ animal owners when compensated for costs incurred with above described conditions. Animal owners are burdened with the transaction costs of reporting depredations by wolves. The state is able to distribute costs of monitoring in that way because it modifies property rights in a way that favours animal owners as responsible wolfs can neither be killed nor would animal holders be compensated.

The second condition (fencing) addresses the trade-off between investments into non-lethal preventive measures and ex-post compensation for incurred damages. Within a distance of 30 km from the wolf area, the state imposes these (transaction) costs for implementing preventive measures on the owners of domestic animals as a condition for compensation. Again, the state is able to make this distributional decision as in the context of the overall modification of property rights it substantially improves the welfare position of animal owners (which otherwise would have had no right). In addition, the state also mitigates the financial implications of this second condition by co-financing such preventive investments. Concerning overall acceptance prevention is presumably more effective than compensation once damages occurred. However, where further away than 30 km from the wolves’ area the likelihood of killings and compensations are too low to justify protective measures. Here, the state accepts negative publicity from such killings and the need to pay compensations.

Maintenance of scattered fruit trees is not prescribed by European, national, or regional legislations. Thus, the *state does not enjoy privilege* in this regard, and in fact, owners have the right to use their land within what is defined as legitimate uses (e.g., zoning). Furthermore, beyond its opportunity costs (benefits forgone from alternative uses of the land) maintenance of scattered fruit trees requires specific investments in preservation activities. Such specific investments do not exist in the same way for the services provided by wolves. With adherence to support schemes to maintain scattered fruit trees, what (Schlager and Ostrom 1992) call 'management right', (i.e. the right in cost and benefit streams from determining and harvesting from the land) is voluntarily sold to private consumers of apple juice, the German Federal State or the EU. For these reasons, governance of maintenance of scattered fruit trees is structured by bilateral voluntary agreements between the land owners and those interested in services derived from scattered fruit tree meadows. As opposed to the case of wolves (presumably for political reasons) neither actor has the ability to impose legal relations for the transacting partners (correlates of no power/ immunity, Bromley 1991)). Still, such maintenance requires asset specific investments and is only reversible in the medium term. For this reason, a hybrid governance structure is selected in form of a long-term contract, which establishes for example how fruit is to be grown in order to qualify for marketing under a specific quality label. It is to avoid opportunistic behaviour by those paying for and those protecting scattered fruit tree maintenance, and insures that asset specific investments made by land owners pay off over time. Property rights to land use (management and harvest) are secured by a property rule as entitlement structure, which requires this property to be purchased before costs are incurred by land owners due to changes in management practices. Such a property rule – in contrast to the liability rule applied in the case of wolves' protection – makes sense on two accounts: 1) given relative certainty of opportunity costs of scattered fruit tree maintenance because of high predictability of occurrence of the transaction (characteristics of low uncertainty, variability, heterogeneity) and associated cost and benefit streams significantly lowers transaction costs of determining and relating compensation levels to benefits foregone and damages incurred; 2) opportunity costs of scattered fruit tree maintenance carried by individual land owners cannot be excluded from. Thus, as they necessarily incur these costs no condition is required that would incentivise applying an optimal level of care or of prevention of damages. Nevertheless, compliance with specified farming practices require monitoring. Finally, due to lack of data we cannot conclusively compare the distributional incidence of monitoring costs. We expect that in distributing monitoring costs of changes in land use practices the state has a much worse negotiation position Owners of scattered fruit trees voluntarily adhere and only do so if their overall benefit (e.g., premiums paid) outstripped overall costs, including monitoring costs.

## 5. Conclusions

In this paper we showed how institutions – as expressions of public policy concerning the environment – are shaped by characteristics of resources and the legal position that specific characteristics of components of nature enjoy in overarching rules for example at the EU level. We found that the state applies a cost-effectiveness calculus concerning its policy objectives, which, in both cases includes the acceptance of changes in environmental management, implying costs either for owners of domestic animals or scattered fruit tree meadows. Among others, in both cases biodiversity as (global) public good as well as specific ecosystem services are provided, benefiting mainly actors at the regional level. A multitude of transactions is connected with the respective environmental management measures. We focused on two transactions that directly link to the provision of the services which were the dominant policy objectives. Differences in the institutional designs organising the transactions emerge, on the one hand, from the differences in property rights as outcome of different

political priorities ascribed to wolf protection and conservation of scattered fruit tree meadows, and, on the other hand, from differences in properties of transactions. The state enjoys privilege concerning interference with wolves derived from European legislations, giving domestic animal owners no rights. Owners of scattered fruit trees, in turn, enjoy a property right in land within the scope of overarching legislation which has to be respected by the national and the regional 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 immobility of scattered fruit tree management practices – explain the way policies enhancing the acceptance of biodiversity provision are institutionally regulated. The state uses its power in the case of wolf protection to impose certain transaction costs upon owners of domestic animals. At the same time, it uses this power to modify property rights in order to increase acceptance of wolf management. Reactions to wolf conservation in the case study as well as all over Europe show that this is essential for political reasons (e.g., to avoid loss of votes) as well as to prevent EU sanctions. On the other hand, scattered fruit tree maintenance is subject to voluntary, long-term agreements, justified by medium term irreversibility and asset specific investments. The specific entitlement regimes can be explained with transaction cost considerations and trade-offs between stochastic prevention and compensation costs in the case of domestic animal depredations. The state responds to the unpredictability of depredations by wolves with a liability rule in order to reduce transaction costs. Given the predictability of cost and benefit streams in the case of maintenance of scattered fruit trees it applies a property rule.

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