Collective choice on different spatial levels and over time: a framework to analyze adaptation and sustainability of common pool resource management in German recreational fisheries (GRF)*

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Abstract

There is some concern that the management of German recreational fisheries (GRF) might impair ecosystem services generated by fish and facilitate social conflicts among resource users. Furthermore, it might be characterized by inefficient resource management.

This paper aims to develop a framework to analyze these potential problems growing out of multiple interactions within and between anglers and fish resources. Both are placed in a complex social and ecological system (SES). Besides the angler's activities, the major components of the social system are the institutional environment on one hand and the agents of the governance structure who decide about resource management on the other. The fish stocks as part of the ecological system are embedded in resource systems such as waters and in the broader biophysical world. Their specific characteristics as renewable common pool resources need particular awareness in resource management. All components are connected by multiple relations, which are explained by using insights from Institutional and Ecological Economics Theories.

Based on the work of Elinor Ostrom (2005, 2007) we develop a framework which is explained from the perspective of the governance structure. Its agents, in charge for a collective choice of a particular management approach, are the key for solving potential problems in resource use. To balance possible ecological, social, and economic problems which arise from the complexity, uncertainty and changes in all components of the SES, we argue that an adaptation of management instruments is needed to achieve a sustainable resource management over time. A specific feature of GRF is the resource management on different spatial levels in East and West Germany. These two distinct governance structures provide a compelling frame to study different efforts to manage for sustainability.

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Contents

1 Introduction

In most industrialized countries recreational fishers[1] are currently the dominant users of fish resources in inland waters. These fish resources provide numerous social, ecological, and economic benefits to society such as fishing experience, fish consumption, relaxation in nature, enjoyment of the angling community, ecological education, environmental monitoring, fishing tackle expenditure etc. (Arlinghaus et al. 2002; Arlinghaus 2004a, b). However, there is a growing concern that intensive recreational fishing activities can have undesirable effects from the perspective of sustainability[2] (Post et al. 2002; Cooke & Cowx 2004, 2006; Lewin et al. 2006), and German recreational fisheries (GRF) are likely no exception. It has been suggested that recreational angling can have ecologically undesirable effects such as overexploitation of targeted fish species, genetic contamination of fish populations though stocking of non-native fish (i.e. non-native to specific catchments), or social conflicts regarding fish stock use (Cooke & Cowx 2004; Arlinghaus 2005; Arlinghaus & Cooke 2005). Freshwater ecosystems provide several services for human use like fish harvesting or recreational activities (Costanza et al. 1997) and issues such as those mentioned above are indicative of a disorder[3] between social and ecological subsystems of GRF, which can compromise the maintenance and future use of the ecosystem services generated by fish[4]

[1] There are many definitions for recreational fisheries, however, there is no universally agreed upon definition (Aas 2002: 254). In Germany, recreational fisheries can be understood as a non-commercial fishing activity conducted during leisure (i.e. non-working) time. This activity is highly restricted with regards to technical equipment (e.g. fishing nets are forbidden) and typically done by rod and line fishing (angling). In addition, getting appropriate angling licenses and permits requires a lot of effort on the part of anglers when compared with other European countries.

[2] Sustainability means that the needs of the present generation do not compromise the needs of future generations; a concept that integrates social, economic and environmental dimensions (WCED 1987). This implies that social, economic and ecological goods and services generated through ecosystems or components of ecosystems such as fish populations must be maintained.

[3] What disorder means exactly highly depends on norms, attitudes and most importantly on the perceptions of the different stakeholders.

[4] Ecosystem services represent the benefits (e.g. food supply) humans derive, directly or indirectly, from the ecosystem (Costanza et al. 1997: 253). Holmlund & Hammer (1999: 255) differentiate four major fundamental and demand-derived ecosystem services generated by freshwater fish populations. These are firstly regulating services such as the regulation of food web dynamics, recycling of nutrients or maintenance of genetic, species, ecosystem biodiversity, secondly linking services such as the linkage within aquatic ecosystems, between aquatic and terrestrial ecosystems or for transport of energy, thirdly cultural services such as the production of food and medicine, reduction of waste, supply of aesthetic values or recreational activities, and fourthly information services such as the assessment of scientific and educational information, assessment of ecosystem stress or revealing evolutionary tracks. The loss of such services due to human activities has negative social, economic and ecological consequences and management approaches have to take this into account.

for humans (Holmlund & Hammer 1999; Low et al. 1999). Moreover, one of the most important objectives of GRF management is to provide satisfactory fishing experiences for the angling public, and mismanagement might comprise this social goal.

Human use of ecosystem services provided by fish populations is regulated by a complex system of institutions (with formal and informal rules for fisheries management), governance structures such as fisheries authorities, angling associations, other fishery stakeholders, and contracts implementing or governing specific fisheries management measures (Williamson 1996). These groups define the approaches and tools used to manage the use of ecosystem services and try to regulate disorder occurring in those systems. These management measures, defined as transactions to organise and implement human activities in recreational fisheries, have several costs such as search and information costs, bargaining and decision costs, and monitoring and implementation costs (Richter & Furubotn 1999: 35). These costs are highly dependent on the arrangement of the institutional environment and governance structures.

GRF can be characterized as a co-management system. Fishery authorities regulate the allocation of fishing rights in inland waters, and monitor the compliance to fishery regulations. However, the holder of the fishing rights has the responsibility by law to manage the resource in a sustainable manner. For recreational fisheries, angler organisations usually own or lease the fishing rights of waters. Angler organisations are angling clubs at the local level which together form angling associations at the regional or states[5] level. However, there is a major difference between East and West Germany with regards to the holding of fishing rights. In East Germany anglers associations usually lease or own the fishing rights whereas in West Germany angling clubs lease or own the fishing rights. As a result, the responsibility for managing the fish stock resources rests with groups organized at different spatial levels. Hence, the distinct governance structures in East and West Germany provide a unique opportunity to study how different groups deal with the challenges of GRF management and the different efforts they employ to maintain long-term sustainability.

A crucial factor in fish resource management is the individual resource system's characteristics which must be considered by all management groups. These characteristics are expected to exert a strong influence on the implementation and enforcement of specific management measures by the different governance structures (Berkes 2006, Carpenter & Brock 2004). Germany's geographical structure is mainly separated into the North German Lowlands with large and often connected lakes and canal/river systems with abundant fish populations whereas the Central German Uplands are featured by fast running, mostly small rivers, and very small ponds or larger dams which are widely scattered over the countryside. Thus, the objective of this study is to determine how the different institutions and governance structures in GRF respond to challenges of social-ecological disorder or potential disorder (i.e., those not yet realised by the majority of stakeholders) in systems that have discrete resource characteristics, and how they generate sustainable and adaptive management systems to provide further utilizable ecosystem services.

Fundamental and comprehensive studies on the institutional environment, the governance structure and management systems in GRF have not been extensive (Arlinghaus et al. 2002; Steffens & Winkel 2002; Arlinghaus 2006: 46), nor has the role of actors' behaviour in GRF

[5] "States" are the so called German "Laender", of which there are sixteen. These federal states are: Mecklenburg-Western Pommerania, Brandenburg, Saxony-Anhalt, Thuringia, Saxony (all Eastern Germany), Schleswig-Holstein, Hamburg, Lower Saxony, Bremen, North Rhine Westphalia, Rhineland-Palatine, Saarland, Hesse, Baden-Wuerttemberg, Bavaria (all Western Germany), and the capital Berlin.

governance systems been thoroughly examined. Furthermore, it is unclear whether the governance structures facilitate adaptive management systems in GRF, a system that is thought to be oriented towards sustainability. Carpenter & Folke (2006: 313) point out the key role of governance in ecosystem management: "Its success or failure (of adaptive environmental management, added by author) appears to depend on the institutional and political processes that govern the project." Examining governance here means "to study the structures and processes by which humans make decisions and share power in the process of managing ecosystem services" (Carpenter & Folke 2006: 313). This study aims to investigate this research objective for GRF and thereby partly fill the existing research gaps.

2 Human-nature-interaction → the research problem in GRF

A recreational angler catching fish appears to be a simple transaction at the first glance, but there exists a web of more complicated relationships of human-nature interactions within the social-ecological system (SES). The impact of angling activities on fish stock resources can produce major disturbances in the functioning of freshwater ecosystems and might cause undesirable outcomes. However, the characteristics of fish stock resources themselves and the fact that they are embedded in larger resource systems challenge the way fish stock populations are used by humans. Fish stock populations as renewable natural resources can be framed as so called common-pool resources[6] and are characterized by a high rivalry for utilisation of the resource and problems in the exclusion of other (non-authorized) users. High rivalry derives from the fact that the use by one fisherman precludes the use by another (both cannot utilise the same fish). This can cause the so called "tragedy of the commons" as depicted by Hardin (1968). The "tragedy of the commons" arises in the following case. Without any regulation (= open access), there is a free run on the common-pool resource. Every angler tries to catch as many fish as possible and every fish not caught is free to be harvested by another fisherman. Problems arise if growing numbers of anglers, improved angling technical equipment, and/or increasing demand for fish cause an overuse of the resource and disturb both the ability of the fish stock to reproduce and its provision of ecosystem services. As a consequence, the regulation of resource use among competing users to hinder these undesirable effects is needed.

The second major feature of common pool resources is the difficulty of excluding non-authorized users. Fish stock populations are nested in water systems. Water bodies are scattered over wide spatial scales which may be interconnected over large distances by things such as long rivers or connected lake systems. Furthermore, their importance for social and economic use makes it difficult to exclude potential users of fish stocks or water resources. For instance many rivers and lakes are used as waterways for commercial or private shipping traffic. Another example is the construction of local water power facilities which build in fish ways (Uhlitzsch 2003). Additionally, many leisure activities such as hiking, swimming, canoeing, or camping utilize water resources. Hence, excluding non-authorized users (e.g. building a fence), from water and fish stock resources to avert things such as fish stock overuse is a difficult task to undertake.

The difficulties arising from these intrinsic resource characteristics are called first order dilemma in the literature. The difficulties of common pool managers to deal with these are

[6] See Perman et al. (2003: 126) for a detailed description of public, private, club, and common-pool resources (goods).

called second order dilemma (or social dilemma) because many of the hitherto used management approaches failed and did not work out economic inefficiencies[7], social conflicts, or destruction of natural resources finally. To overcome these obstacles new management approaches such as the adaptive management approach need to be developed and implemented. The key to achieving this goal lies with the governance structure as the entity that decides how a certain resource management plan is carried out.

To avoid or mitigate the problems that result from typical common pool resource characteristics in GRF several management tools have already been established by the governance structure. Measures such as access regulations (e.g. fishing rights or permits), use regulations (e.g. seasonal closures), or fish stocking activities try to reduce the risk of resource overuse and the loss of ecosystem services. Furthermore these regulations attempt to regulate or avoid social conflicts between different resource users regarding their individual benefits from catching fish. Another issue is to manage the resource use as efficiently as possible to balance the costs and benefits of resource management. It still needs to be investigated whether these management objectives are applied and reached by angling clubs and associations.

However, there is some concern that these attempts to manage and regulate GRF are not entirely successful and that governance structures are challenged by several problems in fish resource use. The challenges in fish resource management are highlighted by the following three major problems: access and use regulations, fish stocking measures and problems that result from multiple stakeholder interest in inland water resources.

2.1 Access and use regulations

Property rights are typically established to regulate access to and the use of fish stock resources by humans. The aim is to share the scarcity of the resources among different users while maintaining a suitable stock structure for the future use of ecosystem services. There are a multitude of management measures regarding access and use in recreational fisheries to reach these policy goals (Young 1999; Hoel & Kvalvik 2006). However, many of these management regulations fail for several reasons (Begossi 1998; Kearney 2001; Wang 2001). For instance unclear specifications and information about how resources may be used and protected may incur transaction costs (Edwards 2003), or management regulations are not ecologically consistent with the resource they are supposed to manage (Almlöv & Hammer 2006).

In GRF, all people or organisations that own or lease the fishing rights on waters, and people who buy angling permits from them have access to the fish stock resources. In East German recreational fisheries, angling associations usually lease or hold the fishing rights on waters over larger spatial scales and try to sell the angling permits as cheaply as possible to provide easy access for many anglers. Between the angling associations in different East German states there are fishing permits contracts which allow anglers from one state to go fishing in another state at low prices. On the contrary, in West Germany angling clubs on a local level usually lease or own a limited number of lakes or parts of rivers and strongly restrict the access of users other than the angling club members. For recreational fishers this often requires a lot of effort to bargain for access and high costs to obtain a permit. These different access and use rules might cause conflicts between East and West German angling

[7] Efficiency is defined shortly as follows: under a designed set of institutions, governance structures, and resource characteristics there is no management improvement possible (Pareto-efficiency).

associations and clubs regarding the use of fish resources. While it is very easy for West German anglers to participate in East German recreational fisheries, it is comparably difficult for East German anglers to participate in West German recreational fisheries.

The fishery laws and regulations in the particular states define access and use restrictions. In addition to the property rights regulations that restrict access to the resource, other regulations may also restrict fish stock use, such as protected species, closed fishing seasons, or the protection of undersized, immature fish which has to release to the water. The owners or lease holders of fishing rights also have the option to make these regulations more stringent, but not to make them less stringent.

Managers must also deal with issues regarding various illegal activities associated with access and utilization regulations. One issue is illegal angling which means harvesting fish without the permission of the owner (free-rider problem: getting the benefit from a good without paying for it, typical for common-pool-resources or public goods). A greater problem concerns non-compliance with the use regulations such as restrictions on bag or fish size, fish species, angling areas and technical limits of angling (e.g. anglers catch eel under limit and take it home or commercial fishing tackles are used like gillnets). There are many reasons for anglers to carry out illegal angling or to ignore use regulations (Sumaila et al. 2006). However, both the complexity of resource systems and the diverse organizational structure of recreational fisheries make it problematic to provide effective enforcement (Pereira & Hansen 2003).

The resource characteristics in the North German Lowlands might further reduce the efficiency of enforcement. The large water resource systems in this region could complicate monitoring and the implementation of access and use regulations and this is thought to be a major contributing factor to illegal activity. Angling associations organized on a larger scale (i.e., East Germany) might be better able to bear the higher financial and personal costs of enforcement because of their large number of members and their strong position (because of their long-range water resource ownership on a regional level) in higher policy-decisions which decide about access and use regulations. Their mandate to provide easily obtainable and cheaper use permits to all anglers and to abandon the fishery licence might hinder illegal angling activities in their water areas.

On the other hand, limited water bodies can be controlled more effectively and strong restrictions on membership, such as in the low-level organized governance structures in West Germany (special-limited water resource ownership), support easier and cheaper control measures for access and use restrictions. Small-scale management may support more control by club members and save financial and personnel resources that otherwise may have been required for enforcement. Furthermore, it is probably easier to monitor the fish resources and gather information about the amount and state of the fish stock population. This knowledge might make it easier to estimate correct restrictions on access and use. However, it is also assumed that in complex resource systems the management by angling clubs is less efficient because of less influence and management capabilities in larger water ecosystems based on their limited ownership and membership.

2.2 Fish stocking measures

Fish stocking is the most widespread and abused management tool used in freshwater fisheries (Cooke & Cowx 2006) and it is a typical human reaction to fish stock decline which may be caused by many different reasons (Feunteun 2002). Generally, it has been carried out to meet the following objectives: a) compensation to mitigate a disturbance to the

environment caused by human activities; b) maintenance to compensate for recruitment overfishing; c) enhancement to increase and maintain the fisheries productivity of a water-body at a higher level, and d) conservation to retain stocks of a species threatened with extinction (Welcomme 2001: 241). Thus, reasons for fish stocking measures can have two aims, firstly to gain similar or more catch satisfaction (considering human use of the ecosystems service fish supply) or to maintain ecosystem services like biodiversity or food chain dynamics in fish stock resources (Hansson et al. 1997). However, some case studies point out that to reach such ecosystem services, better monitoring and information systems have to be established in fisheries management in order to only stock when the situation is appropriate (Welcomme & Bartley 1998; Holmlund & Hammer 2004) and to avoid stocking as a tradition (Klein 1996).

The main problem of using fish stocking as a management measure is that they are carried out without complete information about the actual or potential success of the exercise (Cowx & van Zyll de Jong 2004) or without any definition of the objectives (Cowx 1994). Information about the amount of fishes in the lake/river, about the number and quality of the stocked fish species and of the catch amount by anglers is often lacking. This lack of information arises from non-existing, failed or biased monitoring measures of angler catch amount, lack of research and support by scientist, and lack of monitoring of the status of the resource base. Gathering this information is also made more difficult by very complex resource characteristics. In large-scale water bodies fish migrate and fish populations differ from one water body to another. Additionally, fish stocks are part of a broader food web and birds or mammals could have a strong influence on the quantity and quality of fish stocks. The problem of free-riding can appear as well. Especially in complex resource systems where several property rights on one water body could exist, it is assumed that the benefits of fish stocking measures, carried out by one adjacent owner, can be taken along by the others without own management effort.

In Germany, there are few lakes or rivers which are not stocked with fish and these management instruments are generally uncritically applied and carried out to increase fish yield for recreational anglers (Klein 1996). Recently, concern has been raised that traditional stocking practices are often single-species oriented and do not take into account the complex structures of fisheries food webs (Arlinghaus et al. 2002). This in addition to the other concerns related to stocking suggest that clarification is needed on the objectives that angling associations or angling clubs hope to achieve by fish stocking. Is the objective only to assure selfish angler catch satisfaction or is it to care for ecosystem requirements, which means that stocking is conducted in an adaptive management framework and that stocking is followed by an evaluation of success and future stocking changed accordingly?

2.3 Multiple stakeholder management

The problem that is addressed by this research is that regulating fisheries management on different spatial levels attaches different values to ecosystem services (Hein et al. 2006). There are different interests regarding the use of fish and water resources which cause diverse conflicts in this sector (Arlinghaus 2005). For instance in GRF, interests other than fish catch exist such as scientific interests to investigate fish species or fish behaviour in specific habitat structures. Thus, angling in a system where research is being carried out would disturb the scientific investigation. Other interests in the resource systems (directly and indirectly influencing fish stocks) are the provision of long water traffic ways including river training works. These measures are usually planned and implemented at a regional and

states' level and are carried out over many water basins. As a result, it is difficult for angling clubs at the local level to influence such decisions. Based on former research evidence that small-scale community-based management deals better with ecosystem requirements (Ostrom 1990), proceedings that exist from this point on consider the influence of multiple resource user groups (Wilson et al. 1999; Berkes 2006) on different scales of the resource systems. Many conflicts can be identified regarding different resource use interests (Bennett et al. 2001) and small-scale management measures are not able to react on those challenges (Lester et al. 2003), because other resource users are acting on the regional or states' level. However, regulations that are too stringent at higher scales can in turn also cause management failure (Carpenter & Brock 2004). Thus, management approaches should consider local fish resource requirements organized by anglers clubs and associations and should consider interactions between flexible and multiple resource user demands on higher scales. This approach is widely discussed in this paper under the term "multiple stakeholder management."

German recreational fisheries are often confronted with a high level of complexity (many different interests in fish resource and water resource services covering different spatial scales) in their resource systems. Hence, recreational fisheries management depends strongly on the non-fishery players (Arlinghaus et al. 2002). Fish stocks are mainly used by recreational anglers, but also have to be shared with commercial fishermen. The use of these resource systems is much more differentiated. Other pressures arise from the fact that many rivers, canals and lakes are used as waterways for shipping traffic. To facilitate these activities, most waterways have recently been renovated or are still under reconstruction. Both factors have a great influence on the natural habitat for fishes. The input from industrial or agricultural facilities may also influence fish populations. For instance, the entry of farm animal waste can change water quality from oligotrophic to eutrophic, which affects the fish species whose preferred habitat is one or the other (e.g. pikeperch like highly eutrophic water basins). The construction of local hydroelectric facilities often alters or restricts fish movement (Uhlitzsch 2003) and affects fish habitat. Furthermore, there are many leisure and sport activities that utilize water. These activities usually do not consider the existence of the fish stocks and their habitat requirements and might disturb angling activities at the water. Additionally, trade-offs between different interests can emerge and questions arise about how to deal with such social situations.

In Germany the debate about fish welfare issues is highly controversial. Animal welfare and nature conservation issues are of very high societal concern and are represented by nature conservation interest groups. These concerns have been implemented in several international, European, and national laws (Stoll-Kleemann 2001), and affect many regulations of recreational fisheries management (Cooke & Cowx 2006: 101). The influence of these issues in GRF is twofold. Animal welfare interest groups aim to protect every single fish, and to hinder killing and pain caused by anglers' activities. Nature conservation groups try to establish protected areas to preserve whole habitats including fish populations and to reduce or forbid anglers activities in those areas.

Summing up this chapter, there is a high influence on GRF social-ecological system from various external and internal factors and the users of the resource system have great cross-scale effects on the fish stocks and thus on angling activities (Arlinghaus et al. 2002). Regarding the governance structure in GRF, it is assumed that there is no well connected interaction between different stakeholders (Arlinghaus 2006) and anglers interests are marginalized in some resource system contexts. To consider the interests of anglers in other resource use structures on higher levels (Okey 2003) it is necessary to develop further co-

management systems over different resource use scales (Begossi 2006). The institutional challenge for the governance structures in GRF is to implement their interests in the decision-making process on the states and regional levels and to cooperate with other stakeholder groups, for instance to get the right of hearing regarding decisions on reconstruction of waterways or to demonstrate their own conservation interests to animal welfare stakeholder groups. The high-level governance structure of recreational fisheries in East Germany might be better included in policy-decision processes on water management decisions whereas the low-level organized angling clubs in West Germany might be disregarded because of their local-level activities. It is assumed that the incorporation of stakeholders in the decision-making process causes lower transaction costs and makes it possible to establish suitable management measures (Sutinen & Johnston 2003; Cowx & Gerdeaux 2004). A crucial point here is that the stakeholders are willing to cooperate, which often occurs after an initial phase of behaviour following selfish interests (Stoll-Kleemann 2001; Pereira & Hansen 2003).

Due to the different resource characteristics in the North German Lowlands and the Central German Uplands it is important to consider that (except nature conservation and animal welfare issues) in complex water systems there are many stakeholder groups with different interests regarding the water resources (hydroelectric companies, the tourist industry, commercial fishermen, water sports etc.). Therefore, high-level recreational fisheries organizations might be more successful and efficient in those settings, whereas if the water resource is less complex such as in the Central German Uplands local organized management might be sufficient.

2.4 Research questions

Hence, the research questions of this study are:

1) Which governance structure is more successful in the maintenance of ecosystem services, solving social conflicts, and avoiding economic inefficiency in GRF?

2) Which governance structure is more adaptive in GRF management considering varying resource characteristics?

3 Insights from Institutional and Ecological Economics

Economists study the system of consumption, production and distribution of goods, and the management of these in the human society. Ecological economics considers the importance of natural resources for this exchange process and stresses the limits of economic growth resulting from scarce natural resources (Perman et al. 2003). Furthermore, this branch of economics has moved away from the paradigm of traditional economic theory that natural resources are completely substitutable through human and financial capital and that individuals always maximize their utility (Vatn 2005). Ecologists stress the interdependency of human-ecological interactions (e.g. angler-fish stock interactions) and focus on the outcomes of these interactions. The central idea here is that the function of ecosystems eventually can be destroyed through human activities, and the crucial question is how we can organize the utilization of natural resources and at the same time maintain ecosystem functions, while providing further resource use by humans. That maintenance can be named as resilience, defined as the ecosystem's ability to return back to its organizational structure

intact after a perturbation (e.g. human activity such as overfishing) has taken place (Carpenter & Folke 2006). Securing the resilience of an ecosystem depends on adaptive resource management, which considers the economic, cultural, political, and regulatory dimensions of the system.

In this study, insights from Institutional Economics are chosen because “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. Therefore institutions link social and ecological systems.” (Gatzweiler & Hagedorn 2003: 3) This theory considers market and non-market explanations such as regulatory, cultural, or behavioural factors for the success or failure of natural resource management.

Following Vatn (2005) the core question of Institutional Economics is which choices people make within different types of contexts, both physically and socially. For example, which choices are made by angling associations or clubs when implementing management measures in one way versus another and why do they do so. These choices follow institutions. Institutions are defined as “the humanly devised constraints that shape human interaction. In consequence they structure incentives in human exchange, whether political, social, or economic.” (North 1990: 3) They consist of informal (sanctions, taboos, customs, traditions, and codes of conduct) and formal rules (constitutions, laws, property rights) (North 1991: 97). In the context of this study, this means traditions, rules, regulations etc. related to fisheries management, the constraints on the interaction between angling associations or angling clubs and freshwater ecosystems (use of the fish stock resources) and the choices of certain kinds of management measures. Thus, the institutional environment defines the choice domain within which the members of society operate (Bromley 1989: 741). These members (individuals or groups of people) are called agents (or governance agency), which are organized in different alternatives (governance structure) and defined by institutions. However, the members also have the ability to define institutions. Thus, governance structures are the key for changing traditions, rules, and common customs. They consist of institutions incorporated by humans in discrete structural governance alternatives; classical market, hybrid contracting and hierarchy (Williamson 1996). For the GRF governance structures, these alternatives are private ownership of fish stocks like commercial fishermen (classical market), common ownership like anglers associations or clubs in East and West Germany (hybrid), or governmental ownership (hierarchy). These governance alternatives mediate between individual formal or informal transactions (management measures) to align incentives that organize the allocation of (fish) resources.

The theory of Institutional Economics follows the assumption that the detailed arrangements of institutions matter and that their failure (or success) has a direct influence on a particular outcome of resource use (Vatn 2005). Those institutional arrangements are highlighted by different theories such as property rights theory, transaction cost theory, social capital theory, and the theory of institutional change, which are explained in detail on the following pages.

3.1 Property rights theory

Property rights are an institutional form (these can be also called rules) which regulate the access to and use of resources by humans. Those rights are enforced by the state as the “unit of coercion” (Bromley 1992: 3), which both defines the boundaries of property rights and observes holders of the property rights in their use of the natural resource. Therefore, Bromley defines property rights as “a benefit stream that is only as secure as the duty of all others to respect the conditions that protect the stream.” (1992: 10). Protecting the stream

means for example that natural resources are not squandered in anarchy and that the holders of the property rights invest in the resource to maintain future use. A functioning property rights system depends on well-defined and well-established property rights rules, which give the holders the security that their rights are recognized by potential competitors in the present and the future (Ostrom & Schlager 1996). This security ensures the development of long-term management plans.

To investigate the functioning of property rights, two parameters have to be considered; the attributes of the resource and the attributes of the resource user (Paavola & Adger 2005: 356). Fish stock resources are common pool resources and are characterized by high rivalry and difficult exclusion of users. The difficulties of exclusion depend of the characteristics of the resource, for example whether it exists in approachable and lake-rich landscapes and provides the possibility of free riding, such as resource use in situations without fishery rights and the correspondently costs of its provision. This might imply consequences for the different approaches of recreational fisheries management in East and West Germany. Furthermore, the property rights' holders are also challenged by the attributes of the resource user, i.e. the number, heterogeneity, and the social capital of anglers. For instance, a small number of anglers can be better observed by angling club managers in West Germany, than a high number of users can be monitored by angling associations in East Germany. However, it is still unclear which governance structure is more efficient in the different resource characteristics in Germany.

3.2 Transaction cost theory

The failure or success of management measures in GRF also depends on the amount of transaction costs incurred to achieve a particular outcome, for example management measures such as fish stocking or access restrictions. Transactions of management measures can be defined as "developing initial contracts between parties responsible for the production of the ecosystem services necessary for recreational fisheries" (Rudd et al. 2002: 47). Those contracts are e.g. capture limits or size limits and should be in line with both actors' preferences, goals and motivations and the maintenance of fish resources. However, the carrying out of such management measures has costs. In addition to the production and personnel costs there are so called transactions costs, which are broadly defined as the "costs of running the economic system" (Arrow 1969: 48). These costs are e.g. search and information costs, bargaining and decision costs, and monitoring and implementation costs (Richter & Furubotn 1999: 35). They are all assumed to have an influence on the arrangement of management measures by the governance structure. For instance if regulations at the state or regional level do not fully conform to the attitudes of local resource users (top-down approach), the costs of monitoring and enforcement rise (Costanza et al. 1998). Therefore, the amount of transaction costs incurred might also have a strong influence on the resource managers' choice of which kind of management measure to carry out.

The amount of transaction costs incurred varies greatly among the different forms of the institutional arrangement (e.g. governance structures (Williamson 1991)), resource characteristics, anglers' attributes, and the degree of the resource use complexity (Paavola & Adger 2005). In different situations the transaction costs can be higher or lower. Because of the distinct governance structure in GRF, the structure of the costs differs between East and West Germany. In the West, the small-scale organized angling clubs at the local level might have low monitoring and enforcement costs (regarding access and use restrictions) because

of their proximity to the resource. Nevertheless, the information costs between different angling clubs might be much higher, and the effort required to influence the policy-decision process at higher spatial levels (regional or mostly states' level) about fishery laws might also be high. Therefore, angling clubs at the local level might have higher bargaining and decision costs to enforce their interests relative to the interests of other fish resource interest groups (e.g. nature conservation groups) or water system user (representatives of hydroelectric facilities or water traffic companies). In East Germany, where anglers' organizations are at the regional and states' level, there might have more access to and influence on the policy-decision process because they decide for a wide community of anglers and participate with "one vote." However, information costs about the resource, monitoring and enforcement costs associated with access and use restrictions might be much higher.

Resource characteristics also have a strong influence on transaction costs. In complex water bodies (which are typical for the North German Lowlands) more search and information costs are incurred to obtain information on the status and change in fish stock populations. The monitoring and enforcement of access and use restrictions might also have much higher costs in these systems than in limited and easily observable water bodies such as in the Central German Uplands.

Another parameter to consider in the governance structures are the attributes of the angler community (Arlinghaus et al. 2002, Arlinghaus 2004a, 2005, 2006). Their expectations about resources might influence decisions about management measures by angling associations and clubs managers more than e.g. ecological requirements of the resource system. In addition, the number and attitudes of anglers might have a strong influence on the effective implementation of management measures (Arlinghaus & Mehner 2005). For instance, consideration of varying attitudes, beliefs, and catch orientation of anglers might increase the bargaining costs in governance structure management decisions. However, it could also be the case that the inclusion of anglers' interests in management decisions reduces enforcement and monitoring cost because of the anglers' participation in management decisions.

3.3 Social capital theory

The often described problem in using common-pool resources is the so called social dilemma. This means that the decisions about and the use of fish stock resources highly depend on trust, reciprocity, and equity between the resource users and arise from the characteristics of common-pool resources (Ostrom 2005b). The success or failure of management systems to prevent rivalry in resource use and to enforce restrictions on access depends highly on these values. Additionally, norms and traditions influence anglers' activities and management decisions. Furthermore, the lack of information and knowledge about the complexity in resource systems complicates the management of fish stock resources. The ability of different resource users to communicate about problems arising from resource use also becomes a crucial consideration. All these behavioural and cognitive traits of the resource users are difficult to consider in management decisions and are not easy to incorporate. It is also assumed that strategic behaviour (utility maximization) with complete information does not work in common-pool resource management (rational choice theory). On the contrary the bounded rationality of humans in using ecosystems services (fish stock resources) is obvious (Jager et al. 2000).

However, one way to solve these difficulties is the collective action approach. This approach departs from rational choice theory and points out the importance of sharing norms between

different resource users. Similar to this approach is the concept of social capital (Paavola & Adger 2005: 363), which is defined as the "capacity of social groups to act in their collective interest" and this "depends on the quality of the formal institutions under which they reside." This is also seen as a central strategy for a resource user's adaptation to environmental problems. With respect to the resource use in GRF, this means that resource managers have to build up common preferences in fish resource use, consider all requirements for the different expectations of varying resource users and maintain the ecological system of fish stock populations. To achieve this societal endeavour they have to overcome challenges like communication barriers and the lack of resource knowledge and they have to deliberate the further use of traditional management measures (Arlinghaus 2006).

Regarding the different governance structures in GRF it might be the case that local angling clubs are more successful in building up these strong relationships and communication skills within a well known and homogeneous angler community. However, these issues are also important for high-level angling associations, representing many heterogeneous anglers, and their interactions with other stakeholder or interest groups. It might be easier to trust and work together in small communities. However, to achieve sustainable fish resource management, e.g. in complex resource systems, it is also important to invest in human capabilities at higher levels (Berkes 2006).

3.4 Theory of institutional change

Theories of institutional change are important for the research question of this study: how potential management failure and deficiency of both existing governance structures in GRF in varying resource characteristics can be overcome and move towards an adaptive management approach. Within institutional economics there are many explanations regarding institutional change. For instance transaction costs are often claimed to be essential for change or stability in institutions, because high transaction costs may prevent institutional change (North 1990). Inefficient property rights, technological changes or market changes may also cause institutional change. However, this study focuses on co-evolutionary and collective action approaches to explain institutional change (Paavola & Adger 2005). Economic co-evolution is defined as "mutual adjustment and development of ecological and economic systems" and "social systems in turn reflect the peculiarities and constraints imposed by the resource on which they depend" (Paavola & Adger 2005: 361). This approach allows consideration of a broader range of reasons for institutional change. The central point is the assumption that human decisions follow bounded and imperfect rationality. The choice of resource management is understood as a learning process of trial and error and emphasizes the volitional decisions made by resource managers.

Central in this approach are feedback mechanisms between the user, the resource and the learning processes of resource managers about human resource use (van den Berg & Stagl 2003). Feedback mechanisms of the SES and learning processes influence the decision about management regulations and provide the basis for adaptive management systems. Adaptive governance structures can be defined as follows: "institutional and political frameworks designed to adapt to changing relationships between society and ecosystems in ways that sustain ecosystem services." (Carpenter & Folke 2006: 309)

At this feedback mechanisms are a precondition for institutional innovation, i.e. a change in laws, rules or the behaviour of stakeholders, in order to provide new management approaches that are able to adapt to the changing requirements of social-ecological systems. Furthermore, it is central that the results of feedback information are considered in the

decision-making process and that the stakeholders are able to draw conclusions from them, i.e. to change currently failing management approaches to adapt to the requirements of the social-ecological system. Therefore, the knowledge, attitudes, and resources of fish stock managers (representatives of angling associations and angling clubs) have a high influence on change in the institutional environment, in management systems and in human behaviour and norms regarding fish resource use.

4 A framework to analyze GRF management

This framework shown in figure one, draws heavily on the work of Elinor Ostrom (1990, 2005, 2007). It regards to both the “Framework for Institutional Analysis and Development” (IAD) and further enlargements towards a social-ecological system analysis (2007). The here proposed framework considers the influence of the institutional environment, rules, traits of actors and resource characteristics underlying a particular arrangement of management measures on resource use such as those mentioned in theoretical explanations described in part three of this paper. Furthermore, it takes into account intra-sectoral relationships of ecological systems between resource units and resource systems within the biophysical world, which feed signals back to the social world.

The two parts in the framework, the social and ecological system, do not imply contradicting positions. On the contrary both are strongly connected by everyday human-nature interactions, specifically through multiple interplays between numerous components of the system. Both adapt activities on each other and give feedback to the other part. This view on human-nature interaction is based on the integrated concept of “human in nature” perspective of social-ecological systems by Berkes & Folke (1998). The implication of this concept on resource management is that a sustainable use of natural resources needs the consideration of all three branches of sustainability: economic efficiency and success, social conflict resolution (both on the social part of the SES), *and* ecological resilience (the ecological part of the SES). These management objectives (which are the objectives of this research as well) are the evaluation criteria in the adaptive management cycle. Disturbances in one of these parts might have strong influences on the other parts and might cause social-ecological disorder and hence may hamper sustainable resource use altogether.

As described in chapter two, problems in resource use arise with the daily human-nature interaction. This interaction consists mainly of human activity regarding natural resource use and the outcome fed through the ecological system as a result of this activity. A simple example would be the following: too many anglers have access to a limited area of water. They cause a comparable high angling pressure with a high capture rate. The outcome would be a reduction of the abundance of the fish stocks, changes in fish population structure or in the fish community structure in all. This again has an influence on resource use. The anglers might gain lower catch amounts and might start to argue about the use of reduced fish stock populations (social conflict).

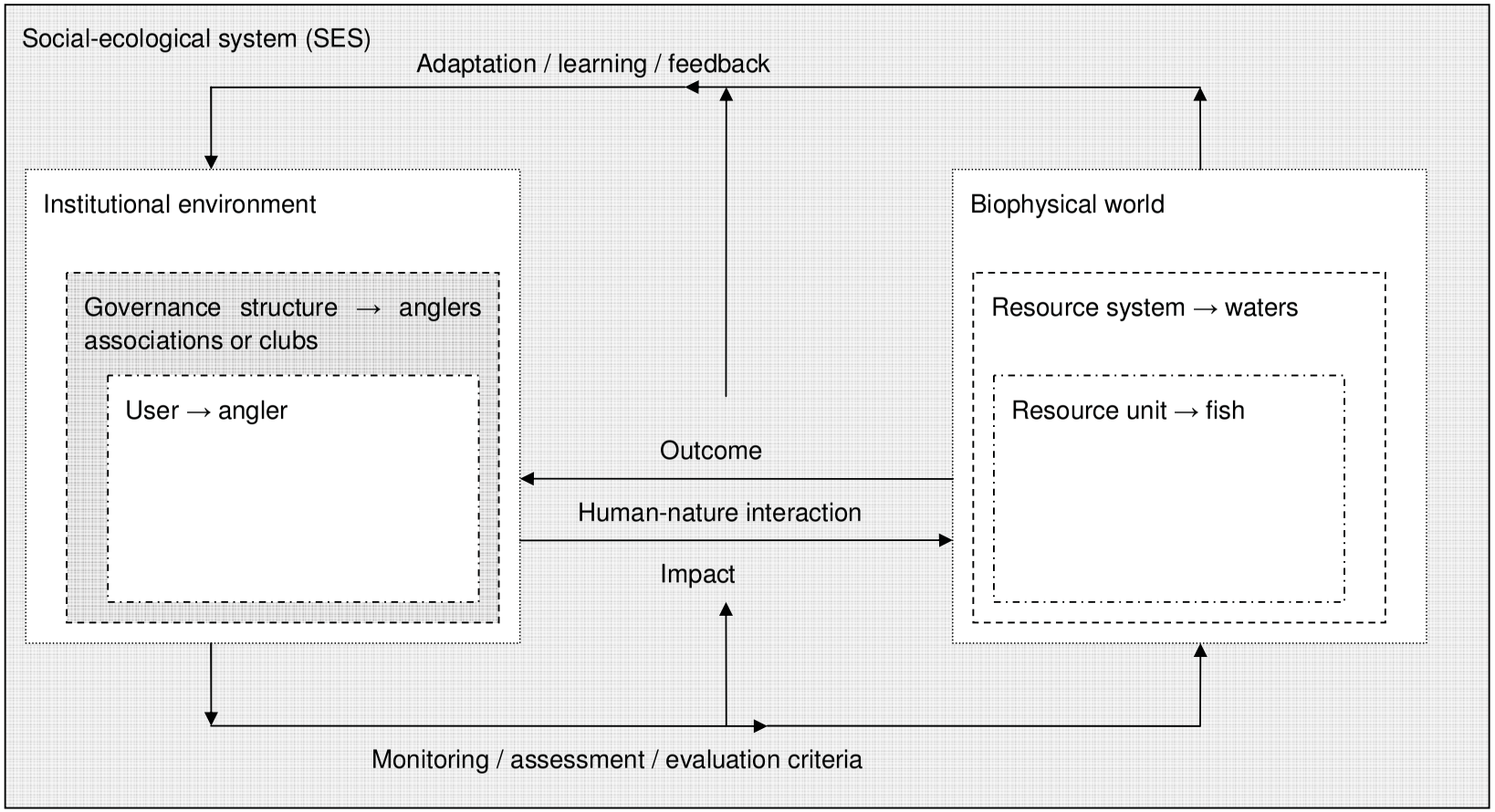


Figure 1: Adaptive management cycle in the recreational fishery social-ecological system (based on Ostrom 2005, 2007)

This framework takes the perspective of the governance structure of GRF, defined as the key part of the SES. It has the choice of how natural resource uses should be organized and the right to set the rules of resource management and use. Only the agents of the governance structure are able to carry out adaptive management. This is due to its (potential) ability to recognize management problems and undesirable effects on the resource and its power to change existing rules on resource use. The permanent interactions and changes between resource users and resource units are nested in the resource system and the biophysical world. Sustainable resource use then requires an adaptive management system consisting of monitoring and assessment tools, and socially defined evaluation criteria to observe what is going on in the ecosystem. However, to complete the adaptive cycle it is necessary to make use of feedback (and its information content). That means to learn what activities have an undesirable outcome with respect to the evaluation criteria and which rules and management instruments do not work accordingly. The adaptation is fulfilled when the managers are able to change those rules and resource use behaviour to reach the listed but not yet achieved evaluation objective. The consideration of the process of adaptation in resource management in the analysis of SES enables the investigation of the (potential) development of rules and norms over time.

Another key issue in GRF is the spatial level at which the governance agency decides on and carries out resource management. The spatial distance to the resource unit and the resource system on the one hand and the organisational distance to anglers and the institutional environment on the other hand are supposed to have a high influence on the success or failure in sustainable resource management.

With the help of this framework the actors, the rules, the resource characteristics and the performance of GRF management regarding the described management problems will be investigated. On the following pages the parts of analysis are explained in detail. Chapter five considers the major components of the SES exemplified by GRF management and fish stock resources. Chapter six focuses on the adaptive cycle between the social and ecological systems of GRF.

5 Major components of the social-ecological system in GRF

5.1 The institutional environment[12] / the constitutional level

Institutions are the rules of the game (North 1990). These rules, or also called norms, customs or traditions regulate human behaviour, such as fish stock resource use. The objectives of institutions are manifold. They protect the interests of different stakeholders, distribute costs and benefits, coordinate human behaviour, and enforce laws (Vatn 2005).

A major distinction in Institutional Economics is the separation of rules into the formal and informal. Informal institutions are, for example, sanctions, taboos, customs, traditions, and codes of conduct arising from the cultural and/or religious background of a society. Formal

[12] Institutions of GRF management do not exist in an isolated environment. Social, economic, and political settings influence rules of GRF management such as economic development (joblessness), demographic trends, political stability, government settlement policies or market availability (Ostrom 2007).

rules are, for example, constitutions, laws[13], and property rights, which are seen as more legally defined with sanctioning conditions (North 1991: 97; Vatn 2005: 65). Williamson (2000) classifies the informal rules in a level of institutional embeddedness which influence all other levels of social analysis: the institutional environment (formal rules), the governance structure (players and decision makers), and resource allocation. This analytical approach is comparable with the Ostrom's multiple levels of analysis (2005: 58), which consists of the meta-constitutional level, the constitutional level (rules in use), the collective choice level (governance structure), and the operational level (resource use). However, Ostrom does not follow the distinction between formal and informal rules because, she argues that so called informal rules can be sanctioned and clearly defined as well. Alternatively, Crawford & Ostrom provide the approach of "a grammar of institutions" to analyze the rules which can be used to understand GRF management, described in detail on page 27 in the subchapter about the analysis of rules in use.

In GRF, multiple fishery laws, regulations on the state-level and special regulations for water bodies by angling organisations exist in written form, which can be comparable easily collected and analyzed. However, an assumption is made that there are additional non-written rules, norms, or strategies on local and regional level as well. These rules need to be determined through face-to-face in-depth interviews with managers of angling clubs or associations and members of fishing authorities as well.

On the following pages, the framework focuses on the property rights system as providing the rules that define which individuals or groups of people have access to and use rights of the resources. This system is used to determine who is in charge of resource management as well as the analysis of rules in use.

[13]The different governance structures and their activities in recreational fisheries are regulated by laws and regulations (institutional environment) on states' level. This implies that there are sixteen discrete fishery laws ("Fischereigesetz") on property rights, fishery management, fish stocking, and species protection in Germany. In addition, detailed regulations on specific fishery issues exist such as fishery license examination, placing of fishery licenses and permits, the implementation of management measures etc. also differ. Although there are sixteen different fishery laws with correspondently regulations in the single states, these laws and regulations are generally similar[1]. Some fishery laws resemble each other more than others based on the fact that after the reunification in 1990 old West German states helped to build up the fishery laws in the newly-formed German states in the Eastern part. Furthermore, the states' fisheries regulations are not completely independent because they have to incorporate German national state or the European Union regulations regarding e.g. animal welfare, nature conservation (Federal Nature Conservation Act, EU Flora-Fauna-Habitat-Directive), and water protection issues (EU Water Framework Directive) into their laws. These regulations aim to implement sustainability in different parts of society therefore influencing GRF management. For example, decisions about catch limits for endangered fish species, nature protection areas with very limited access for anglers, potential restrictions on fish stocking measures and also measures to maintain recreational fishing areas would be influenced by these regulations. However, these European and German state laws provide a framework upon which the particular states are able to build up their own laws considering regional and local characteristics. The fishery law liable the fishing rights holders to conservation, advancement, and upkeeping of native fish stocks correspondent to the size, conditions, and natural biodiversity of the waters as a precondition for resource use. Furthermore, the fishery laws points out that recreational fishery should be encouraged in general.

3.3.1 Property rights systems in GRF

As opposed to a no property rights regime (open access)[14] according to Ostrom et al. (1999), there are three possibilities for property rights regimes to limit the access: individual-, group-, and government property.

Property rights on waters, the fishing rights and the disposal are similarly organized throughout Germany. It is open for people or organizations, who own a fishery licence to buy or lease water bodies inclusive the fishing rights. The states' fishery authorities distinguish property rights on inland waters between those accruing to private persons, groups of people and keeping it under its own head. In the latter case it depends on the importance of the lakes, dams, or rivers for common societal interests such as water traffic, or public water supply. Thus, following the distinction by Ostrom et al. (1999) there are all three forms of property rights existent in Germany as can be seen in table two. However, it is prevalent that angling clubs or angling associations purchase the property rights (group/common property rights regime) or lease the fishing rights from the owner of lakes (Steffens & Winkel 2002). In Germany, anglers are the dominant users of freshwater resources. Angling associations or angling clubs own or lease the fishing rights in the majority of inland waters (Hilge 1998, Arlinghaus 2004).

The rights of ownership or lease holding of fish resources incur the duty of managing the resource in a sustainable manner with regard to its ecosystem functions. This entails the obligation to mitigate the effects of environmental degradation ("Hegepflicht" – liability to care for natural resources) and satisfying the recreational fishing community. To fulfil both objectives, management measures like access and use restriction (e.g. bag and fish size limits), fish stocking coupled with habitat maintenance or rehabilitation, or providing catch possibilities are carried out (Welcomme 2001: 15).

The arrangement of property rights in GRF regarding particular actions in resource management is shown in detail in table one. By design the owners of water bodies have the full bundles of property rights connected with the ownership: access to and the withdrawal of the fish stock resources, the duty to manage the fish resource for further use, the right to exclude potential but not authorized users from the resource and the right of alienation. A fishing right owner has the same rights and duties except for the alienation right of the waters because he or she only acquires rights on the fish resources and not on the water body. Both the owners of water bodies and the owners of fishing rights can sell fishing (or angling) permits to individual persons such as anglers. However, owners of fishing permits are only allowed to obtain access to the resource and to withdraw fish resources. This is also the case for landownership bordering lakes and rivers.

	Operational level		Collective choice level		
Water ownership	Access	Withdrawal	Management	Exclusion	Alienation
Fishing rights	Access	Withdrawel	Management	Exclusion	
Fishing permits	Access	Withdrawel			
Landownership at lakes and rivers	Access	Withdrawel			

Table 1: Bundles of rights in GRF (based on Ostrom & Schlager 1996)

[14] Vatn (2005: 296) denominate these property rights regimes as follows: private-, common-, and state property rights.

The distinction of rights between operational and collective choice level is important. Rights on operational level just allow exercising these rights. Rights on collective choice level in turn allow the owners of these rights to participate in the definition of all rights (Ostrom & Schlager 1996: 131). Owners of water bodies and fishing rights are therefore automatically defined as the governance structure of freshwater fisheries. In recreational fisheries these are mainly angling clubs or organisations.

As described above, allocation of fishing property rights in Germany is being regulated by fisheries authorities. The ownership of water bodies and of fishing rights is subject to such authorization by fishery authorities. Also the restrictions on e.g. catch amount, closed fishing seasons, or the protection of undersized, immature fish are regulated through administrative order. Fishery stakeholders and others have the possibility to participate in this fishery policy decision process. Fishing property rights in GRF are leased or purchased by angling associations or angling clubs. The angling clubs in turn organize the purchase of angling permits ("Angelerlaubnisschein") for their members, which are usually valid for one year. Furthermore, there are arrangements where property rights can be linked. This means that a single water body may have several owners or lease holders ("Koppelfischereirecht") that exist side by side.

GOVERNMENT PROPERTY	Water ownership			
	Fishery authorities		Collective choice	
	Fishing rights are being leased out to angling organizations or commercial fishermen or private persons or other corporations			
COMMON/GROUP PROPERTY	Water ownership or fishing rights			
	Angling associa-tions	*East Germany*	Collective choice on states or regional level	
	Angling clubs	*West Germany*	Collective choice on local level	
	Fishing permits are sold to angler			
INDIVIDUAL PROP-ERTY	Water ownership or fishing rights			
	e.g. Fishermen		Private choice	
	Fishing permits can be sold to angler			

Table 2: Specification of property rights regimes in German inland fisheries

German recreational fishery management is characterized by two distinct ways of organizing the allocation of property rights. As shown in table two the purchase or lease of fishing property rights are undertaken either by angling clubs on local level (low-level) or angling associations on regional or states level (high-level). The former is typical for West-Germany while the latter is typical for East-Germany. However, there is also co-existence to a minor degree. This general pattern of different allocation of fishing property rights in Germany is defined as common property rights regimes and will be described in detail in the following.

In East Germany angling associations are owners or leaseholders of the resource and hence they are in charge for its sustainable management. That means both angling clubs and so called "free" anglers (no membership in clubs) are relatively free of obligation in resource management because representatives at the states level take most of the responsibility for

local management. Activities by single angling clubs are mainly voluntary and support the anglers associations on the regional and states level. Punishment for neglected activities is usually not possible. However, the angling associations try to include angling clubs in water and fish resource management. They established a “System der betreuenden Vereine“(water steward-ship by angling clubs), in which angling clubs are supposed to monitor, protect or clean the lakeside of water bodies in the local area. However, the clubs do not have the possibility to restrict access or use of the nested fish stock or carry out fish stocking measures.

In contrast to the East German anglers associations, the associations in West Germany have mainly representative character without management duties. The individual angling clubs on local level own or lease fishing rights and thus they are in charge for fish resource management. The local club members decide on access and use restrictions and are responsible for managing their water and fish resources by themselves. Their management is often characterized by high levels of exclusion implemented by high costs of club membership and angling permits.

Nonetheless, basic traits of property rights regimes can be violated or misarranged which causes additional costs (Wang 2001). The basic features of property rights regimes should be completely specified, exclusive, transferable, and effectively enforced (Caddy & Seijo 2005: 69-70) for sustainable resource use. In GRF a property rights systems is well established (Arlinghaus 2005, 2006) and every individual, organisation or the government have the possibility to purchase or to let utilization rights or water bodies as long as it is guaranteed that the owner has a fishery licence. However, it would be a fallacy to assume that there are perfectly functioning systems operating. For example, the enforcement of exclusion of un-authorized people is often suspected to be ineffective (free-rider problem/illegal angling; in the case of commercial marine fisheries, cp. Sumaila et al. 2006). Another reason for inappropriate regulations could be the high density of anglers or outside resource system/unit users, the diversity or availability of water basins, and the mobility of technology (Begossi 1998). Again, concerning GRF there is no scientific evidence of successes or failures in property rights regimes.

Analyzing rules in use

Rules in use are the structure of institutions that shape the interactions of actors in the policy (i.e. management-decision process). “Rules can be thought of as the set of instructions for creating an action situation in a particular environment.” (Ostrom 2005: 17) One way of analyzing rules is to investigate them according to linguistic terms. Crawford & Ostrom (1995) provide such an approach to analyse institutions in collective choice situations, which can be applied to observed regularities in GRF management. Under the notion of *institutional statements* which relates to a “shared linguistic constraints or opportunities that prescribes, permits, or advises actions or outcomes for actors” (Crawford & Ostrom 1995: 583), they distinguish three concepts of institutions: rules, norms, and strategies.

“By rules, I mean shared prescriptions (must, must not, or many) that are mutually understood and enforced in particular situations in a predictable way by agents responsible for monitoring conduct and for imposing sanctions … By norms, I mean shared prescriptions known and accepted by most of the participants themselves involving intrinsic costs and benefits rather than material sanctions or inducements. By strategies, I mean the regularized plans that individuals make within the structure of incentives produced by rules, norms, and expectations of the likely behaviour of others in a situation affected by relevant physical and material conditions.” (Ostrom 2005b: 825)

Regarding this definition the linguistic syntax of rules, norms, and strategies is defined as follows (Crawford & Ostrom 1995: 584):

		Rules	Norms	Strategies
A	ATTRIBUTES Is holder for any value of a participant-level variable that distinguishes to whom the institutional statement applies	X	X	X
D	DEONTIC Is a holder for the three modal verbs using deontic logic: may (permitted), must (obliged); and must not (forbidden)	X	X	
I	AIM Is a holder that describes particular actions or out-comes to which the deontic is assigned	X	X	X
C	CONDITION Is a holder for those variables which define when, where, how, and to what extent an AIM is permitted, obligatory, or forbidden	X	X	X
O	OR ELSE Is a holder for those variables which define the sanctions to be imposed for not following a rule	X		

Table 3: The ADICO format of rules, norms, and strategies[15]

This distinction makes it possible to compare different strategies, norms, and rules of GRF management. For instance, it can be used to determine which institutions regarding the GRF management are formulated as strategies, norms, or rules. The latter includes the sanction mechanism that can be identified as the tool to put through (e.g. fish catch limits more efficient because anglers want to avoid the punishment costs). However, norms (without sanctions) or strategies (without sanctions and permission, obligation, prohibition) can also be efficient, as long knowledge about the usefulness of rules and trust between the anglers exist. This approach is useful to summarize the content of institutions, and to distinguish between the different forms and their impact of human behaviour (Ostrom 2005: 139). Nevertheless, as described in the analytical framework, other components of the SES have to be considered, (e.g. characteristics of the resource unit, system, and the biophysical world), to explain human angling behaviour sufficiently.

Another way to examine rules in use in GRF management is through the comparison of the eight design principles by Ostrom (1990, 2005). These design principles were developed from hundreds of case studies (Ostrom 1990) and several scholars have found empirical evidence to support these principles.

[15]Crawford and Ostrom (1995: 583) point out three restrictions regarding institutional statements: they are not always easily and fully articulated or recognized by participants; they are not supposed to be always meaningful; and they are not sufficient for the analysis of human behaviour.

1.	Clearly defined boundaries	The boundaries of the resource system and the individuals or households with rights to harvest resource units are clearly defined.
2.	Proportional equivalence between benefits and costs	Rules specifying the amount of resource products that a user is allocated are related to local conditions and to rules requiring labor, materials, and/or money inputs.
3.	Collective-choice arrangements	Many of the individuals affected by harvesting and protection rules are included in the group who can modify these rules.
4.	Monitoring	Monitors, who actively audit biophysical conditions and user behaviour, are at least partially accountable to the users and/or are the users themselves.
5.	Graduated sanctions	Users who violate rules-in-use are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other users, from officials accountable to these users, or from both.
6.	Conflict-resolution mechanism	Users and their officials have rapid access to low-cost, local arenas to resolve conflict among users or between users and officials.
7.	Minimal recognition of rights to organize	The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.
8.	Nestled enterprises	Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Table 4: Design principles by Ostrom (1990, 2005: 259)

However, the methodology cannot be used to completely design robust social-ecological systems. On the contrary, Ostrom points out that using the design principles "is a beginning point for conducting a broad search for appropriate means of solving problems" (2005: 271). Thus, there might be further designs of rules which are successful in sustainable resource use as well. However, part of the analysis will be the investigation into whether the identified formal and informal rules of GRF management comply with the eight design principles by Ostrom. This analysis will be used to compare which of the identified rules might support or hamper long-enduring management systems. Furthermore, it is assumed that the different management systems in East and West Germany caused by the governance structure on different spatial levels might show differences in these design principles – in particular in collective-choice arrangements (number three in table four).

Additionally, the focus of this analysis will also be on the enforcement mechanisms because of their assumed influence on the success of GRF management (cp. Paavola 2007). The key question is: on which spatial level are enforcement mechanism organised and who participates in this process? Furthermore, awareness of the varying and detailed access and use regulations in GRF management (often existing for single waters), will help determine whether anglers are overtaxed by these rules and what influence this potential overregulation has on resource use customs on operational level.

5.2 Governance structure/ collective choice on different spatial levels

The agents of the governance structure in GRF who are responsible for resource management are mainly managers of angling clubs and angling associations. As introduced on the previous pages, there are two structural alternatives in managing fish stock resources: in East Germany the managers of angling associations on regional or states level and in West Germany the managers of angling clubs on local level. It is assumed that this difference in the organisational structure has influence on the transaction of resource management. For instance, what it will be important to identify the costs for the angling association to collect information about aspects such as anglers behaviour on local level, or how long it takes until problems of resource use are reach the managers on states level.

The collective choice of both structural alternatives about a particular management approach can be analyzed by the "Institutional Analysis and Develop-ment Framework" (IAD) by Ostrom (1990, 2005). With this framework it is possible to model the choice of angling clubs and association managers in their particular setting of institutions and resource conditions. This management decision process is symbolized by the action arena, which includes the actors/agents/participants and the particular action situation. This situation is influenced by the institutional environment (rules in use, Chapter 5.1), the attributes of the angling community considering the anglers view on resource use (Chapter 5.3), and the attributes of the biophysical world (Chapter 5.4).

A typical arrangement of this action arena causes certain patterns of interaction. GRF managers make decisions about detailed regulations of (e.g. fish size limits or seasonal closures). Their decisions then cause a certain kind of interaction in fish sock use, such as resulting angling activities (e.g. seasonal closures). This interaction leads to a specific outcome. Outcomes of access and use regulations could be angler dissatisfaction in catch requirements caused by high restrictions, or the destruction of fish habitat or stocks resulting from high angling intensity caused by too low restrictions.

Important in this framework are as well evaluative criteria to monitor success or failure of management measures. They are a precondition for changes in the action arena and for change in the influencing factors such as rules and angler behaviour, but also in resource characteristics. Crucial at this point is to determine the evaluative criteria (e.g. anglers catch satisfaction or support of fish habitats) and are the actors willing and able to adapt to the existing use regulations on undesirable outcomes. This important issue in resource management is explained in detail in chapter 6.1. The following subchapter gives attention to the analysis of the action arena to understand how GRF managers come to a decision on regulations of fish stock use.

Analyzing choice in the action arena

Collective choice in GRF management is related to multiple aspects of management including: who makes decisions about resource use, what the position is of the participants, what the participants can actually do, what kind of information is available to them, what they can control, and what the expected costs and benefits of the potential outcome of their decisions are (Ostrom 2005: 33). Participants of the action arena can change existing rules in reaction to anticipated problems in resource use. Whether this happens depends highly on the single components in the action arena.

"Participants in an action situation are decision-making entities assigned to a position and capable of selecting actions from a set of alternatives…" (Ostrom 2005: 38). In GRF the managers of angling clubs or angling associations are the participants in the action situation.

They are elected by the members of the clubs and associations and represent the angler's community. The number of participants can vary, because of the individual structure of the organisations. However, they all have a so called team status because their decision about resource management measures depends highly on the expectations of the anglers and the chance to be re-elected in future. Furthermore, the attributes of participants are supposed to influence the decision as well. This includes their knowledge about the resource, their negotiation skills, their experience in resource management, their leadership abilities, and the level of trust towards the other participants or to the angler's community. A crucial point here is the perception of the managers about the resource (Edwards-Jones et al. 2000). What do they think about fish habitat structures in lakes or rivers? Are fish species compensable or not? For instance, regarding fish stocking measures: do they think it is important to stock local endemic fish species or are fish species from elsewhere useful to stock as long as the price is acceptable?

The participants in an action arena are assigned to positions. This position, such as members of chair, managers, members etc. defines the standing of the participant in that situation: "the standing of a position is the set of authorized actions and limits on actions that the holder of the position can take at particular choice set in the situations." (Ostrom 2005: 41) For instance, a manager in an angling association might have less influence on the decision-making process than a president of the angling associations by definition of their position. Managers are recruited to supervise the association and the particular resource management. Presidents and other members of chair are elected to assert the interests of anglers and have the right to define the particular management approach. Thus, it can be assumed that the decision for a certain kind of management measure will be more influenced by the president of this association.

The choice of the participants for one alternative as opposed to others in resource management can be named as undertaking an action in the decision process. This choice of a participant for a particular management approach depends on the information about the decision process, on the opportunity to control the action situation, and on the expected costs and benefits of the potential outcome of the management choice (Ostrom 2005: 33). The balance of costs and benefits of a particular management decision is presumed as a major point. An example could be the weight up of how much fish should be stocked in waters and rivers to increase (e.g. catch opportunities for anglers). The participants of the action arena could choose between two alternatives: on the one hand they could stock endemic fish species which are usually more expensive (because of costly production) or on the other hand they could stock other species which are cheaper in production and purchase. Given a fixed financial basis the decision for the former case means they can buy less fish or, in the latter case, more fish. However, if they consider anglers preferences for increasing their catch amount they might decide to purchase less expensive but more fish for stocking. But if they consider the possibility that the given habitat can bear only a limited amount of fish stocking (surplus stocked fish will die) and endemic species would fit better into the existing fish community, they could decide to purchase more expensive but less endemic fish species for stocking. The unequal distribution of information and power of control over the decision process by participants (e.g. to oppress other participants of the action arena) could to influence the outcome as well. For instance, if the information about fish stocking success of endemic species is known and accepted only by one participant of the action arena, the person can be easily voted down by others. Furthermore, power relations between the participants can be crucial as well. Continuing the example, this could mean that this single participant, convinced about the stocking benefits of less but endemic fish species in natural

waters, has a high extent of control over the other participant. A reason for that could be that this person is the president of an angling association or club for many years and his knowledge is highly appreciated by other participants. Moreover, even private motives in the participants' relationship could play a role.

An action arena does not take place isolated or not always only at one point (Ostrom 2005: 53-64). On the contrary, quite often it needs more than one action situations to come to a decision in resource management. Moreover, the decision about different management instruments needs different action situations. In addition, the management outcomes need to be re-negotiated in future decision processes. If the decision processes are repeated games, participants start to use cooperative strategies because of former built trust or to increase future trust between them. They also might include the "Tit for Tat"-strategy (if one participant take a step back in one action situation, the other participant will take a step back in the next action situation). This strategy can save both the participant's own advantages and reduce the risk of loosing advantages. The future action situation controls the current action situation. Furthermore, an action situation is embedded in other action situations. In GRF, the action arena takes place at different levels and organisational structures. In East Germany managers and representatives of angling associations usually decide about management measures which are applied on regional or states level. In West Germany managers and representatives of angling clubs usually decide about management measure on local level.

Choice on different spatial levels

A major feature of GRF is that the collective choice of resource management rests on different spatial levels as graphed by figure two. The decisions on how to regulate access and use restrictions, and fish stocking measures are taken by angling associations at regional or states level in East Germany and by angling clubs at local level in West Germany. Angling associations, both in East German and in West German states, participate in the policy decision process with other stakeholders. However, it is assumed that the degree of influence might be dependent of if the managers of angling associations are directly responsible for the resource management such as in East Germany or not such as in West Germany. Considering this major distinction in the GRF governance structure, collective choice in the action arena takes place on different spatial levels symbolized by the ellipses in figure two.

Angling associations at state or regional level in East Germany (defined here as **high-level governance structure**) are characterized by a low level of exclusion. They try to increase the number of members and usually set low prices on angling permits (access). A guideline for East German angling associations is the so-called "liberality of angling": anybody who wants to fish should be able to and easily (DAV 2004). Furthermore, because of the ownership of fishing rights on wider spatial scales the angling associations provide an easy access to the waters. For instance, an angler who purchases the angling permit of the angling association in the German state "Brandenburg" is allowed to go fishing in about 30,000 ha water area.

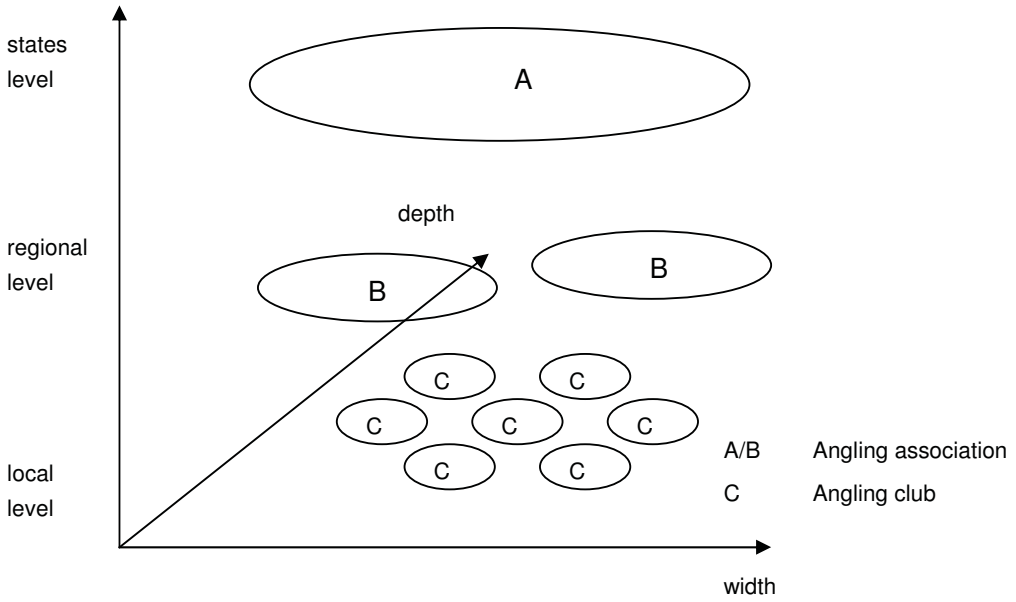


Figure 2: GRF governance structure on different spatial levels

The following table five shows the sixteen German states separated their differences regarding GRF common property rights regimes.

	Common property rights regimes on …		
	States level	Regional level	Local level
West German states			
Schleswig-Holstein			Yes
Hamburg			Yes
Lower Saxony		Yes	Yes
Bremen			Yes
North Rhine-Westphalia			Yes
Hesse			Yes
Rhineland-Palatinate			Yes
Baden-Wuerttemberg			Yes
Bavaria			Yes
Saarland			Yes
East German states			
Brandenburg	Yes		
Mecklbg.-Western Pom.	Yes		
Saxony		Yes	
Saxony-Anhalt		Yes	Yes
Thuringia		Yes	Yes
Berlin	Yes (East Berlin)		Yes (West Berlin)

Table 5: Common property rights regimes on different levels in the German states

In contrast to the East German anglers associations, the local angling club in West Germany own and lease out the fishing rights only for a limited number of waters and strongly restrict other users (defined here as **low-level governance structure**). Often this involves high levels of exclusion implemented by high costs of club membership and angling permits. This, however, varies between angling clubs. In West Germany, it is not easy to change angling water bodies or negotiate the use of water bodies (permits) of other anglers clubs. The restricted organization on the local level might lead to the movement of recreational fishers to other lakes or rivers for angling. Often this involves long distance travel. However, for recreational fishers it often requires a lot of effort to bargain for access rights and high costs to obtain a permit.

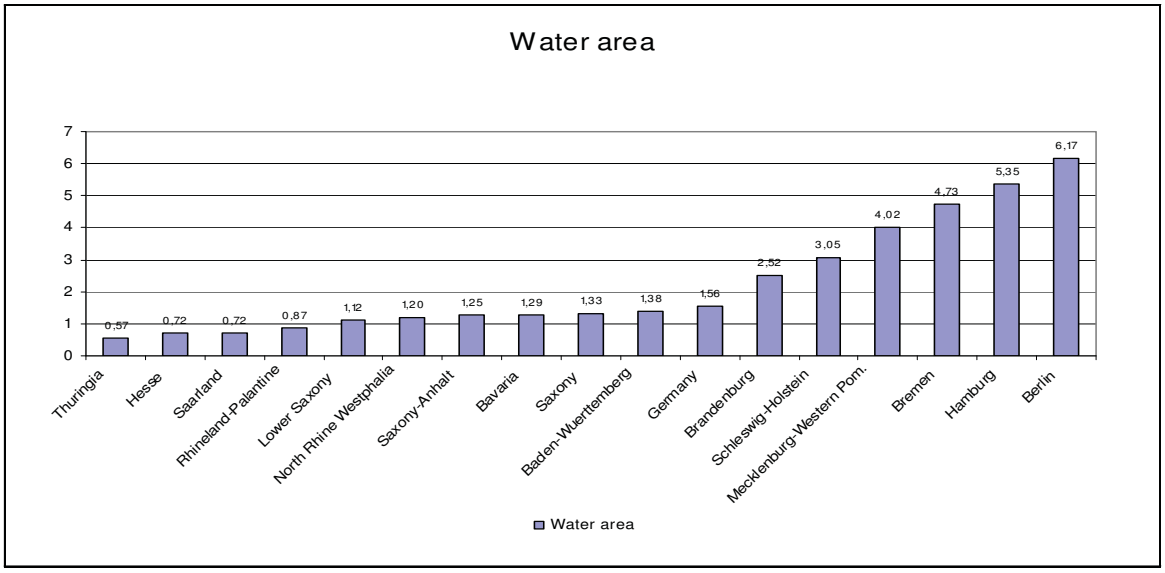
5.3 Resource user/ the operational level

The characteristics and attitudes of the angler community is a further decisive point in GRF management (Arlinghaus et al. 2002, Arlinghaus 2004a, 2005, 2006). Basically anglers are supposed to follow the regulations crafted by the agents of the governance structure on collective choice level. However, the compliance or non-compliance with the regulations on operational level (where the resource use and allocation actually takes place) depends highly on the characteristics and recognition of anglers. This should be taken into account by managers of angling associations in their decision about management instruments. Table six shows major second-tier variables to analyze anglers that should be considered in the management decision process. Apart from point five all other issues might be important for the success or failure of GRF management which is explained in the following paragraphs.

1.	Number of users
2.	Socioeconomic attributes of users
3.	History of use
4.	Location
5.	Leadership/entrepreneurship
6.	Norms/social capital
7.	Knowledge of SES/mental models
8.	Dependence on resource
9.	Technology

Table 6: Second-tier variables analyzing users in a SES (Ostrom 2007)

The **number of anglers** is important for the allocation management of fish stock resources. For instance a limited abundance of fish populations needs access and bag regulations when too many anglers want to catch fish. The figure three shows the number of fishing licences per ha water area in the German states. It points out that despite of the higher participation of the human population in angling activities in the North German Lowlands, the lake-rich landscape provides still various water resources for fishing. In contrast, the number of fishing licences in South German states per ha water area is clearly higher. Thus, we could assume that there exists a higher angling pressure on fish stock resources.



Source: Bundesamt für Kartographie und Geodäsie, DLM 250

Figure 3: Number of fishing licences per ha water area

A further point is the **socioeconomic status** of anglers. The GRF management needs to consider two points: the costs of fishing licenses and angling permits, and the objectives of anglers to catch fish. The socioeconomic status can vary highly. For instance unemployed anglers vote for cheaper angling licenses and angling permits. Their objective for angling is often to support their own food supply and aim to catch fish as much as possible. For other anglers fishing has a higher social status represented by using e.g. expensive angling equipment. Their **dependence** on fish resources might be less for food supply but more for recreational relaxation and the amount of the fish caught is less important than the trophy status of the fish.

Furthermore the **history of use** might play an important role in GRF management as well. The two distinct angling organisations in East and West Germany refer to different angling traditions. The former sees its roots in workers angling clubs established at the beginning of the last century to provide favourable access to fish resource for people of lower classes. The latter draws on the traditions of prior civic angling clubs which were more elitist oriented. This historical background might have influence on the self-conception of anglers and might cause a certain demand on managers of angling organisations to arrange e.g. access regulations.

The **location** of anglers and resources might play an important role in fish stock management insofar that anglers might have preferences to cover a short distance to closer located lakes or rivers. Additionally, certain kind of waters could be more popular than others. Thus, particular waters are more frequented than others and the consequently higher fishing intensity should be considered into the management decision process.

The **norms** of anglers and the degree of trust and communication within the anglers community is another crucial issue for GRF management. If managers of angling clubs or associations try to implement a particular management regulation, which is in contradiction to norms on local level, it might cause non-compliance within the angler's community. This could be even reinforced when anglers on local level have built a "sworn confraternity" where they carry out angling activities following their own rules. This situation might be intensified

when the **knowledge** about fish resources of anglers are not considered in resource management decisions. There is scientific evidence that the inclusion of local or indigenous knowledge support sustainable resource management (Berkes & Folke 1998).

The **technology** used by anglers is a subject of GRF management institutions as well. The limitations on angling tackles aim to reduce the fishing intensity. For instance, fishing nets are forbidden for anglers. They are only allowed to use a limited number of rods or lines. Technological progress is another important point. For instance the use of more effective angling tackles might have exhausting impacts on fish stock resources. In this case the management should monitor the altered impact on the resource and if problems arise such as resource overuse they should adapt rules on this new situation to reach their management objectives.

5.4 Fish resources as a part of a complex and changing biophysical world

Institutional analyses can not afford an investigation of resource systems functioning or resource unit's interactions within the biophysical world. This is a task for biologists, ecologists or other natural scientists. However, important for an analysis of institutions and governance structures in GRF is to look whether the components of and changes in the biophysical world are considered in fish resource management, and how the social system react on changes in the ecological system.

This chapter is subdivided regarding the three major components of the ecological system. The biophysical world means here the biological, material, and climatic attributes of the ecological system on wider spatial scale wherein water systems (resource system) and fish stocks (resource unit) are embedded.

The biophysical world

The influence of the biophysical world on water systems and fish stocks can be manifold. Ostrom (2007) identifies three major second-tier variables within the environment of related ecosystems: climate patterns, pollution patterns, and flows into and out of the focal SES (defined here as the water resource system with fish stocks). Climatic conditions could have strong impacts on GRF. For instance long dry periods or hot temperatures can reduce the water level and might put fish stocks under pressure and might cause fish diseases or mortality. Similar impacts might be caused by agricultural or industrial production situated close to waters which introduce pesticides or chemical ingredients in the ecological system (pollution patterns). Furthermore, predators such as sea ravens or other animals might have a high fish consumption in particular water spots and might cause a decrease in fish stock abundance (flow out of the resource system). These are only some examples. GRF management should consider interactions like these within the biophysical world to be able to regulate or avoid social-economic problems caused by these interactions.

Resource systems in North and South Germany

A further crucial factor in fish resource management are the characteristics of the resource system which are expected to exert high influence on the implementation of specific management measures by the different governance structures (Berkes 2006, Carpenter & Brock 2004). Resource management has to consider the characteristics of waters such as lakes or rivers etc. Lakes are standing waters and bodies of water enclosed by land. They can be classified by size, origin, and/or nutrient richness status (oligotrophic, mesotrophic, eutrophic, dystrophic). Rivers are linear features of the landscape that transfer the water from

mountain springs (South German Uplands) or runoff from precipitation on the land, to the sea (North German Lowlands). Rivers are open systems and have a hierarchical structure from small tributary streams to large rivers, with a highly seasonal natural state, alternating between periods of high and low flow (between rising and falling water). However, many rivers in Germany are now controlled to the point where normal flooding of the lateral plains no longer occurs (Welcomme 2001: 17-28).

Germany's geographical structure is mainly separated in the North German Lowlands and the South and Central German Uplands. These show significant differences in lake and river characteristics and corresponding nested fish populations. Those different characteristics are suggested to have a high influence on the transaction costs of fish stock management, e.g. the control of access to fish resources and the use of fish resource regulations, for the different property rights regimes in East and West Germany.

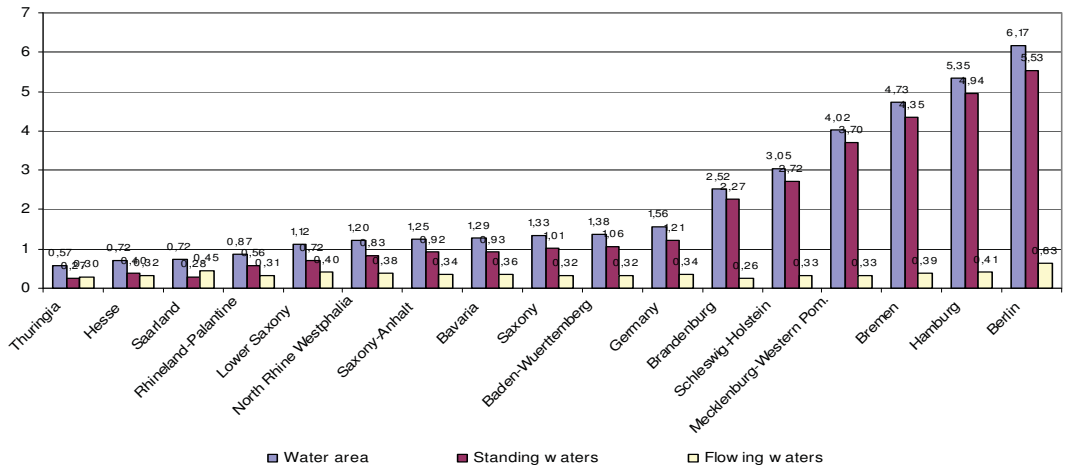
The North German Lowlands are mainly characterized by slow large rivers, canal systems, and large, often connected lakes including primarily bream and sometimes barbel populations (pilot fish zones, cp. Feld et al. 2005). Usually these water bodies contain rich fish stock resources due to a high nutrient status of the waters. Such featured water bodies are defined as **complex resource systems** here.

The Central German Uplands are featured by fast running, mostly small rivers and a limited number of often very small lakes or larger dams. The fish population structure is characterized by trout or grayling (Feld et al. 2005). The lakes are widely scattered over the countryside. The nutrient status of the rivers and lakes is usually low and fish stocks are not as high as in the North German Lowlands. Such water bodies are defined as **simple resource systems**.

	Complex resource systems	Simple resources systems
	North German Lowlands	Central German Uplands
West German states		
	Schleswig-Holstein	Hesse
	Hamburg	Rhineland-Palatinate
	Lower Saxony	Baden-Wuerttemberg
	Bremen	Bavaria
	North Rhine-Westphalia	Saarland
East German states		
	Brandenburg	Saxony
	Mecklenburg-Western Pom.	Thuringia
	Saxony-Anhalt	
	Berlin	

Table 7: German states divided by features of resource characteristics

In the following figure the surface water area in the German federal states is depicted in percent of land area. Most of the North German states have a higher share of waters on land area mainly caused by the amount of wide-ranging standing waters. Bremen, Hamburg, and Berlin are city states in the North German Lowlands. They show the highest share of waters on land area because they are located nearby large rivers and waters, but are limited in land area.



Source: Bundesamt für Kartographie und Geodäsie, DLM 250

Figure 4: Water area in German states in percent of land area

Resource unit

Such as the influence of the biophysical world the particular characteristics of fish stocks should be considered in GRF resource management. Non-consideration of these characteristics (shown in table eight) might cause inefficient resource management, social conflicts and destruction of fish habitats in GRF. However, the complex interactions can be only roughly described at this point.

1.	Resource unit mobility
2.	Growth or replacement rate
3.	Interaction among resource unit
4.	Economic value
5.	Size
6.	Distinctive markings
7.	Spatial & temporal distribution

Table 8: Second-tier variables for analyzing resource units in a SES (Ostrom 2007)

The varying resource system characteristics in North and South Germany enclose different nested fish populations. They are separated in so called pilot fish zones which vary from upstream (fast waters) to downstream (calm waters). These pilot fish zones (listed from South to North: trout zone, grayling zone, barbel zone, bream zone) are dependent upon different water quality, ecological environment and habitat structure. The **mobility** of fish species can highly vary. Beside stationary species which are very faithful to their habitat, there are also species which extensively or locally migrate along rivers and connected lake systems. Some of them such as eel or trout are diadromous species that use both marine and freshwater habitats during their life cycle. This varying mobility of fish species has consequences for e.g. fish stocking management. Migrating fish stocks might flow to water areas where other stakeholders own the fishing rights. In this case GRF managers should

make sure that their fish stocking measure benefit the own waters and anglers and not other fishing rights owner in the resource system. Furthermore, the construction of local hydroelectric facilities might restrict fish movement and might impair the abundance of fish stocks for angling activities.

Fish stocks are renewable natural resources and are reproducible. That means their reproduction rate is directly related to the size of the stock (Perman et al. 2003). Thus, the fish stock **growth rate** is exponentially increasing until limiting factors stops this development. Those influencing factors could be habitat competition, biotic or physiological reasons, or over harvesting by humans. However, renewable resources are exhaustible when the use rate is higher than their natural capacity of reproduction. When fish stocks are exploited to a certain level, the water habitat often provides enough food for the remaining fish. Their growth rate increase and anglers might have the opportunity to catch bigger fish. Fish with slower growth rate can be a sign of fish stock overpopulation. The fish compete for limited food and this impair their growth rate and anglers could catch much smaller fish. GRF management should take this in account considering the fact, that many anglers would like catch bigger fish. Too high stocking rates in a limited water habitat would include the risk to waste investment for unpreferred small fish.

Interaction among the resource units, here mainly the interaction between predatory fish and prey fish, are influenced by angling activities and resource management as well. In GRF there is a catch preference of anglers for predatory fish such as pikeperch, pike, perch, or eel. Furthermore, fish stocking measure try to increase the abundance of these species in waters. In any case, too many or too less predatory fish in the water habitat will cause changes in the whole food chain.

The **economic value** of fish in GRF for anglers is not “economic” in the proper sense because they are forbidden to sell caught fish. Their benefit lies in the angling activity, the consumption of caught fish, or in the play with the fish. However, anglers are supposed to count up their angling permit costs with their actually caught fish and sometimes blame GRF managers to neglect appropriate fish stocking measures. The economic value of fish for GRF managers plays an important role in those fish stocking measure. As previously mentioned they have to calculate the costs of stocked fish under a given amount of money, under a certain expectation of the angler community, and under the limits requirements of water habitats.

In GRF management the **size** of fish plays an important role as well because many use regulations are often connected to a limited size of the fish. Caught fish under a certain limit must be released. The reasons for this size restriction lies in the management approach that every fish should have the change to reproduce itself at least one time. On the contrary catch and release of fish above this limit is forbidden. That means bigger and faster growing fish is disadvantaged in the reproduction of the fish stock. This effect might be reinforced by angler’s preferences on catching large fishes. Scientific studies show some evidence that this might cause stunted fish stocks and evolutionary changes in the fish stock structure (Birkeland & Dayton 2005, Munch et al. 2005), or indirectly on entire aquatic ecosystems (Post et al. 2002, Pauly et al. 2002).

For some renewable resources such as cattle herds **distinctive markings** are very useful to mark ownership rights on the single animal. However, this tool to identify resource ownership and to facilitate the implementation and in consequence the enforcement of ownership rights is not applicable for fish stock resources. On the contrary, their existence hidden in waters makes it more arduous to identify which fish stock resources are owned by a particular stakeholder. Additionally, this trait makes it complicated to assess the abundance and quality

of fish resources for appropriate management measures. Furthermore, this “invisibility” causes a low perception of fish stocks in the public and makes it difficult for GRF managers to assert their interests in the society.

Caused by the varying mobility and the growth rate of different fish species the **spatial and temporal distribution** of fish stocks alter as well. A consideration of these characteristics needs a careful long-term monitoring in resource management. Local knowledge of anglers and/or angling club members might support the efficiency of the resource management as well. For instance, for some well-monitored lakes water maps with indicated spatial distribution of fish species are available. Such as other characteristics the varying spatial and temporal distribution of fish stocks makes it difficult to allocate property rights on particular fish as well. Before the fish are caught, anglers own fishing rights (angling permits) only on particular water. This provides an equal allocation within authorized users and the catch success depends on ability and fortune of the angler. After the fish is caught the angler gets the right on this individual fish.

6 The capacity to solve social-ecological problems

Both social systems and ecological systems are characterized by complexity, change, and uncertainty (Berkes & Folke 1998, Wilson 2002). Complexity arises from uncountable single components which generate a SES. Change originates from the manifold interactions between these components influencing each other. Uncertainty comes from the limited ability of humans to understand or even recognize these manifold components and interactions[16]. So an adaptive management approach aims to be aware of essential components and react on these transformation processes in a SES. For instance, a change in the technical equipment of anglers might increase their catch yield of certain fish species. This might endanger the abundance of fish stocks and requires a reaction by GRF managers to change used regulations, such as a higher limitation of the allowed number of fish caught. However, bearing in mind that the various other influencing mechanisms, such as the food web structures, the nutrient status of waters, and angler’s attitudes may compensate the opportunity of higher catch amount and make stronger regulations redundant.

The capacity to solve social-ecological problems lies in the ability of humans to adapt their actions on changes in the environment. The precondition of institutional and behavioural adaptation is to get information about the impact and outcome of human-nature interactions. Knowledge about and understanding of what is going on in the ecological system, what is the amount and abundance of the fish stock, what kind of problems are caused by human impact guided by resource use rules, what is caused by other influences within the ecological system is crucial to be able (and willing) to alter the rules and human activities to eliminate inappropriate resource management and use outcomes.

The core issue in investigating GRF management is to find out whether there is an adaptive cycle. Are there monitoring tools and an assessment of management measures and resource traits? Which evaluative criteria are in use? Will the governance structure take in the feedback? Are the agents of the governance structure able and willing to learn from changes in the ecological system and from resource use problems, and are they able to adapt their management system on new situations? Or do they just what they always do in the resource management and do they keep the status quo?

[16]Considering these conditions, the framework delineated here can only be restricted as well.

6.1 Starting the adaptive cycle

The initial point of adaptive management is on the one hand the monitoring and the assessment of processes in SES and on the other hand the definition of evaluative criteria for the findings of the information gathering process. These criteria can be named as management objectives as well – following the previously defined social, economic or ecological goals.

The need for gathering information about complex SES is obvious and managers of natural resources require support by social and nature scientists. However, "scientific knowledge of the conditions and trends of ecosystems is far from complete," (Carpenter & Folke 2006: 311). Therefore, a long-term monitoring process which includes systematic data gathering and supervision of the processes in SES should be established. This is furthermore the basis for appropriate assessment of SES which can be defined as follows: "a structured process for synthesizing technical information in a way that is useful for policy." (Carpenter & Folke 2006: 309)

The results of the monitoring and assessment process need to be comparable with previously defined **evaluative criteria**. This makes it possible to judge whether the outcomes of the resource management and use comply or do not comply with these criteria (Ostrom 2005, Imperial/Yandle 2005). There can be manifold criteria (or management objectives). However, GRF management is bound in law to manage and use fish stock in a sustainable manner. Therefore, this study concentrates on the evaluative criteria of economic efficiency, social agreement, and maintenance of ecosystem services as the three major components of sustainability.

Efficiency is notionally defined as follows: under a designated set of governance structures, rules, and resource characteristics there is no management improvement possible (Pareto efficiency). The goal is to achieve the highest amount of benefit with the lowest possible amount of costs to gain common societal goals such as averting the exploitation of fish resources or satisfying anglers catch requirements.

However, being aware that fish stock resource themselves and the management of them are characterized by high biological and social complexity, we have to admit our imperfections of measuring all costs and benefits of these social-ecological system arising of use interactions. Thus, it is unlikely to achieve full Pareto-optimality. Also economically feasible management options are highly constraint by limited knowledge and uncontrollable resource variations (Wilson 1982: 417).[17]

Nevertheless, the investigation of **economic efficiency** is possible as so far as to compare incomes and expenditures of the distinct governance structures in East and West Germany carried out in different resource systems. For instance, this includes incomes such as angling permits, membership fees, or other financial sources on one hand and expenditures on the purchase of fishing rights, fish stocking measures, or other management instruments on the other hand. The monetary measure is often quite difficult. Thus, spending time hours or number of engaged people in resource management are important parameters as well. A further crucial point is the evaluation of transaction costs. For instance, it is to figure out how far information costs differ regarding the distinct governance structure, how high enforcement costs differ to monitor the compliance of rules in varying resource characteristics, or how

[17] Therefore, Wilson suggest to understand efficiency "in this kind of environment … much more closely related to the adaptive, learning behaviour of individual economic actors than to the traditional notion of input cost minimization." (Wilson 1982: 417)

high bargaining and decision costs of self-regulated GRF management differ on different organisational levels. Issues like these can only be measured by interviewing and surveying the perceptions of GRF managers on those issues.

The balance of income and expenditure and the appropriateness of transaction costs support the functioning of GRF management and can be seen as a precondition to achieve the other management objectives. It is assumed that, when management fails in economic issues, then the chances to solve social conflicts and maintain ecosystem services are comparative low.

Another evaluative criterion is the **social agreement** about the allocation of fish stock resources. This is to find out whether the distribution follows the maxim of equity (everybody has the same opportunity to use the resource), is there a redistribution process to support poorer people of the society, or is the goal to restrict the number of potential users in general. Furthermore, it is important to clarify whether the management is organized in a way that those who benefit from the resource use should bear the costs as well (and vice versa). For instance, this is crucial in the policy-decision process with other stakeholders of the resource. How do they deal with arising positive or negative externalities of the use of resource systems or units? It is important to achieve a social agreement between the resource users to support the maintenance of the resource. Otherwise, in extreme cases, social conflicts might cause oppositional reactions by anglers and non-compliance with management regulations to save from environmental degradation and economic inefficiency.

The criterion **maintenance of ecosystem** services means that managers should take into account that certain kind of human impact might destroy fish stocks or freshwater habitats which provide services within the ecological system and for the human use as well. This holistic view should be considered in resource management to maintain further functioning and use of ecosystem services.

The challenge for the governance structure is to find optimal solutions in trade-off situations such as on the one hand between the different evaluative criteria, e.g. the calculation of costs for fish stocking measures and the consideration of habitat requirements or on the other hand the opposed objectives of different interest groups regarding inland waters and fish resource use, e.g. water power plants block fish routes and hamper catch possibilities for anglers. The choice between different management alternatives can be facilitated by calculation of opportunity costs. If a GRF manager decides to stock non-endemic species because of limited financial resources and a high demand for fish stocking by anglers, he faces the risk that in the long run these non-endemic species will derogate the ecosystem in general and will cause lower angling satisfaction.

6.2 Getting the cycle closed

Crucial to get the adaptive cycle of natural resource management closed is to take in the **feedback** loops of the SES. Feedbacks refer to “the result of any behaviour which may reinforce (positive feedback) or modify (negative feedback) subsequent behaviour” (Berkes & Folke 1998: 6). That means managers and users of natural resources should develop the “ability to observe and interpret essential processes and variables in ecosystem dynamics to develop the social capacity to respond to environmental feedback and change” (Folke et al. 2005: 445). Different authors have identified several feedback mechanism and principles of adaptive management to balance the social-ecological system in a sustainable manner (Folke et al. 2005; Almlöv & Hammer 2006; Lebel et al. 2006). These feedback mechanisms consist of monitoring tools, management evaluation, data collection on the status of fish

stocks, knowledge building, learning processes, consideration of anglers' responses to management measures, utilisation of cost-benefit analyses as management tools etc. This social capacity consists of the following major matters: **learning**, meaning, knowledge, and experience of ecosystem dynamics. Considering the complexity and dynamics of SES agents of the governance structures need to realize that not single-species models or managing for control and stability help to sustain ecosystem services but knowledge and understanding of the whole system. This understanding should "be continuously updated and adjusted, and each management action viewed as an opportunity to further learn how to adapt to changing circumstances" (Folke et al. 2005: 447, Carpenter & Gunderson 2001). A rewarding step to attain comprehensive information about changes in SES is to combine local and scientific knowledge. And other research found out that besides gradual changes particularly rapid crises seem to activate learning and knowledge generation (Folke et al. 2005: 446, Olsson & Folke 2001).

Based on these learning processes and knowledge building the next step is the **adaptation** of resource management on the dynamics in SES. Adaptive management means that agents of the governance structure continually adjust rules in use on the unwanted outcome of previously implemented resource management measures. This might include the alignment of property rights or the cross-scale integration of institutions (Carpenter & Folke 2006: 311). Folke et al. (2005: 463-464) characterize this process as follows: "The sharing of management power and responsibility may involve multiple and often polycentric institutional and organizational linkages among user groups or communities, government agencies, and nongovernmental organizations… Adaptive comanagement relies on the collaboration of a diverse set of stakeholders, operating at different levels through social networks. This aspect emphasizes the role of multilevel social networks to generate and transfer knowledge and develop social capital as well as legal, political, and financial support to ecosystem management initiatives." This definition makes it possible to investigate GRF management regarding the major traits of adaptive governance (see page 18).

7 Connecting theory and framework – the research hypotheses

The framework considers various features of the components in a SES. However, for the analysis of GRF management it is unlikely that all of them play a major role in the explanation of successful or not successful sustainable resource use. Therefore, the guiding hypothesis of this study is focused on the potential key exogenous variable "resource characteristics" influencing the capacity of the "two distinct governance structures" in East and West Germany to manage for sustainability (figure five).

Capability here means the ability of the governance structure to manage for sustainability. It is assumed that the distinct governance structures in East and West Germany have different success in achieving economic efficiency, different potential to solve social conflicts and to maintain ecosystem services considering the different resource system characteristics in the North German Lowlands and the South German Uplands. On the following pages two hypotheses are explained exemplified by the three major potential problems in GRF management and resource use which are access and use regulations, fish stocking measures and multiple stakeholder management.

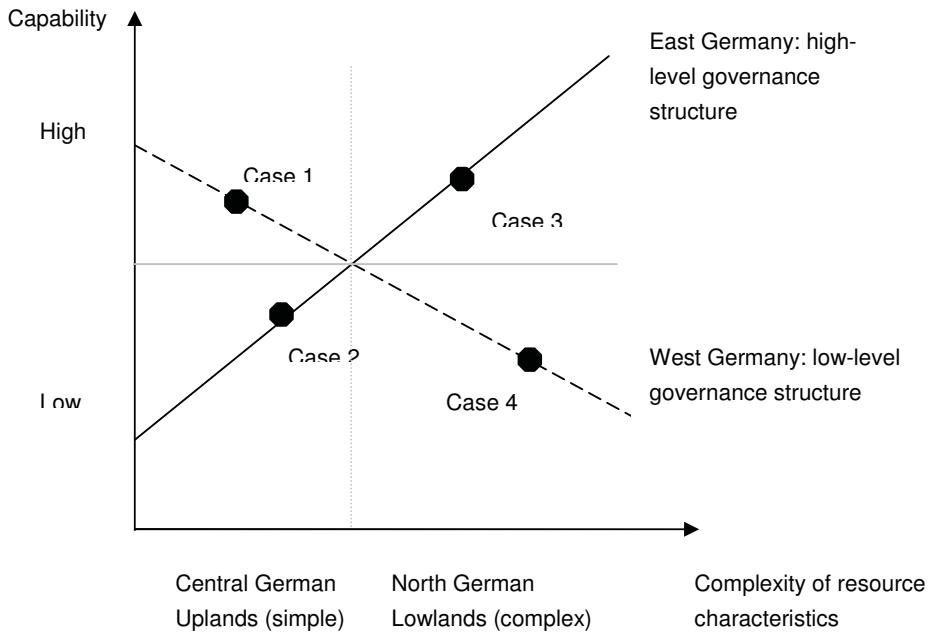


Figure 5: Capbility of distinct governance structures to manage for sustainability in varying resource characteristics

Hypothesis:

High-level governance structures in East Germany (case three) have a higher capability to manage access and use regulations, fish stocking measures, and multiple stakeholder's interests for sustainability in complex resource systems, such as the North German Lowlands, than low-level governance structures in West Germany (case four).

Complex water systems (lake-rich landscape with interlinked canals and rivers such as in North German Lowlands) increase the area that has to be controlled by enforcement of property rights, especially for access and use restriction by the owner. It is also more difficult to define clear property rights in large lakes, e.g. those shared by commercial fishermen and recreational fisheries associations. They also increase the area in which fish stocking measures take place and those measures have to consider the characteristics of fish populations over multiple lakes and rivers because of their connectedness. Complex water systems increase the number of owners and interests groups utilizing the fish or water resources. Rarely a single stakeholder would own an entire water system. This situation might lead to free-riding in resource management. On the contrary, large lakes and complex river/canal systems usually have multi-stakeholder settings that include, for example, commercial fishermen, public water transport administrations, tourist industry, nature conservation groups, farmers etc. Therefore, complex water systems usually increase management (financial and personnel costs) and transaction costs (search and information, bargaining and decision, monitoring and implementation costs) in comparison to simple resource systems. This further increases the boundedness of the rationality of recreational fisheries managers. More communication, information, interpersonal trust, and coordination within different stakeholder groups are necessary for sustainable recreational fisheries management. However, complex water systems usually increase anglers' catch and leisure

satisfaction because of the multitude of fish populations in large water areas, the short travel distances, the nature experience etc.

For this study it is assumed that high-level organized angling associations (property rights on regional or states' level) deal better in complex resource settings than local angling clubs with full property rights, because of the fact that their extent of resource management match with the wider spatial scale of complex resource systems. They also have a better bargaining position (more money and members) to get property rights for water resources and to enforce anglers' interests in policy-decision processes supporting their own interests against other water resource interests groups. The decision and bargaining costs are reduced for anglers overall. If anglers' interests are considered in policy decisions and laws, the costs of monitoring and enforcement of use, and access restrictions are decreased because anglers are more willing to comply with those decisions reducing illegal activities. Furthermore, they might have a stronger influence on fisheries authorities and higher changes to get property right on freshwater resources. Despite the higher information costs associated with the quality and quantity of the fish resources in complex resource systems, high-level angling associations might be more effective with regards to fish stocking measures because of the large amount of financial resources available (more members who pay for angling licenses and permissions), the consideration of wide ranging ecosystem characteristics and the recruitment of specialists in fish ecology and resource use. Property rights on higher level might also increase the concern of the owner to manage the resource carefully on wider ecological scale.

In contrast, low-level organized angling clubs with full property rights on locally constrained parts of complex water resources might bear higher costs in recreational fisheries management. They have lower costs associated with the monitoring of their small number of members regarding use and access restriction in their area. However, in complex water systems the fish populations migrate and the control of angling activities in connected water areas is much more difficult and costly. The same is true for gathering information about the quality and quantity of fish population in complex water systems. Therefore, the benefits of fish stocking measures become less predictable because fish populations can migrate to other parts of the resource system to which the angling club members do not have access. In addition, the position of low-level organized angling clubs within the policy-decision processes on a higher level is weaker. They have to arrange their position with other angling clubs. This usually takes place within representative angling associations. However, the representatives of those angling associations (without property rights on the resource) might have other interests and do not consider the interests of the fish resource owner on a local level. This makes the negotiation with other interest groups in the policy-decision process about water resource use more difficult and increases the bargaining and decision costs overall. Furthermore this might cause dissatisfaction of anglers with those decisions and the resulting laws which might lead to an increase in illegal angling activities and poaching.

Counter-Hypothesis:

Vice versa, low-level governance structures in West Germany (case one) have a higher capability to manage access and use regulations, fish stocking measures, and multiple stakeholder's interests for sustainability in simple resource systems, such as the South German Uplands, than high-level governance structures (case two).

Simple resource characteristics are supposed to create lower transaction costs associated with resource management in comparison to complex water systems because small lakes and rivers usually have very few interested stakeholders, and in some cases only have one

stakeholder, interested in the resource. These limited waters are not interesting for instance as water transport ways. Therefore, less bargaining between different interest groups and negotiation in the policy-decision process are necessary. The exclusion and monitoring costs are much lower in readily comprehensible water areas than in complex water systems. Thus, the implementation of access and use restrictions are easier for local angling clubs and the delegation of those tasks to higher governance structures would be more expensive than necessary. Furthermore the management and transaction costs of fish stocking measures might be lower. Fish populations do not migrate in enclosed waters, search and information gathering on fish populations is easier and the local knowledge of the owner is taken into account. It may also be expected that angling clubs with low member numbers trust and communicate better than in high-level organized governance structures and therefore the restriction on access and use of the fish resource receive better compliance by the angler community.

In contrast high-level governance structures in simple water resource systems might produce high organizational and transaction costs in managing small lakes and rivers because angling clubs on the local level are not able to bear the costs of recreational fisheries management on higher scales. They also might ignore particular traits of local resources, which are better controlled by the local anglers clubs. Furthermore the carrying out of fish stocking might be easier and cheaper on the local level, because wider ecosystem settings do not have to be taken into account.

These assumptions will guide this study. However, it will be kept in mind that the opposite can take place. High-level governance structures in Central German Uplands may achieve sustainable management by implementing and using a more local management setting to reduce e.g. information costs within the angling association. On the other hand, low-level governance structures in North German Uplands may use additional management tools on the higher (regional or states) level to gain more influence in policy-decision or for the management requirements of complex resource systems. To sum up, it has to be determined which kind of collective action on the regional/states' level and on the local level is appropriate to complex and simple resource systems.

8 Further steps

Following the delineated framework in this paper the further steps of research will include the discovery of the described problems in fish resource use and of the participants of GRF management on local level. Furthermore, an analysis of rules in use and of management decision process in angling clubs and angling associations on different spatial level will conduct to find out the reasons of choice for a particular management approach. Moreover, it is to clarify in how much angler's attitudes and specific characteristics of fish resource and waters are considered by managers. An additional crucial point is to identify the management objectives which are used to arrange a particular management approach. Finally, the research has to find out whether there exist traits of an adaptive cycle in GRF management.

The research will be conducted in four selected counties in Germany following the parameters of "governance structure on different levels" and "characteristics of the resource system" as pictured in figure five. The analytical framework will be used for every single case. Thus, it is possible to compare collective choice on different spatial levels in East and West Germany considering varying resource characteristics in North German Lowlands and South German Uplands.

To get the data for the analysis different methods will be applied. First, face-to-face structured interviews are planned with different stakeholders of fish resources and decision makers in GRF management like representatives of angling clubs and angling associations on local, regional or state level. Furthermore, it is required to interview members of the states and regional administration authorities and other stakeholders who are involved in decisions about recreational fisheries management (politicians, scientists, representatives of nature conservation and animal welfare associations). They will be asked, among other things, about conflicts and problems with other resource users, about scientific support for management, about monitoring mechanisms, information gathering, and alternative management strategies. Special attention will be given to actors who participate in the actual decision-making processes. This will lead to the second instrument which will be participant observation in the decision-making process, in angling associations and angling clubs meetings, where the implementation of management measures is organized. Both instruments make it possible to appraise the interests, motivations, perceptions, influence and behaviour of stakeholders within the decision-process, as well as the implementation and execution of recreational fisheries management (Scholz et al. 2004). Complementary mapping tools of decision and management networks can be applied (Lejano & Ocampo-Salvador 2006). Third, it is planned to collect data with standardized questionnaires from representatives of angler associations/clubs and fisheries authorities on countable violations of management regulations, on number of members or other fish resource users, on financial, and personnel resources for management measures, and on catch amounts or fish stocking costs. Furthermore, they will be asked about their perceptions of problems and solution possibilities in management regulations, and their practical application. It is also planned to survey the attitudes of anglers regarding these issues. Fourth, the content analysis of documents regarding fisheries regulations, policy decisions, management contracts, minutes of meetings, or court decisions will be carried out.

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