

After the blue rush

Assessment of the sustainability of recreational fisheries in
Peenemünde, Germany as part of a social-ecological system

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Abstract:

In the shadow of commercial fishing fleets, recreational fishers are a lesser known but still substantial group exerting pressure on the world's aquatic ecosystems and its fish stocks. Enthusiastic angler participation, high catch rates, catch selectivity and harmful fishing techniques characteristic of recreational fishers can have detrimental impacts on the aquatic environment. Furthermore, recreational fishing is recognized as an important economic and social factor deeply entrenched in many coastal communities. Even though it is well understood that humans and fisheries form a complex and dynamic social- ecological system (SES), the conceptualization of recreational fisheries as such is often lacking. This thesis therefore is intended to contribute to the understanding of recreational fisheries as part of a complex SES. In addition to this theoretical knowledge input, this thesis further aims to increase the understanding of recreational fisheries decision-making process, e.g. restocking schemes, and reveal management necessities to further the sustainable utilization of fisheries. In doing so, the thesis also addresses the current limitations of the original Ostrom (2009) SES framework by incorporating social and ecological valuation variables which have thus far been largely neglected. Consequently, an updated SES framework for recreational fisheries is developed based on a systematic literature review. The updated recreational fisheries SES framework and an exemplary assessment of its usefulness in evaluating the overall sustainability of recreational fisheries were tested by applying the framework and the related Institutional Analysis & Development (IAD) framework to the case study area Peenemünde at the German Baltic Sea coast. The results show that a) the inclusion of norms and values plays an important role in recreational fisheries management and have to be included in future SES framework applications and b) that the Peenemünder recreational fisheries is currently being sustainably managed, but with an increase of anglers, i.e. recreational fisheries tourists, would face threats to the long-term utilization of the fish stocks. As this is one of the few case study applications of a recreational fisheries SES framework, more research is certainly needed. This should include the integration of non-monetary values, especially ecological values, which is a novel addition to the framework proposed by this thesis.

Keywords: recreational fisheries, social-ecological systems (SES) framework, sustainability, ecological values, environmental ethics, Germany

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Abbreviations:

SES Social-ecological system

IAD Institutional analysis & Development (framework)

MPA Marine Protected Area

LEK Local ecological knowledge

TEK Traditional ecological knowledge

IUU Illegal, unreported and unregulated fishing

EUCC Coastal & Marine Union (environmental NGO)

CATCH Coastal Angling Tourism – a development chance for the South Baltic Region (Interreg-Project)

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1. Introduction

The decline in the richness and the overall health of global marine ecosystems is a generic example of anthropogenic disturbance of natural processes and ecological equilibria (Halpern et al., 2008; Halpern, Selkoe, Micheli, & Kappel, 2007; Lancaster, Haggarty, & Ban, 2015; Pauly et al., 2003). As pointed out by Halpern et al. (2008), the main human interference across all marine ecosystems, was overharvesting of fish stocks. Subsequent drivers, such as pollution, habitat destruction, eutrophication or introduction of alien species, amplified ecosystem alterations and loss (Halpern et al., 2008; Jackson et al., 2001; Lotze et al., 2006). Up until today science and policy communities focus predominantly on the management of commercial fisheries, their socio-economic benefits and impacts on aquatic ecosystems. In comparison to commercial fishery, recreational fisheries and their management is put in second place. To set the basis, recreational fisher is defined as an individual or a group of individuals fishing for non-commercial purposes as a hobby, sport, leisure or for personal consumption in her/his or their free time (Arlinghaus, 2005, Ditton, 2008).

This negligence is surprising, since recreational fisheries have “become the dominant or sole use of many freshwater and coastal fish stocks in industrialised countries” (Arlinghaus et al., 2016, p. 178) and can have severe environmental impacts, such as loss of genetic variability or altered food web structures by selectively fishing key species (Coleman, Figueira, Ueland, & Crowder, 2004; Cooke & Cowx, 2004; Lewin, McPhee, & Arlinghaus, 2008; Post et al., 2002). Adverse ecosystem changes due to recreational fisheries pressures subsequently affect human systems as well. These ripple effects are far-reaching, as recreational fisheries are of great cultural, traditional and societal importance, e.g. shown in high participation rates. Furthermore, angling contributes substantial to local and regional economies, e.g. by recreational fishing tourism (Arlinghaus et al., 2016; Arlinghaus, Tillner, & Bork, 2015; Cooke & Cowx, 2006; Ditton, 2008). This disregard and the often accompanying lack of data, makes it difficult to account for the recreational fisheries and its impacts, thus making it unlikely that they are managed in the best and most sustainable way possible (Arlinghaus, Tillner, & Bork, 2015; M. A. L. Young, Foale, & Bellwood, 2015).

These outlined ecological, economic and social interrelations are not only typical for recreational fisheries, but constitute complex social-ecological systems (SES) (Arlinghaus et al., 2017; Ostrom, 2009). As defined by Ostrom (2009), “SESs are composed of multiple subsystems and internal variables within these subsystems at multiple levels” (p. 419). Consequently, decomposing and

understanding the individual subsystems and layers, as well as their interrelation is critical in managing a particular SES sustainably (Ostrom, 2007).

Though there is an emerging body of literature focusing on fisheries SES, e.g. Basurto, Gelcich, & Ostrom (2013), research on recreational fisheries as SES is, however, scarce. Consequently, this thesis will address these research gaps by contributing in several different ways to the understanding of recreational fisheries as a SES and, drawing on these results, discuss SES framework enhancements with regard to the necessary, stricter inclusion of the social and ecological dimension into the diagnostic framework.

Prerequisite to these goals is a literature review of academic papers discussing recreational fisheries and their management. This aims to understand the current state of recreational fisheries and their management and shed a light on the research focus of the recreational fisheries, especially regarding its conceptualization as a SES. Furthermore, the literature review is the basis for updating the SES framework for recreational fisheries and the subsequent application to the case site of Peenemünde. The following case analysis, focusing on social and environmental sustainability, is supported by case specific information gathered in field research and a survey. Based on the results limitations of the framework, regarding the predominance of monetary valuation in the SES variables, and solutions to these are discussed.

2. The SES framework and recreational fisheries management

2.1. Research aim

The initial research questions of this thesis were focusing on the local recreational fisheries features in the case study site Peenemünde. This especially includes, but is not limited to: What are the characteristics of the recreational fisheries? What are the main management mechanisms? What impacts would the introduction of new actors or processes have on the SES's current state? In order to answer these questions the SES framework, initially presented by Ostrom (2009), was applied to the case. Due to its iterative, i.e. updating of the framework based on a literature review, empirical analysing of the updated framework with a case study, revising of the results and expanding the framework with the findings, and diagnostic character, i.e. the facilitation of general applicability to any case, more questions were uncovered. This includes, for example, questions regarding the applicability of the economic focused framework aspects in a SES case, which is characterized by social, cultural and environmental importance.

2.2. Sustainability development, sustainability science and sustainability frameworks

Sustainability and sustainable development in themselves are concepts, which deviated from their original meaning and “suffered from a proliferation of definitions” (Hopwood, Mellor, & O’Brien, 2005; P. Johnston, Everard, Santillo, & Robèrt, 2007, p. 60). The main conflict issues are a) the human-nature relation addressing the question whether humans are nested within nature or dominate nature, and b) the question whether natural resources are compatible or substitutable with man-made, artificial capital, such as money, technology or knowledge (Daly, 1990; Giddings, Hopwood, & O’Brien, 2002; Hopwood, Mellor, & O’Brien, 2005; Solow, 1991; Stern, 1997).

Acknowledging these conflicts, this paper, however, follows the overall understanding pointed out by Brundtland (1987) and other papers seeing sustainability in a more holistic light. The core idea of sustainable development has to be meeting and satisfying human needs, while ensuring the health and the functioning of the Earth’s ecosystems in the long term (Clark & Dickson, 2003; Jerneck et al., 2011; Kates et al., 2001). In this sense, both aspects, socio-economic and environmental dimension, share a complex, reciprocal relationship which cannot be neglected. Hence, disciplinary or community isolated research and knowledge generation falls short in addressing this interrelation (Binder, Hinkel, Bots, & Pahl-Wostl, 2013; Partelow, 2016). In order to address these interconnected “nature-society systems” issues (Clark & Dickson, 2003, p. 8059), or in other words the “social-ecological systems” (SES) issues (Ostrom, 2007, p. 15181), the newly emerged sustainability science scholarship aims for bridging natural and social sciences seeking for holistic solutions to complex, multi-scale and multi-level challenges (Jerneck et al., 2011; Kates et al., 2001). Inherent in this, is the notion of altering current environmental harmful social and economic pathways towards the sustainable co-existing of humans and the environment (Clark, 2007).

Due to its transdisciplinary character, the sustainability science include different epistemologies, ontologies and methods from various research fields and scientific backgrounds (Jerneck et al., 2011). Studying, analysing and comparing cases, as well as finding solutions for SES issues, however, require comprehensive guidelines to incorporate different experiences, knowledge types, minimize misunderstandings, facilitate comparability, create a common language and pave the way for “the effective implementation of practical solutions” (Partelow, 2016, p. 400). These general difficulties can be overcome by utilizing frameworks integrating crucial aspects of social and ecological systems and theories (Hinkel, Bots, & Schlüter, 2014; Schlüter, Hinkel, Bots, & Arlinghaus, 2014). However, not only does the sustainability science benefit from integrating frameworks, a new diagnostic “lens” so to speak, but also the other way around (Partelow, 2016). This includes, amongst other things, the

integration of structured knowledge types, the facilitation of stakeholder inclusion and the introduction of sustainability criteria (Ostrom & Cox, 2010; Partelow, 2016).

2.3. The Social-Ecological Systems Framework

One of these frameworks is the social-ecological systems (SES) framework. Drawing on various theories, e.g. game theory, collective action theory and common pool resource management, and science disciplines, Elinor Ostrom with fellow scholars designed a diagnostic, multi-tier framework to assess internal SES interlinkages, governance challenges related to them and outcomes of SES management (Hinkel, Cox, Schlüter, Binder, & Falk, 2015; Ostrom, 2007, 2009; Ostrom & Cox, 2010; Schlüter et al., 2014). In order to do so, the SES framework provides scientists with “a general list of concepts that can be used to analyse all types of SESs” (McGinnis & Ostrom, 2014, p. n.d.). These concepts, exchangeable from the second-tier onwards, offer scientists the possibility to integrate different aspects for the analysis of complex SES. This flexible application mirrors on the one hand the dynamic processes of SESs and on the other hand aims to “provide an essential scientific dictionary for core concepts and their subconcepts” for improving transdisciplinary research (McGinnis & Ostrom, 2014, p. n.d.). Inherent in this idea of improving and furthering transdisciplinary research is the aim of breaking down what Miller et al. (2008) call “epistemological silos” in which “individuals work from their own epistemological perspective” (p. n.d.). Such research approaches narrow potential outcomes and neglect the complexity of human-nature systems and their subsystems (Miller et al., 2008). Consequently, epistemological pluralism, emphasizing the utilization of various insights, ways of knowing and knowledge types, is more appropriate for systematically researching and understanding complex SESs, as well as producing sustainable and resilient outcomes (Miller et al., 2008).

The primary step in analysing the individual aspects and the interlinkages within a particular SES is the identification of the initial first-tier variables, i.e. *resource system*, *resource unit*, *governance system* and *actors* (Basurto et al., 2013; McGinnis & Ostrom, 2014; Partelow & Boda, 2015) (Fig. 2).

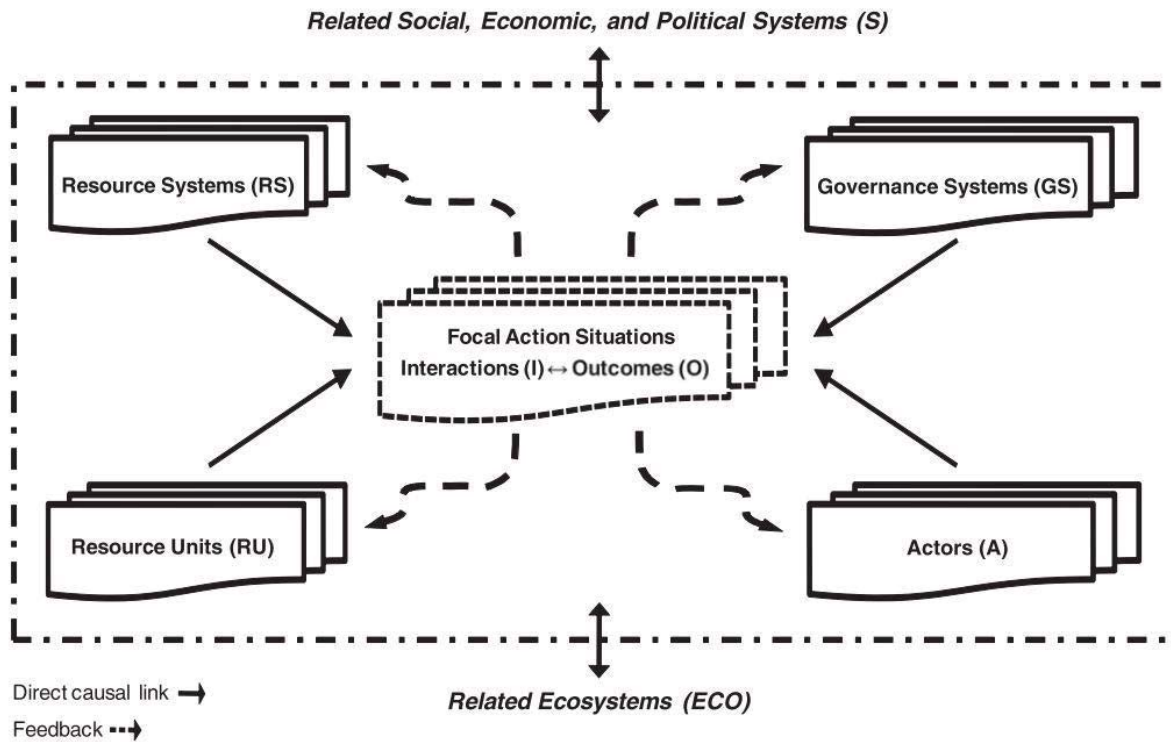


Figure 5. The social-ecological systems (SES) framework. The SES consists of four first-tier variables, resource system (RS), governance system (GS), resource unit (RU) and actors (A). With regards to the original Ostrom (2009) framework, this figure includes the change from Users (U) to Actors (A). Interactions between the four aspects, displayed with direct causal link-/feedback-arrows create and their outcomes are called action situation. The SES is furthermore influenced by related ecosystems (ECO) and related social, economic, and political systems (S). (Ostrom & Cox, 2010).

As seen in Fig. 2, the interaction between the four tiers constitute what McGinnis & Ostrom (2014) call “focal action situation”. Action situations, adopted from the “Institutional Analysis and Development” (IAD) framework (see section below), are patterns of interactions, outcomes and subsequent feedbacks affecting the first-tier variables (Ostrom & Cox, 2010). Based on a multitude of case studies, relevant and recurring second-tier variables are grouped subsequently (Ostrom, 2009). These subdivisions “decompose”, as Hinkel, Cox, Schlüter, Binder, & Falk (2015) describe, “higher-tier concepts further into more fine-grained variables” (p. n.d.). In contrast to the first-tier variables, however, these categories are case dependent and their applicability has to be determined individually. Consequently, due to this contextuality of the framework, i.e. case specific exclusion or inclusion of new concepts provides the researcher with a modified framework improving its capabilities for the case-specific knowledge accumulation.

2.4. The Institutional Analysis and Development Framework

As indicated above, the SES framework is a further development of the Institutional Analysis and Development (IAD) framework devised by Vincent and Elinor Ostrom and other scholars (McGinnis, 2011). Best thought as a meta-theoretical map, the IAD framework, “identifies an action situation,

patterns of interactions, outcomes and an evaluation of these outcomes” (Ostrom & Cox, 2010, p. 5) (Fig. 3).

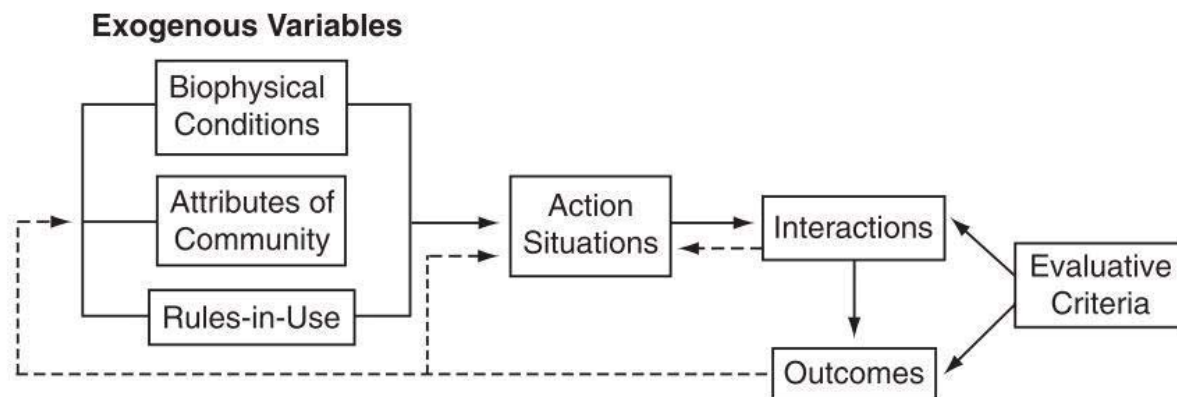


Figure 6. The institutional analysis & development (IAD) framework. Exogenous/external variables influence the action situation. The interaction and the outcomes can be evaluated by evaluative criteria. Outcomes feedback and influence a) the action situation and b) the exogenous variables. (Ostrom & Cox, 2010).

Drawing on game theory, actors are thought to act rational, they are influenced by rules-in-use and the attributes of the community and are constraint by case dependent biophysical conditions (McGinnis, 2011; McGinnis & Ostrom, 2014). Especially when analysing governance settings surrounding the utilization of common goods, such as fisheries, which hold many informal rules and specific norms or values, the IAD framework proves useful for researchers to analyse and understand what creates certain actor preferences, strategies and decisions. At the very heart of the IAD is the action situation (Fig. 3), in which a set of actors, individuals or representatives of organisations, interacting with each other, drafting policy choices and consequently affecting the outcomes of the overall SES (McGinnis, 2011; McGinnis & Ostrom, 2014). An action situation is defined by seven criteria: 1) the set of actors, (2) the sets of positions actors fill in the context of this situation, (3) the set of allowable actions for actors in each position, (4) the level of control that an individual or group has over an action, (5) the potential outcomes associated with each possible combination of actions, (6) the amount of information available to actors, and (7) the costs and benefits associated with each possible action and outcome (Ostrom & Cox, 2010).

In addition to these basic analytical components, a particular action situation can be analysed and evaluated based on certain criteria, such as efficiency, accountability, fiscal equivalence or legitimacy (McGinnis, 2011). In this thesis a specific focus rests on environmental and social sustainability criteria, e.g. equity, adaptability and participation, which were chosen from numerous criteria discussed in the literature, e.g. Gibson (2006), McGinnis (2011) or Vallance, Perkins, & Dixon (2011).

2.5. Linking the SES framework to other theoretical approaches

Coming from numerous theoretical backgrounds and research foci, the SES framework can be related or even been linked with other frameworks and concepts focusing on SES (Partelow & Winkler, 2016; Rova & Pranovi, 2017). As there are many frameworks describing and analysing SES, for a detailed analysis see Binder, Hinkel, Bots, & Pahl-Wostl (2013), overlapping is not unusual offering the possibility of linking concepts or at least fostering mutual learning.

This overlapping is especially true for the “ecosystem service” (ES) concept. Similar to the SES framework, the ES framework addresses tangible goods such as fish, food or timber. Contrary to the SES framework however, the ES approach further covers intangible goods and services, such as supporting, e.g. nutrient cycling, regulating, e.g. water purification, and cultural, e.g. aesthetic, services (Millennium Ecosystem Assessment, 2005). By incorporating the conceptualized intangible services, the ES approach can add new and important features to the concrete goods management of the SES framework (Partelow & Winkler, 2016). By this, the SES framework would be broadened by additional value systems (Partelow & Winkler, 2016). Considering only economic values, as it is done predominantly in the SES framework, neglects important aspects of the human-nature relationship. Social, cultural or relational values are often attached to the natural surrounding and consequently influence our perceptions, interests and lastly decision-making processes (Abson et al., 2014; de Groot, Wilson, & Boumans, 2002; Partelow & Winkler, 2016).

Though drawing on the idea of incorporating non-economic values in the SES framework, this thesis will not discuss ES theory and the integration into the SES framework. For further information on this topic see Partelow & Winkler (2016) or Rova & Pranovi (2017).

2.6. The importance of recreational fisheries

Even though, the socio-economic importance of recreational fisheries and their impact on aquatic ecosystems is often underestimated, there are a number of reasons, why decision-makers should include recreational fisheries, their catches and the subsequent socio-economic affects and environmental impacts in their rulings (Arlinghaus et al., 2016; Brown, 2016).

First of all, it has to be acknowledged, that recreational fisher constitute a considerable large group, i.e. often more than 10% of recreational fishers of total population, within developed and developing countries (Arlinghaus, 2005; Cooke & Cowx, 2004, 2006; Ditton, 2008; Pawson, Glenn, & Padda,

2008). This, consequently, leads to substantial extraction rates, which in some cases matches or even exceeds the commercial harvest (Coleman, Figueira, Ueland, & Crowder, 2004; Cooke & Cowx, 2006).

The high participation and extraction rates, secondly, have severe environmental impacts, which are additionally furthered by the catch selectivity, e.g. specific target stock, fish species or fish size, of recreational fisher. According to Lewin, McPhee, & Arlinghaus (2008) these factors especially cause a) ecological disruptions, e.g. changes in the reproduction dynamics, and b) genetic disturbances, i.e. limited genetic variables within a small population.

Thirdly, recreational fisheries play an important social, cultural and traditional role within Germany and in many other countries (Arlinghaus, 2005; Arlinghaus et al., 2016; Arlinghaus, Tillner, & Bork, 2015). The social importance of recreational fisheries is for example underscored by the high numbers of recreational fisher organised in angling clubs. Currently, around 620.000 recreational fishers are member of the German recreational fisher umbrella association “Deutscher Angelfischerverband” (DAFV) (Deutscher Angelfischerverband e.V., 2017). Furthermore, according to the Ministerium für Wirtschaft (2017), around 3,4 Mio. tourists engaged in angling between 2011 and 2014 further emphasizing the social importance of recreational fishing.

Finally, monetary gains and benefits generated by recreational fisheries and angling tourism contribute substantially to national, regional and local economies. The initial sources of expenditures are, amongst other things, fishing and guide fees, renting or purchasing of equipment, such as rods, nets, hooks, fishing clothes, boats and accommodations, and food (Ditton, 2008; Strehl, 2013). Ditton (2008) for example estimates, that a German recreational fisher spends around 379€ per year. This accumulates to more than 1.2 billion € for all 3.3 million German anglers. These direct impacts generate subsequent indirect economic gains, such as jobs or selling of goods and services to tourist companies, e.g. local agricultural products sold to hotels and restaurants. According to Hughes (2014), due to the economic multiplier effect, the initial \$40 billion in retail sales or angling activities, amount to a total economic impact of “estimated \$115 billion economic impact and over 800.000 jobs” in the United States in 2011 (p.1).

2.7. Case description – Recreational fisheries in the eastern Greifswalder Bodden

Located in the north-east of Germany, the Greifswalder Bodden, or Bay of Greifswald, is the largest German Bodden, a “broad shallow irregularly shaped inlet or bay along the southern Baltic coast” covering an area of 514 km² (Neuendorf, Mehl, & Jackson, 2005, p. 75; Schiewer, 2008). The

Greifswalder Bodden is enclosed by the island of Rügen in the west, the German mainland in the south and the island of Usedom in the east (Fig. 3).

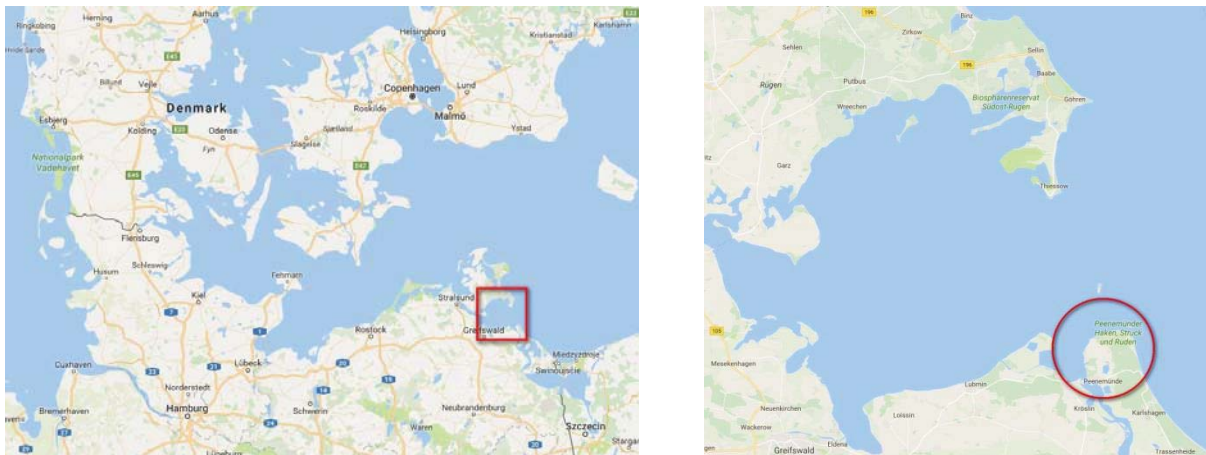


Figure 7. Case study location. The image on the left displays the location of the case study area Greifswalder Bodden (red square) at the German Baltic coast. The image on the right displays the location of the case study site within in the Greifswalder Bodden area (red circle). (Google, n.d.).

The case study site of Peenemünde, see red circle in the left picture of Figure 3, in the eastern Greifswalder Bodden is further characterized by the influx of freshwater from the Peenestrom into the Bay (Fig. 3). Consequently, “the water balance is determined by the Baltic Sea exchange and the inlet of freshwater rivers flowing into the Peenestrom” creating a rich and unique aquatic ecosystem (EUCC – The Coastal Union, 2017, p. n.d.; Schiewer, 2008). Furthermore, geographical features of the Greifswalder Bodden, such as bays and shoals, are “ideal for a large variety of fish” (EUCC – The Coastal Union, 2017, p. n.d.).

The biophysical and geographical diversity of the Greifswalder Bodden is mirrored in the abundant variety of fish. Around 60 different saltwater and freshwater can be found in the Greifswalder Bodden (Fey et al., 2014). The most common species are garfish, cod, flounder and herring (IFAÖ, WWF, UmweltPlan Stralsund, & Greifswald, 2010). In addition to that, in the Peenestrom, with its lower salinity as the rest of the Bodden, freshwater fish such as perch, zander, pike, eel and common roach can be found (EUCC – The Coastal Union, 2017; IFAÖ et al., 2010; Münster, Richter, Wichmann, & Schmiedel, 2006). The piscine diversity aside, the Greifswalder Bodden is also home to a rich benthic flora and fauna and bird life (Schiewer, 2008; Schmiedel, Meier, Abraham, & Strunk, 2016).

Due to the rich fish grounds, the Greifswalder Bodden is an important commercial and subsistence fishing area contributing substantially to the region’s economy, culture and society (Hahlbeck &

Gröhsler, 1999; IFAÖ et al., 2010). As a result of the rich fish biodiversity and abundance, recreational fishing is a popular free time activities for the local population and for tourists. The most important species for angler in the case study area are herring, garfish, pike, pikeperch and perch which are all targeted predominantly in the main angling season from March till October (EUCC – The Coastal Union, 2017; IFAÖ et al., 2010).

As a result of the unique Bodden ecosystems, the whole area of the Greifswalder Bodden was incorporated into the NATURA 2000 network of protected areas (Schmiedel et al., 2016). This incorporates fourteen natural reserves, one biosphere reserve and one national park. In the case of Peenemünde, the most relevant natural reserves and bird sanctuaries are the “Peenemünder Haken, Struck und Ruden - Gebietsteil A and B”. Laws and rules attached to the establishment of these, as well as national, wide-ranging nature conservation and protection regulations, e.g. temporal and spatial closings, catch quotas, fishing license requirements or gear restrictions are influencing fishing activities in these areas (Fey et al., 2014).

Due to the economic potential of and interest in recreational fisheries, the peninsula of Peenemünde was privately bought and the angling tourism and subsequent economic developments are promoted (EUCC – The Coastal Union, 2017). As history shows, uncontrolled and unregulated promotion and development of economic activities, here recreational fisheries tourism, often led to ecosystem threats and in the worst case overexploitation and natural degradation (Holden, 2005; Organisation for Economic Co-Operation and Development (OECD), 2000). The EU-funded “CATCH” project in the Greifswalder Bodden addresses this development and aims to direct the economic opportunities and the ecological perils of angling tourism into sustainable channels. This will be done by fostering target-orientated marketing, information sharing, knowledge transfer and the facilitation of stakeholder cooperation (CATCH - Southbaltic, 2016; EUCC – The Coastal Union, 2017).

3. Methodology

3.1. Introduction

In order to conduct this master thesis, analyse the case at hand and further the SES knowledge several methodological steps have been deployed. The specific methods, briefly explained below and expanded in detail in following chapters, were chosen to provide quantitative and qualitative data and offer insights into complex social-ecological systems and the management of common-pool resources.

Systematic literature review

As an initial step, a systematic peer-reviewed literature review was conducted. Based on a specific designed search string, the search produced a great number of scientific papers addressing issues of various aspects, including social-ecological systems, recreational fisheries, governance, etc. After an in-depth review and exclusion of articles, the found literature provided the basis for updating the SES framework for recreational fisheries.

Additional documents & literature

Further data, e.g. grey literature, newspaper articles, NGO publications, databases and additional scientific papers, was gathered to a) get a deeper understanding of recreational fisheries and the local and regional regulations and management approaches attached to them, and b) to find information regarding the case study site Peenemünde to fill out the updated framework. The literature for updating the framework was found by searching via Google for information regarding individual tiers, i.e. number of actors, had the search string: “commercial fishers” AND “Greifswalder Bodden”. Additional scientific papers were found by searching via the science search engines Google scholar, scopus and LUBsearch for papers and books discussing recreational fisheries in general and for the case site in particular. Furthermore, the reference lists of scientific papers were used to find more literature.

Updating of the SES framework for recreational fishery

Based on the one hand on the developed SES frameworks by Basurto, Gelcich, & Ostrom (2013) and Ostrom (2009) and on the other hand on the literature review, an updated SES framework was developed. This updated framework is specially designed for the recreational fisheries. Consequently, this updated “checklist” allows, by its subsequent and step-by-step application, analysing the SES and management situation in the case study area Peenemünde adequately. Updating the framework was a necessary step in analysing the case study Peenemünde

Stakeholder/Project meeting participation

As part of the CATCH project, an initial stakeholder meeting was conducted in Peenemünde. The participants represented the most important stakeholder groups attached to the project and the recreational fisheries tourism development in the Peenemünde region. The workshop, addressing various aspects of sustainability and recreational fisheries and the informal discussions helped to gain qualitative insights in management preferences, concerns and preferences of the present stakeholders. This information gained in the field visit was especially useful for evaluating the action

situation as described in the “Institutional Analysis & Development” framework and to fill in information in the SES framework application, which I would have not gotten otherwise, e.g. from scientific papers or books.

Survey

Following the stakeholder meeting in Peenemünde and to further the understanding of the management of the common property fishery and the development of the region for sustainable recreational fisheries tourism, a survey, addressing elementary aspects of an action situation, was designed. The survey was distributed to representatives of the involved stakeholder groups. The specific targeting and the relatively brevity of the survey was intentional and aimed for a heightened response rate.

Application of the updated framework to the case side Peenemünde

After examining and updating the SES framework, the framework was applied to the case side of Peenemünde and its recreational fisheries development. First of all, by applying it to a case, the framework is tested empirically and furthers the understanding of the applicability of the framework by deploying literature review, survey results and first-hand knowledge. Secondly, it helps to analyse and evaluate the management of the common pool resource fish in the region of Peenemünde.

Application of the “Institutional Analysis & Development” framework to the case

In addition to the application of the SES framework, the action situation, in the CATCH project case the stakeholder meeting and its potential subsequent meetings, interactions and outcomes, was analysed. This was done by analysing the seven action situation criteria presented in the theory section 2.4 and outlined by Ostrom & Cox (2010). Especially the participation in the meeting and the survey helped to do analyse the informal institutional arrangements and evaluate the outcomes of the common resource management.

3.2. Literature review

As pointed out by Bryman (2012), two of the main reasons for conducting a literature review is a) to gain insights in the topic at hand and b) to “know what is already known” about the specific topic (p. 98). Accessing the topic of recreational fisheries empirically and theoretically includes learning on the one hand about individual aspects of recreational fisheries and on the other hand about the understanding of recreational fisheries as a SES. Additionally, by using the method of a systematic literature review I set the basis for updating the SES framework for recreational fisheries. By

identifying important aspects in managing recreational fisheries from multiple case studies and theoretical papers I can adjust the general Ostrom (2009) framework. The individual steps of the systematic literature review are described in the Table 1 below.

Table 1. Individual steps of the literature review. Overall six steps were used to search, gather and extract information.

Step	Process	Result
1. Conceptualization	Initial planning of the research. Gathering background information by internet and literature screening, focusing on a) recreational fisheries and b) social-ecological systems (SES) and c) the interrelation of both.	Search string (see Appendix 1) including recreational fisheries aspects, management key words and SES features, as well as excluding spatial (inland and freshwater fisheries) and temporal (older than 2008) research focuses.
2. Search string application	Entering the search string in Scopus	The search string was used on the 3 rd of February 2017 in Scopus. A total number of 93 articles were found.
3. First data processing	Downloading of the basic information, amongst other name, author, title, year, keywords and abstract, of the 93 potential relevant articles from Scopus into a excel document. Screening of the articles' title, keywords and abstracts. The focus of the screening was: "Does the article touch upon aspects of social-ecological systems and recreational fisheries or its management?"	After the initial screening 35 papers addressing aspects of the SES and recreational fisheries were identified as potentially relevant.
4. Accessing the papers	All 35 papers were downloaded and subsequently uploaded into the citation and organization programme "Mendeley".	In Mendeley, a folder was created containing all 35 relevant articles.
5. Second data processing	In Mendeley, every article was fully read to exclude unsuitable papers not focusing on the research aspects.	In total, 22 papers were identified as relevant for the research. Full list of the articles in Appendix 2.

6. Data categorization & analyzation	Analysis and classification of the 22 articles. A twofold strategy was used to gain insights into recreational fisheries, its management, its linkage to SES aspects and other research foci. First of all, while reading handwritten notes were taken. Secondly, the articles were analysed against the backdrop of 22 pre-defined categories relevant for gaining insights in recreational fisheries, SES aspects and the overall alignment of recreational fisheries research, see Appendix 9.	Both, the recreational fisheries characteristics and the research focus, are presented and outlined in the respective sections.
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The last step of the literature review was the classification of the 22 articles by applying 22 categories defined after reading the literature review articles. These categories were specifically designed based on various variables, such as frequent mentioning of the category or specific emphasis in the literature review papers. The overall aim of the categories was to better understand the current state of the recreational fisheries research and the overall state and diversity of recreational fisheries and their particular management, see Appendix 9. Consequently, every category was specifically designed and chosen by the author to gather and analyse information from the literature review articles for this study. The results of the category application were stored in Microsoft excel.

3.3. Updating of the SES framework for recreational fishery

The updating of the SES framework was first and foremost based on the Ostrom's (2009) initial outline of the framework. Consequently, the first and the second tiers, describing generic features of any SES, were adopted. In a subsequent step second tier variables were excluded, included or renamed. This was done with the insights from informal discussions with stakeholder participants, the literature review articles and the fishery SES papers by Arlinghaus et al. (2017), Basurto, Gelcich, & Ostrom (2013) and Partelow & Boda (2015). Exclusion and inclusion decisions of the second tiers were based on their usefulness and applicability to study and analyse coastal recreational fisheries. These changes especially affected the *governance system* variable. The other three variable *resource system*, *resource unit* and *actors* stayed for the second tier the same as in the initial framework. Furthermore, based on the literature review, spontaneous discussions with workshop participants and the stakeholder meeting, second, third, fourth and fifth tiers were included to fit exactly to coastal recreational fisheries.

As one of its main characteristic is the social dimension, recreational fishing is defined as fishing not for profit, but for recreation and leisure, a special emphasis has to be put on the social side of

recreational fisheries (Arlinghaus, 2005). In this refinement and particular alignment, the paper by Arlinghaus et al. (2017) was very insightful and helpful. Their inclusion of social aspects was consequently borrowed to some extent in this thesis and this updated framework, too. By including this new perspective and extending the economic focus of the original SES framework, the framework becomes more holistic and suitable for analysing the coastal recreational fisheries case in this thesis. The complete and updated framework is shown in Table 2. The extended framework, including definitions and sources for new tiers can be found in Appendix 3.

Table 2. Updated SES framework for coastal recreational fisheries in Peenemünde

<p>Actors</p> <p>A1 Number of actors</p> <p> A1.1 Commercial</p> <p> A1.2 Recreational</p> <p> A1.2.1 Local recreational fisher</p> <p> A1.2.2 Recreational fisheries tourists</p> <p> A1.3 Tertiary/Service industry</p> <p> A1.4 Illegal, unreported, unregulated (IUU) fishing actors</p> <p>A2 Socioeconomic attributes of actors</p> <p> A2.1 Socioeconomic resilience</p> <p> A2.2 Operative costs</p> <p> A2.2.1 Replacement rates</p> <p> A2.2.2 Ecosystem management</p> <p>A3 History or past experience</p> <p> A3.1 Crisis</p> <p> A3.2 Duration</p> <p>A4 Location</p> <p> A4.1 Accessibility</p> <p> A4.1.1 Ports/ Harbors/ Built Infrastructure</p> <p> A4.1.2 Beaches/ Non-built/ natural access</p> <p> A4.2 Locational conflicts</p> <p>A5 Leadership/entrepreneurship</p> <p>A6 Social capital</p> <p> A6.1 Spatially based</p> <p> A6.1.1 Clubs/organizations/Chapters</p> <p> A6.2 Non-spatially based</p> <p> A6.2.1 Online format, blogs, social media, publications</p> <p> A6.3 Norms , cognitions and emotions</p> <p> A6.4 Values</p> <p>A7 Knowledge of SES/mental models</p> <p> A7.1 Local/traditional ecological knowledge (LEK/TEK)</p> <p> A7.2 Western Science and Management Knowledge (SMK)</p> <p> A7.3 Knowledge sharing/Social learning</p> <p>A8 Importance of the resource</p> <p> A8.1 Economic dependence</p> <p> A8.2 Cultural dependence</p> <p>A9 Technology used</p> <p> A9.1 Ownership of technology by fishers</p>	<p>RS4.3 External productivity variables</p> <p> RS4.3.1 Indirect factors</p> <p> RS4.3.2 Direct factors</p> <p>RS5 Equilibrium properties</p> <p>RS6 Predictability of system dynamics</p> <p>RS7 Human constructed physical features</p> <p> RS7.1 Access structures</p> <p> RS7.2 Delineation structures</p> <p> RS7.3 Expanding infrastructure</p> <p>RS8 Connectivity</p> <p>RS9 Location</p> <p>Governance System</p> <p>GS1 Policy area</p> <p> GS1.1 Social-ecological policies</p> <p> GS1.1.1 Spatial regulations</p> <p> GS1.1.1.1 Marine Protected Areas (MPA)</p> <p> GS1.1.1.2 No-Take-Zones</p> <p> GS1.1.1.3 Spatial Zoning</p> <p> GS1.2 Catch treatment</p> <p> GS1.2.1 Catch-and-Release</p> <p> GS1.3 Temporal regulations</p> <p>GS2 Geographic range</p> <p>GS3 Population</p> <p>GS4 Organizations</p> <p> GS4.1 Government organizations</p> <p> GS4.1.1 National Level</p> <p> GS4.1.2 Regional level</p> <p> GS4.1.3 Local Level</p> <p> GS4.1.4 Support Enforcement</p> <p> GS4.1.5 Support Funding</p> <p> GS4.1.6 Restoration efforts</p> <p> GS4.1.7 Underlying governance principles</p> <p> GS4.2 Nongovernment organizations</p> <p> GS4.2.1 Environmental Organizations</p> <p> GS4.2.2 Research Organizations</p> <p> GS4.2.3 Social/ Welfare Organizations</p> <p> GS4.2.4 Restoration efforts</p> <p>GS5 Decision-making structures</p> <p> GS5.1 Network structure</p> <p> GS5.1.1 Vertical</p> <p> GS5.1.2 Horizontal</p>
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<p>A9.2 Homogeneity A9.3 Gear restrictions and limits A9.4 Environmental impact of gear</p> <p>Resource Unit</p> <p>RU1 Resource Unit Mobility RU1.1 Recruitment RU1.2 Spatial distribution</p> <p>RU2 Growth or replacement rate</p> <p>RU3 Interaction among resource units RU3.1 Reproduction RU3.2 Interaction between different resource species</p> <p>RU4 Socio-economic dynamics RU4.1 Economic Values RU4.1.1 Fish Harvest RU4.1.2 Economic mechanisms RU4.1.3 Economic spillover effects</p> <p>RU4.2 Social values RU4.2.1 Cultural values RU4.2.2 Recreational values RU4.2.2.1 Use value RU4.2.2.2 Non-use value RU4.2.2.3 Recreational industry revenues</p> <p>RU5 Number of units RU5.1 Legal harvest rate RU5.2. Illegal, unreported, unregulated (IUU) fishing RU5.2.1 By-catch RU5.2.2 Catch-and-release RU5.3 Ecological Importance of resource units</p> <p>RU6 Distinctive characteristics RU6.1 Minimum length RU6.2 Fish species</p> <p>RS7 Spatial and temporal distribution RS7.1 Seasonal distribution RU7.2 Natural home range</p> <p>Resource System</p> <p>RS1 Sector RS1.1 Coastal Fish Species</p> <p>RS2 Clarity of system boundaries RS2.1 Life history RS2.1.1 Within governance system boundaries RS2.1.2 Outside governance system boundaries</p> <p>RS2.2 Zonal management areas RS2.3 International or binational waters</p> <p>RS3 Size of resource system RS3.1 Carrying capacity</p> <p>RS4 Productivity of the system RS4.1 Stock status RS4.2 Biophysical factors</p>	<p>GS5.1.3 Transparency</p> <p>GS5.2 Management Strategy GS5.2.1 Top-down management GS5.2.2 Co-management GS.5.2.2.1 Consulting GS.5.2.2.2 Collaborating GS.5.2.2.3 Delegating</p> <p>GS5.2.3 Adaptive management</p> <p>GS5.2.4 Self-governance/community based</p> <p>GS5.2.5 Inclusiveness GS5.2.5.1 Committee/ Board/ Council GS5.2.5.2 Open forum/ Public comment GS5.2.5.3 Research involvement</p> <p>GS5.2.6 Multiple outcome recognition and planning</p> <p>GS6 Rules-in-Use GS6.1 Constitutional Rules GS6.2 Collective Choice Rules GS6.3 Operational Rules GS6.4 Property rights GS6.4.1 Access GS6.4.2 Withdrawal GS6.4.3 Management GS6.4.4 Exclusion GS6.4.5 Alienation</p> <p>GS6.5 Recreational resource management GS6.5.1 Input controls GS6.5.1.1 Access regulation GS6.5.1.2 Fishing moratorium GS6.5.1.3 Equipment/gear GS6.5.1.4 Seasonal closing GS6.5.1.5 Spatial closing</p> <p>GS6.5.2 Output control GS6.5.1.1 Harvestable size limits GS6.5.1.2 Bag limit</p> <p>GS7 Monitoring GS7.1 Social GS7.2 Biophysical</p> <p>GS8 Sanctions</p> <p>GS9 Public education and training GS9.1 SES rules and regulations GS9.2 Reasoning behind rules and regulations GS9.3 Fish treatment GS9.4 Training of fishing guides</p>
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3.4. The stakeholder meeting of the CATCH project in Peenemünde

On the 22nd of March 2017, a stakeholder meeting, to which I was invited, was hosted by the NGO EUCC-Deutschland to a) bring all relevant stakeholders to the table, b) explain in more depth the ideas and intentions behind the CATCH project and c) to get feedback from the participating stakeholders. The overall structure of the meeting mirrored the equal status of the stakeholders. This means, every participant had the right to express her/his opinion at any time. The discussions were, however, facilitated by members of the NGO EUCC-Deutschland, see Fig. 4. For the full list of participants, see Appendix 4.

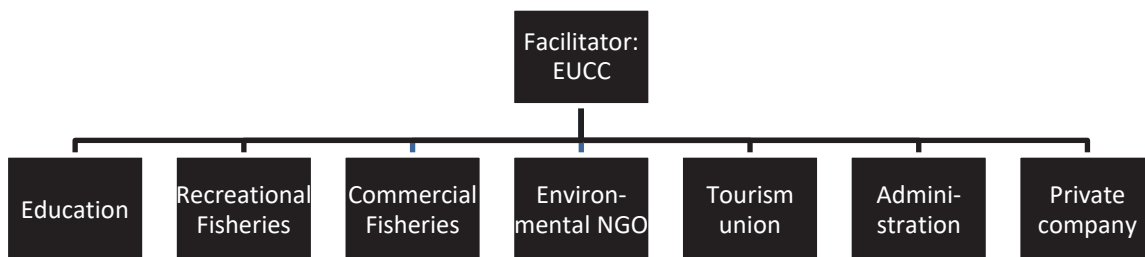


Figure 8. Internal structure of the first stakeholder meeting of the CATCH Project in Peenemünde. The higher position of the EUCC does not represent a higher or centralized status within the group, but indicates the position as facilitator.

As being a bystander, I was able to observe the process and listen to the discussions between participants and within the whole group. This allowed me, to gather important insights in the viewpoints of the individual stakeholder. Furthermore, as the discussions were very direct and open the emotionality of the topics, e.g. sustainability in the recreational fishery, was very visible and hearable, e.g. by loud and angry interjections, gestures, whispering between each other or laughter. This underpinned my perception of recreational fisheries as being deeply embedded in the coastal culture and the individual emotional connection to this hobby.

3.5. Survey design & implementation

Following the stakeholder meeting, a survey (online link, Appendix 5) was drafted to deepen the knowledge of this particular action situation and the understanding of the critical stakeholder groups' perceptions concerning the institutional arrangements, including the stakeholder meeting and its internal processes, their views on expanding recreational fisheries tourism and its social, environmental and economic implications.

Designed with Google Forms, the survey used different types of answering options, including Likert scale, Yes/No possibility and open-ended questions. Following the recommendations by Nardine Stybel, project partner EUCC-Deutschland, these varied response possibilities should increase the response rate by making the survey more diverse (personal conversation. April 3, 2017). According to Hartley & Betts (2010) and Maeda (2015) the Likert scale answering options were aligned vertically using positive wording. In addition to the given answering possibilities, a voluntary comment section after each question was paired to give respondents more flexibility to express their views and the possibility to elaborate on their answers as well as gain insights in the stakeholders' perceptions.

Due to possible time restrictions on the part of the stakeholders and a potential correlation between fewer questions and more feedback, only 21 non-mandatory questions were included in the survey. In addition to these attempts to increase the responsive rate, only the representatives of the individual stakeholder groups were asked to fill out the survey. This is in accordance with the recommendations given by Nardine Stybel, stating that many of the stakeholders are not familiar with scientific research or not interested in participating (personal conversation. April 3, 2017). This choice is underpinned by following Brymans (2012) argument that purposive sampling ensures "as wide a variation as possible in terms of the dimension of interest" (p. 419).

Though the stakeholders were briefed that a survey for this master thesis will be conducted, a statement concerning the purpose and the reasoning for the survey was included in the survey distribution email. Due to the late date of the meeting, the survey could be sent out earliest on the 18th of April with the deadline on the 26th of April. As only two out of six stakeholder representatives replied within the deadline, the remaining representatives were contacted by mail or phone reminding them to fill out the survey. Furthermore, the deadline was extended to the 3rd of May, which increased the response rate only slightly from two to four responses.

3.6. Empirical application of the recreational fisheries SES framework

In order to test the theoretical framework empirically and diagnose the specific case at hand, the updated framework was applied to the case study area of Peenemünde.

To find information concerning all variables of the framework, a great variety of sources were used. This includes official state and administrative documents, e.g. laws, regulations and statistics, as well as documents, studies and information leaflets issued by environmental NGOs, a tourist agency and recreational fisher associations. Furthermore, first-hand information, i.e. participation in the

stakeholder meeting, discussions with stakeholders and in the field experiences were incorporated, too. For the filled out table of SES framework components see Appendix 6.

The main challenge in matching SES categories and responding variables was the condensation and simplification of available sources. Consequently, extensive data and information had to be broken down and simplified for the purpose of usefulness and readability. In general, two types of shortenings were used. Yes/no-categories indicate whether or not a variable, activity, rule, regulation, etc. was presented in the case study and a yes/no answer was sufficient to give that information. A generic example for this answer category would be the question whether or not a no-take zone is present or not. The limited/medium/high-category was used when a level of differentiation of applicability was necessary for the understanding of the specific variable or the case study. In this it is an extension of the yes/no category since for example "limited" should be understood as present, but to a minor extent.

4. Analysis & Findings

Following the application of the above described methods, this section will present the results. The procedure of this follows the logic of the method application, i.e. literature review, then framework, then application to context, then action situation. This was adopted as each methodological step builds upon the former one.

4.1. Research trends and characteristics

When looking at the research characteristics of the articles identified in the literature review, the two main foci of the findings rest on the articles inclusion of the concept of social-ecological systems, including the specific mentioning of Ostrom (2009), and whether or not the author(s) addressed sustainability aspects or challenges in their publication.

First of all, only four out of the 22 articles reviewed, i.e. less than 20%, explicitly mentioned or recognized recreational fisheries as a SES. Furthermore, none of the articles mentioned Ostrom's (2009) SES framework. However, two papers used related publications, i.e. Berkes and Folke (1998), Folke et al. (2005), Folke (2007), Levin (2006) and Olsson P, Folke C, Berkes F. (2004). In addition, no similar concepts, e.g. the ecosystem service framework, were used to describe the interrelation between human and the nature dimension. Connected to this result is the fact, that only two articles,

i.e. Brown (2016) and Camp et al. (2013), focus on the ecological, governmental and social dimension to the same extent. The other papers, have an overall focus predominantly set on either ecological (three out of 22), social (nine out of 22) or governmental (five out of 22) aspects. This is surprising, since there is an overall understanding, that there are no simple solutions to complex SES problems, and that there is consequently “a need to increase interdisciplinary studies that will foster a systematic understanding of recreational fisheries as complex adaptive social-ecological systems” (Arlinghaus et al., 2017, p. 178). (Arlinghaus et al., 2017, p. 178; Binder et al., 2013; Ostrom, 2007; O. R. Young et al., 2006).

Secondly, sustainability was addressed, to at least some extent, in almost all papers, excluding Alós & Arlinghaus (2013), Ferter, Borch, Kolding, & Vølstad (2013) and Parnell, Dayton, Fisher, Loarie, & Darrow (2010). Specific foci rest on whether or not current management decisions support socioeconomic and/or ecological sustainability or recommendations to facilitate sustainability were given. Out of these nineteen articles addressing sustainability eighteen furthermore identified challenges to the sustainable management of the fishery. The main challenge is identified in management problems, e.g. lack of monitoring or enforcement, exclusion of some important stakeholders or incomplete regulations. A second challenge is the non-compliance of stakeholders, due to opposing attitudes towards regulations or lack of knowledge of rules or boundaries, and lack of knowledge, i.e. negative impacts of management decisions, e.g. wild fish stocks ecology is threatened by ecological unsuitable restocking approaches. Furthermore, external factors, such as agricultural run-off or industrial pollution, further threaten the sustainability of fisheries in general and recreational fisheries in particular.

In short, though acknowledging the importance of an all-inclusive research approach and focusing on sustainability dimensions, a holistic, i.e. addressing all sustainability aspects, viewpoint aided by the conceptualization of recreational fisheries as a SES would be beneficial for the research.

4.2. Recreational fishery characteristics

Analysing the articles according to the presented fisheries and case studies helps to get a clearer picture on what the main recreational fisheries characteristics, benefits and threats are and how recreational fisheries are managed today.

First of all, most of the studies found in the literature review articles, sixteen out of 22, analysed fisheries situated within national parks, marine protected areas (MPA) or other spatially regulated

areas all over the world. An example for this is the Great Barrier Reef (GBR), which is the “largest coral reef system in the world and an environment of outstanding cultural and natural value” (Arias & Sutton, 2013, p. n.d.). In addition to that, the majority of the recreational fisheries discussed were traditional rod-and-reel fisheries. Other fishing techniques, however, e.g. spearfishing or Catch-and-Release fishing, are mentioned, too.

Secondly, with regard to the importance of the recreational fishery, i.e. fishing activities or direct and indirect economic benefits, the literature suggests, that respective fisheries are socially and economically very important to coastal communities. For example, Ferter et al. (2013) point out that the Norwegian marine recreational fishery tourist sector, “has expanded rapidly during the past two decades and has become economically important for many coastal communities” (p.138). In addition to that, the discussed fisheries are important and highly frequented recreational fisheries tourist destinations creating substantial spill-over effects for the local economy.

Thirdly, as pointed out above one of the main tools in recreational fisheries management is spatial closures, either to all or particular fishing stakeholders. Furthermore, output, i.e. bag limit, size or age limits, and input, i.e. temporal restrictions, fishing license requirements or gear restrictions, controls are common, however their usage and extent varies from case to case and often in place. Florida’ management goal of 40% escapement, for examples, “is managed solely by size and bag limits” (Camp et al., 2013, p. 396).

Finally, outcomes of the utilization and the management of the recreational fisheries were analysed. However, no clear picture of the most appropriate or sustainable management strategy emerged. An example for this outcome ambiguity is MPA. In some cases, e.g. Martin, Momtaz, Jordan, & Moltschaniwskyj (2016), the spatial zoning led to an increase in biomass, size and fish density. In other cases, e.g. Rife et al. (2013), there was little or no success in improving the recreational fishery. It can be said, that the socioeconomic and ecological success depends on case specific and individually designed approaches, including overall objective, enforcement of the regulations, monitoring and especially the involvement of all relevant stakeholders.

4.3. Findings from updating of the SES framework

As described in the methodology section, the two main steps in updating the SES framework for the case study were a) the adoption of the first and the second tier from the initial Ostrom SES framework and b) the inclusion of new and the exclusion not useful original tiers by using the articles

from the literature review, selected literature and first-hand field experience information from the case site. By the inclusion of new variables, up until the fifth tier, the case specific framework consists of a total amount of 166 variables. In comparison to this, the original SES framework consists of 37 tiers (Ostrom, 2009). These 166 variables, however, are only integrated into the four main categories *governance system, resource unit, resource system* and *actors*. Almost half of the variables, i.e. 72 tiers representing ca. 43% of all variables, address the *governance system*. The majority, i.e. fourteen out of the 22 articles, addressed social and governmental aspects, indicating the possible reason for the many *governance system* variables. The *social, economic, and political settings, the interactions, outcomes* and *related ecosystems* tiers remain unchanged.

4.4. Application of the updated SES framework and the findings

After updating the framework, it was applied to the case study site of Peenemünde to test it empirically and to analyse the recreational fishery and its management on site. In the following only excerpts of the framework will be depicted. For the whole list see Appendix 6.

Starting with the *governance system*, the regulations, rules and laws in place suggest an overall well managed system. Especially recreational resource management, i.e. input-/output controls, see Table 3, are well defined and in line with the overall German regulations.

Table 3. GS6.5 Recreational resource management

GS6.5 Recreational resource management	--
GS6.5.1 Input controls	--
GS6.5.1.1 Access regulation	Yes, fishing license (from 14 years onwards) and fishing permit (day, week and year permits) necessary
GS6.5.1.2 Fishing moratorium	Yes, depending on fish species
GS6.5.1.3 Equipment/gear	Yes
GS6.5.1.4 Seasonal closing	Yes, depending on fish species
GS6.5.1.5 Spatial closing	Yes
GS6.5.2 Output control	--
GS6.5.2.1 Harvestable size limits	Yes, depending on fish species
GS6.5.2.2 Bag limit	Yes, depending on fish species

Furthermore, most of the relevant stakeholders are included and local cooperation can be found on site. A future inclusion of more stakeholders, e.g. the agricultural sector and tourist unions, was,

however, suggested in the stakeholder meeting (comments in Q11, Appendix 7). When it comes to actual decision-makings, e.g. introduction of daily bag limits for cod, local stakeholders, i.e. commercial and recreational fisher, are often left out. This top-down management, see Table 4, causes discontent, a general feeling of unfairness and resistance in the local community (personal communication, stakeholder meeting Peenemünde). The conflict is often fuelled by the perception of neglecting local ecological knowledge, prioritization of scientific knowledge and especially the disregard for protecting the cultural and traditional values attached to fishing in the local communities (personal communication, stakeholder meeting Peenemünde).

Table 4. GS5.2 Management strategy

GS5.2 Management strategy	--
GS5.2.1 Top-down management	Depending on the recreational fisheries aspect; top-down especially for catch regulations
GS5.2.2 Co-management	Yes
GS.5.2.2.1 Consulting	No
GS.5.2.2.2 Collaborating	Medium
GS.5.2.2.3 Delegating	Yes

In addition to this, the local management lacks comprehensive social and biophysical monitoring approaches (GS7). Both are to some extent caused by the physical size of the area making it difficult and costly to monitor recreational fisher, their practices, especially catch-and-release practices, and their catches. Furthermore, it is not required to register catches to any authority like in other countries, e.g. Iceland (Solstrand, 2013). Finally, the public education and training can be enhanced (GS9). As shown in Table 5, none of the characteristics are fully developed, potentially leading to non-compliance and/or to harmful fishing practices.

Table 5. GS9 Public education and training

GS9 Public education and training	--
GS9.1 SES rules and regulations	Limited
GS9.2 Reasoning behind rules and regulations	No
GS9.3 Fish treatment	Limited
GS9.4 Training of fishing guides	No

Turning now to the *actor*-tier, recreational fisheries participation is well understood, though in some cases on site data is missing, e.g. number of recreational fisheries tourists (A1.2.2) or data regarding the tertiary industry (A1.3). Overall, many people, local residents and tourists, participate in recreational fishing generating socioeconomic benefits and financial spill-over effects (RU4.1.3). The fishing location is in general well developed, i.e. availability of harbours, marinas and accessible coastline (A4.1), and future infrastructural projects are planned (personal communication, stakeholder meeting). Furthermore, social, cultural, traditional and ecological values play a great role in the local community, see Table 6. Currently there are no conflicts present. This might however change if more tourists are visit and fish within the *resource system*.

Table 6. A6.3 Norms, cognitions and emotions

A6.3 Norms, cognitions and emotions	Yes Socio-cultural and environmental importance, e.g. in terms of respect for the fish or appreciation of unique nature present
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As the Greifswalder Bodden and the Peenestrom are important fishing grounds and fish ecosystems, scientific knowledge about distribution patterns, life history and threats is abundant. Consequently, the *resource system* and the *resource unit* are both well understood. When linked to social values (Table 7), the non-economic importance of the resource becomes visible.

Table 7. RU4.2 Social values

RU4.2 Social values	--
RU4.2.1 Cultural values	High
RU4.2.2 Recreational values	High
RU4.2.2.1 Use value	High
RU4.2.2.2 Non-use value	High
RU4.2.2.3 Recreational industry revenues	~ 21€/person (Germany, no local data)

Nevertheless, as Table 8 shows, more efforts have to be put in the monitoring of illegal, unreported and unregulated fishing activities, as they are potentially harmful to the ecosystem and consequently have to be taken into management decisions.

Table 8. RU5.2 Illegal, unreported, unregulated (IUU) fishing

RU5.2 Illegal, unreported, unregulated (IUU) fishing	--
RU5.2.1 By-catch	Unknown
RU5.2.2 Catch-and-release	Unknown

To sum up, the local recreational fisheries SES is well understood in terms of the social, governmental and ecological dimension. Nevertheless, as pointed out above the main areas of future improvements are communicating rules, regulations and the reasoning behind them, monitoring, enforcement and filling of knowledge gaps, especially illegal, unreported and unregulated IUU fishing.

4.5. Application of the IAD framework to the case study site of Peenemünde

Following the stakeholder meeting and the closure for survey replies, the Institutional analysis & Development (IAD) framework was applied to analyse the socio-institutional interaction, i.e. the action situation, in the case study area. As the IAD framework is the predecessor of the SES framework many of the seven working parts defining an action situation, outlined in section 2.4 above, can be found in the SES framework. These interlinkages between the two frameworks include, amongst other aspects, GS4.2 Nongovernment organizations, GS4.2.4 Restoration efforts, GS5.1.3 Transparency, GS.5.2.2.3 Delegating (management approach), A1 Number of actors, A7.3 Knowledge sharing/Social learning and A8 Importance of the resource.

The application of the seven action situation criteria and the analysis of the case study is based on the participation in the stakeholder meeting, informal conversations with stakeholders and the survey conducted after the meeting. Ultimately four out of six stakeholder representatives filled out the survey; nevertheless, some meaningful and insightful conclusions can be drawn from the recreational fisheries, the non-governmental organization, the tourist industry and the administration representatives' responses regarding opportunities and challenges to managing the recreational fishery in Peenemünde.

To get a deeper view into the *action situation*, the individual working parts of the framework are analysed in more depth, including the integration of external variables and their relation to the individual working parts. This is done a) as these exogenous variables affect the stakeholder interaction and b) when it was helpful or needed to understand the *action situation* (Ostrom & Cox, 2010).

1) the set of actors

The total number of stakeholder meeting participants was nineteen, representing seven important local stakeholder groups, e.g. recreational fisher, private company and education (full participant list; Appendix 4). Though the missing tourist unions were mentioned in the survey (comment in Q11, Appendix 7), the meeting was fairly inclusive, addressing the SES framework criteria GS5.2.5 - Inclusiveness. Since individual participants in the stakeholder meeting represented and spoke for larger, different sized groups, these exogenous factors have to be mentioned too (McGinnis, 2011). The commercial fishers, for example, are a relatively big group with around 255 coastal commercial fishers fishing in the case study site (A1.1). The recreational fishers are a similar important and large stakeholder group as well, with around 2.200 anglers are organized in the regional angler association "Ostvorpommern" (A1.2.1).

2) the sets of positions actors fill in the context of this situation

As the stakeholder meeting was not a hierarchical, top-down event, all participants filled out the same equal role. However, as they were stakeholder groups representatives they argued from their respective stakeholder position. Regarding the environmental sustainability of the *resource system*, for example, the recreational fisheries representative argued, that angling is sustainable, as they don't angle more fish than could grow back (Q1, Appendix 7). In contrast, the NGO representative argued that due to noncompliance bird sanctuaries and fish habitats are threatened (Q1, Appendix 7). In addition to this, members of the EUCC and the University of Rostock facilitated the discussions

3) the set of allowable actions for actors in each position

Overall the set of allowable actions is two folded. First of all, every actor in the meeting has the same possibility to express values, point of views, ideas, knowledge, etc. To this all survey respondents agreed (e.g. Q12, Appendix 7). Secondly, though there are no internal rules, external rules systems affect stakeholders and their actions. These external variables, i.e. Rules-in-Use, cover "all relevant aspects of the institutional context within which an action situation is located" and consequently influence the scope of action of the stakeholders (McGinnis, 2011, p. 175). Regarding the case at hand, this includes for example fishing regulations, such as present GS6.4 Property rights, GS6.5.1 Input controls or GS6.5.2 Output control (Appendix 6).

4) the level of control that an individual or group has over an action

When looking at the case study recreational fishery, it can be said, that the overall management and decision-making competences often rests in the hands of the local fishery stakeholder, indicated by

the presence of collaborating (GS.5.2.2.2) and delegating (GS.5.2.2.3) co-management (Appendix 6). However, far reaching, i.e. national and international, rule settings, e.g. catch quotas or bag limits, are beyond the control over the stakeholders causing frustration, e.g. the recreational fisheries respondent noted, “get rid of the incomprehensible regulations limiting fishing effort” (Q3, Appendix 7).

5) the potential outcomes associated with each possible combination of actions

Though the goal of the stakeholder meeting was to determine and discuss how fish stocks are currently managed and how future increased fishing pressure, e.g. angling tourism increase, will be managed, the survey respondents are rather unclear, three out of four respondents, about how this project and meeting helps (Q18, Appendix 7). However, improved communications, stronger integration of stakeholder in decision-making process (GS5.2.1), as well as increased social and environmental monitoring (GS7), are aspects mentioned fostering sustainable recreational fisheries (Appendix 6 and 7).

6) the amount of information available to actors

One goal of the stakeholder meeting was the distribution of information, e.g. regarding the fisheries and the CATCH project, and the fostering of information transfer between the participants. The successful learning and knowledge transfer in the meeting was absolutely agreed too (Q12, Q13, Appendix 7). Furthermore, local/traditional knowledge (A7.1) and scientific knowledge (A7.2) is available to the stakeholders (Appendix 6). However, an often heard complain from stakeholders was, that there is no inclusion of local community knowledge into management decisions (informal personal communication).

7) the costs and benefits associated with each possible action and outcome

Overall it was acknowledged, three out of four survey responses, that in order to guarantee sustainable recreational fisheries and an increase in tourism the stakeholders have to make compromises, compensations and concessions (Q9, Appendix 7).

5. Discussion

In this section, two central aspects associated with the SES framework and its application to the case study site of Peenemünde will be discussed. First of all, the empirical findings, based on the updated

framework and the analysis of the action situation, will be approached with regards to the social and environmental sustainability aspects of the recreation fisheries on site and potential tourism expansion. In this way the findings of the thesis are meant to contribute to some degree to the CATCH project and the future sustainable management of coastal recreational fisheries in the Peenemünde area. Secondly, in an attempt to further the SES framework and show that the inclusion of non-economic values is an important aspect in the common-pool resource management, the expansion of the framework by including social and ecological values will be discussed.

5.1. Sustainability characteristics in the recreational fisheries in Peenemünde

After the analysis and the presentation of the findings, some of the subsequent outcomes have to be discussed. Outcomes “are generated by the conjuncture of the outputs of a given action situation,[...] and exogenous influence” (McGinnis, 2011, p. 176). Though there are many different evaluative criteria useful to determine which outcome aspects of the case study are managed satisfactory or sustainably, this section will focus on criteria determining the social (O1) and the environmental sustainability (O2) (McGinnis & Ostrom, 2014). Discussing the outcomes, especially against the backdrop of social and environmental sustainability, is an important aspect in the evaluation of a recreational fisheries action situation, because a) it reveals where the common-pool resource is managed sustainable and where improvements are necessary, b) feed-backs link the outcomes back to the exogenous variables creating a dynamic social-ecological system and c) recreational fisheries is a non-economic focused activity (McGinnis & Ostrom, 2014).

5.1.1. Social performance measure

Overall, three different social sustainability aspects, equity, adaptability and participation, are discussed. These aspects were chosen as they address current and future social and environmental issues and were identified in the field visit as important for the case study and were discussed as particular important in the papers of Gibson (2006), McGinnis (2011), Mckenzie (2004), Ostrom (2011) and Vallance, Perkins, & Dixon (2011).

5.1.1.1. Equity

Equity is defined as “distributional outcomes and processes” (McGinnis, 2011, p. 176), ensuring that “the community provides equitable opportunities and outcomes for all its members” (Mckenzie, 2004, p. 18). This includes actions and decisions, which “preserve or enhance the opportunities and capabilities of future generations to live sustainably” (Gibson, 2006, p. 174).

In order to achieve equity, communication and participation with the relevant stakeholders is critical. Both aspects were stressed and highlighted in the survey responses. All respondents agreed to the importance of open communication and expression of own values and aims (Q.5-7, Appendix 7). As pointed out by the representative of the tourism sector,

“direct contact with suppliers and other interest groups we will get new insights and knowledge. Such workshops are very important for us (to see beyond one's own nose)” (comment in Q5, Appendix 7).

Correspondingly, overall positive responses to questions regarding participation and influence on outcomes, e.g. Q15, underpinned the importance to achieve equity. One possibility, to strengthen the equity outcomes and decisions, is to give the currently loose network a permanent organizational structure. Results from the survey, however, indicated mixed feelings, i.e. responses ranged from disagree to strongly agree, about that (Q16, Appendix 7). With respect to the overall equity alignment of the recreational fisheries SES, delegating co-management (GS.5.2.2.3), self-governance (GS5.2.4), collective choice rules (GS6.2) and presences and importance of clubs (A6.1.1), amongst other things, are present and underpin equity safeguarding.

5.1.1.2. Adaptability

According to Gibson (2006), the core features to cope with uncertainties, risks and threats, to either the social system or the environment, is to “plan to learn, design for surprise, and manage for adaptation” (p. 174).

Especially learning and merging of local and scientific knowledge are important aspects in the management of recreational fisheries in general and in Peenemünde in particular. The importance of updating own knowledge is pointed out by the recreational fisheries respondent by stating the presence of

“recurring educational programs by experts in angling clubs [and] [d]istribution of information in own club newspapers about latest scientific insight regarding fish biology, changes in the fish stock and maintenance of the water bodies”. (Q1, Appendix 7)

Furthermore, knowing the current state of the SES and raising awareness about threats to the resource system is an important aspect to increase the environmental, and subsequently the social

adaptability. As pointed out by the recreational fisheries representative, this is addressed especially in angling clubs by recurring educational programs regarding ecosystem maintenance, latest scientific insight regarding fish biology and changes in the fish stock by experts (comment in Q1, Appendix 7). In addition to that, knowledge and experience integration and transfer in the stakeholder meeting, underpins the importance and the consideration of adaptability. All respondents agreed that new insights, e.g. in fish biology, were gained in the stakeholder meeting (Q13, Appendix 7).

5.1.1.3. Governance and participation

Based on the conclusion by Agrawal & Gibson (1999) participation and the inclusion of the community in the management of common-pool resources, e.g. fish, is an essential aspect to create “successful and sustainable alternatives to state and private management of resources” (p. 632)

Overall, this social sustainability criteria is well translated into the management of the recreational fisheries SES and recognized in the stakeholder meeting. Recreational fisheries stakeholders in the community are involved in the co-management (GS5.2.2) of the fish stocks. This includes, amongst other things decision-making competences in the ecosystem management (A2.2.2), e.g. especially restocking programs, and the overall decentralized decision-making competences in Germany. With respect to the stakeholder meeting and the inclusion of all relevant stakeholders, the responses were rather mixed, i.e. only two agreed, that other stakeholder groups were represented appropriately, while two disagreed (Q11, Appendix 7). It was stressed, that the tourist unions and representatives of the leader management are missing (comment in Q11, Appendix 7). Furthermore, stakeholders influencing the ecosystem externally, e.g. agriculture, have to be included in the future, too (informal personal communication).

Furthermore, concerns were raised addressing the disregard of local fisheries knowledge and experience in decision-makings on the national and European level. According to one interjection in the stakeholder meeting by a member of the recreational fisheries group, the scientific data on which EU regulations, e.g. gub and catch limits, are based are inaccurate. It was further claimed, that due to their long experience and being on site recreational fishers have more accurate knowledge about abundance, health and composition about the fish stock than the science community. But this knowledge is not utilized and disregarded by the national and international decision-makers (unrecorded interjection, stakeholder meeting). This perceived dis-integration of important community features might lead to noncompliance with rules and regulations. This felt non-inclusion

can be linked to a lack of communication between the local and the international level. Improving the communication and explaining the reasoning behind decisions, e.g. the policy aims for a greater, European or global context, would include the local stakeholders again.

5.1.2. Ecological performance of the recreational fishery in Peenemünde

The ecological performance is especially guided by the question, how current SES management decisions, potential outcomes of the stakeholder meeting and the increase in recreational fisheries tourism affect or will affect the local ecosystem. In contrast to the social sustainability aspect, this section will be split into current and future fishing management affects. This was done to present and discuss the current management in its entirety and to contrast it more descriptive to future challenges.

5.1.2.1. Management and ecological sustainability of recreational fisheries

Especially with regards to the input (GS6.5.1) and output (GS6.5.2) controls various fish resource management mechanisms, e.g. access regulations, temporal and spatial closing as well as bag and catch size limits, are used. Furthermore, spatial regulations (GS1.1.1), e.g. no-take zones, are in place. Overall, the management tools are accepted by the local communities and understood as protection to sustain recreational fisheries. Examples for this are compliance with size and species limitations, refrain from fishing in no take zones and fishing license requirements (Q1, Appendix 7). This statement by the recreational fisheries representative is however questioned by the environmental NGO who mentions, that “[n]oncompliance with conservation area regulations” is a main threat to the aquatic ecosystem (Q2 in Appendix 7). This discrepancy is probably due to different perceptions regarding the state and the health of the fish stocks, the location of where it is necessary to protect fish habitat and the overall diverging understanding of what recreational fisheries sustainability means.

Though, recreational fisheries stakeholder group overall understand that these regulations aim to maintain the healthiness of the fish stocks and the aquatic ecosystem, they feel constrained if the regulations will be extend (Q2, Appendix 7). Regarding the future sustainability of angling the recreational fisheries representative states, “*get rid of the incomprehensible regulations limiting fishing effort*” (comment in Q3, Appendix 7). This specifically addresses the new bag limits for cod. In addition to this, education about ecological maintenance and the distribution of similar information is on the recreational fisheries agenda (Q1 in Appendix 7). Nevertheless, the general tone in the

stakeholder meeting was that the recreational fishery is managed and fished environmentally sustainable.

However, in order to make a final and more comprehensive statement regarding the environmental sustainability, more data would be necessary. This includes especially specific numbers of the Greifswalder Bodden regarding questions such as: How many recreational fishers and tourists fish in the resource system; How many and what kind of fish do they catch?; Whether or not they release the caught fish back in the water again?; How many anglers fish illegally in the no-take zones? What is the current status of individual fish species? Social and biological monitoring (GS7), which both are lacking at the moment, would be necessary to answer these questions (see Appendix 6).

5.1.2.2. *Future recreational fisheries and the promotion of angling tourism*

With regards to future environmental sustainability challenges, a threat will be the noncompliance with existing rules and regulations, as well as the lack of knowledge of the tourists regarding input and output controls, especially conservation and no-take zones (Q2, Appendix 7). In addition to that, high fishing pressure might have negative impacts on the fish stocks, too. In order to mitigate these adverse impacts, public education and outreach programs, including leaflets or hand-outs, have to be designed as so far only few exist (GS9). This might reduce the lack of knowledge of tourists regarding rules and regulations. Furthermore, new fishing techniques, such as catch-and-release have to be addressed by the government, by delineating rules and regulations, as so far none are in place (GS1.1.2.1). In addition to that, monitoring and rule enforcements have to be carried out, since these are not or only to a limited amount in place right now (GS7).

5.2. The SES framework: Change your mind

To assess a specific SES, such as the above mentioned fishery, a diagnostic approach is needed, “capable of teasing out what makes each resource use problem unique and what makes each case generalizable and comparable across settings” (Basurto, Gelcich, & Ostrom, 2013, p. 1367). In aiming for that, the complex SES framework integrates data, perspectives and knowledge from a diverse range of natural and social science disciplines (Ban et al., 2013; Leslie, Basurto, Nenadovic, Sievanen, & Cavanaugh, 2015, p. 5979). However, the SES framework follows predominantly an economic approach of evaluating and managing SES. In the following section, the focusing on the economic aspect is outlined and the integration of social values is discussed and the introduction of a new ecological value dimension as a way forward to make the SES framework holistic is presented.

5.2.1. Setting the basis: Focus on predominantly economic aspects

The theoretical and academic diversity of the SES framework, however, is not completely translated into the tier variables. By looking at the second-tier variables of the most recent framework outline by Ostrom, i.e. McGinnis & Ostrom (2014), economic characteristics are dominant. This includes, S1-Economic Development, S5-Markets, RU4-Economic value, A2-Socioeconomic attributes and to some extent A8-Importance of resource (dependence) (McGinnis & Ostrom, 2014). Revising the other variables in the original Ostrom SES framework it becomes clear, that there are no other valuation tiers, but only descriptive first- and second-tiers in the framework. This includes for example RS2 – Size of the resource system, GS1- Monitoring and sanctioning rules or A1 – Number of relevant actors. The sole exception here is tier A6-Norms (trust-reciprocity)/social capital. In this context, descriptive means the characterization of a specific feature, characteristic or status of an individual SES component as it is, without assigning a value, monetary or non-monetary, to it.

Yet, it can be argued, that the economic focus is not surprising, because a) Ostrom's SES work was developed within her background of institutional economics, and b) that Ostrom's SES framework is only the very basic tier outline and that more in-depth studies might contain more tiers related to environmental, cultural, traditional or social values, i.e. the framework is open for contextual modification and addition. Regarding the first argument it can be said that even though Ostrom argued against policy panaceas and for a holistic science and management approach, this has not necessarily been translated into the SES framework, as no further integration of social and ecological values was conducted in the latest framework updates (McGinnis & Ostrom, 2014; Ostrom & Cox, 2010). The second argument to some extent addresses the non-inclusion of social and ecological values in the latest SES framework descriptions by Ostrom, as it relinquishes the obligation of their inclusion to the case-specific and empirical application of the framework (McGinnis & Ostrom, 2014; Ostrom & Cox, 2010). However, based on the literature review and additional papers used for this thesis, it can be stated that most of the applications of the SES framework expand on the original framework and include third or fourth tiers which tend to neglect non-economic values, too. The only two prominent exemptions found are Arlinghaus et al. (2017), who for example expanded the *resource unit-tier economic value* by *economic and social value*, and Basurto et al. (2013), who expanded the *actors-tier importance of the resource* by *cultural dependence*.

5.2.2. New trends: Inclusion of a social dimension

In the most recent years, the predominant focus on economic valuation in the SES analysis and the SES framework changed slightly, as some researchers argued for the integration of a social dimension (Hunt, Sutton, & Arlinghaus, 2013). With regard to recreational fisheries Hunt et al. (2013) argued, that “[e]ffective management of recreational fishing requires understanding fishers and their actions” (p. 111). The aim was to show that these social components fit into recreational fishery SES and helps to improve the management of recreational fisheries. For example, regarding management decisions, e.g. new harvest regulations, it is important to understand how fisher perceive fishing regulations in order to mitigate and avoid future conflict and non-compliance when drafting new regulations.

In a subsequent paper, Arlinghaus et al. (2017) expanded the original SES framework with the inclusion of human aspects, i.e. the integration the new second-tier variable *A6 – Norms, cognitions (beliefs, attitudes) and emotions* and the expansion of *RU4 – Economic value*, to *RU4 - Economic and social value*. Though recognizing the important of social norms (A6) and the expansion of economic value (RU4) for a holistic SES management, Arlinghaus et al. (2017) state that the application of the above mentioned second-tier variables “must be dictated by the specific case systems, the research question, available data and the diagnostic approach chosen by the analyst” (p. 22). However, as almost all natural resource systems are subject to social, traditional and cultural norms and values, it can be argued that the utilization of the new A6 and RU4 variable should be incorporated in *all* SES frameworks. The reason for this is first and foremost, that most SES framework applications address management schemes and conflicts on the local or regional level.

As pointed out by Agrawal & Gibson (1999) and underscored by the literature findings, inclusion of communities in decision-making is a critical aspect in successful resource management, e.g. recreational fisheries. With the inclusion of the second-tiers A6 and RU4, managers get a deeper, more accurate picture of the case at hand. This, furthermore, can help in identifying and mitigating conflicts and thus can facilitate improvements in overall management.

5.2.3. Going a step further: Inclusion of ecological values

The integration of social values, norms, cognitions and emotions is an important step to align the SES framework with the basic understanding of what sustainability and sustainable development means. Daly’s interpretation of Brundtland’s well-known definition (see section 2.2) is that a sustainable development has to be seen in general as a) a qualitative socio-economic improvement or unfolding of potentialities, i.e. not solely quantitative economic growth, b) the safeguarding of environmental

aspects (natural capital) and c) overall the consideration of the environmental, social and economic dimensions (Daly, 1990). The expansion of the SES framework and the alignment with this notion of sustainable development is desirable and necessary, as it allows decision-makers and researchers to capture, analyse and manage all aspects of complex SES, i.e. environmental, social and economic aspects, their interactions and outcomes more accurately.

This can be achieved with the additional inclusion of ecological values and ethical aspects, presenting a more accurate picture of a particular case at hand and provides managers with comprehensive information to make sustainable decisions. By knowing, for example, the economic value of a fish species, the social preference of angling this particular fish species, but also understanding the ecological value fishers ascribe to the fish, will help decision-makers to draft suitable regulations acknowledging all three dimensions and mitigate socio-economic conflicts. Furthermore, by incorporating the three sustainability aspects, the realization of the economic potential within safe social and environmental limits will be promoted (Daly, 1990).

Acknowledging the complexity and numerous theoretical streams within the discussion of ecological values, morals and ethics, only moderate additions based on my research are proposed here. Overall, I propose the inclusion of two new tiers, a second-tier variable (GS7) and a third-tier variable (RU4.3).

First of all, the integration of the *environmental ethics* tier (GS7) in the *governance system* tier should be considered, as it addresses considerations regarding the moral and ethical basis of decision-making (Table 9). Integration of environmental ethics allows the analysis of these ethical and moral preconditions in local communities within an SES. Knowing these aspects helps to mitigate potential conflicts by promoting the designing of conflict resolution schemes within the community or between the community and foreigners, e.g. tourists, with different ethical or moral viewpoints.

Intrinsic values, i.e. “the value that something has “in itself,” or “for its own sake,”” (Zimmerman, 2014, p. n.d.), ascription and overall environmental ethics considerations, as being the basis of our viewpoints and actions, thus influencing our decisions, should be incorporated into the SES framework. Such an inclusion would enhance the comprehensiveness of the framework, since it would better account for the complexity of nature and the human-nature relationship. Subsequently, it can be helpful for diagnosing and addressing conflicts between communities with diverging perceptions of nature, its usage and ecological values (Callicott, 2002; Light, 2002).

Table 9. Proposed integration of Environmental Ethics in the SES framework. The new tier (GS7) gives researcher the opportunity to highlight whether or not environmental ethical consideration played a role in the governance of the specific SES, in this case coastal recreational fisheries. If yes, which ethical considerations were present? This helps to get a better understanding of the management of SES and opens the door for potential governance adjustments.

GS6.5.2.1 Harvestable size limits	Yes, depending on fish species
GS6.5.2.2 Bag limit	Yes, depending on fish species
GS7 Environmental Ethics	No
GS8 Monitoring	
GS8.1 Social	No
GS8.2 Biophysical	Limited; no obligation to report recreational catches

Secondly, in accordance with *RU4 – Economic value*, which was moved from a second-tier variable in McGinnis & Ostrom's (2014) original SES framework outline to a third-tier variable (*RU4.1 – Economic values*), and the *RU4.2 – Social values*, introduced in Arlinghaus et al. (2017), I propose the integration of *RU4.3 – Ecological values* (Table 10). Ecological values, i.e. non-monetary values attached to the importance of a particular ecosystem, functions here as an umbrella term for subsequent values, such as religious or amenity, i.e. the value of a species, whose “existence improves our lives in some nonmaterial way”, values (Norton, 1988, p. 201). Based on the findings from the stakeholder meeting and informal discussions with stakeholder only amenity values were present in the case study, and therefore only this type will be discussed here.

In terms of recreational fisheries, amenity values might include, amongst various other things, that a fisher comes to the same fishing spot, as she/he came here with e.g. her father, building up emotional connection with the site, or because it has a beautiful scenery with many other wildlife to see, e.g. ducks, swans or geese, because it is secluded creating the feeling of being for her-/himself and as one with nature can be found there. Amenity values are consequently important to preserve as they add to our “cognitive development, mental relaxation, artistic inspiration, aesthetic enjoyment and recreational benefits” (de Groot, Van Der Perk, Chiesura, & Van Vliet, 2003, p. 194). Though, they are often attributed with a monetary value, their importance go beyond economic terms, as they contribute “significantly and maybe even critical to human well being” (de Groot et al., 2003, p. 195). With regards to the management of recreational fisheries, this means that not only the economic benefits are addressed, but also the non-monetary benefits and needs of recreational fishers, e.g. aesthetic and recreational leisure, are included.

Table 10. Proposed integration of ecological values in the SES framework; including amenity and religious values

RU4.2 Social values	--
RU4.2.1 Cultural values	High
RU4.2.2 Recreational values	High
RU4.2.2.1 Use value	High
RU4.2.2.2 Recreational industry revenues	~ 21€/person (Germany, no local data)
RU4.3 Ecological values	Yes
RU4.3.1 Amenity values	Yes
RU4.3.2 Religious values	no
RU5 Number of units	Unknown

The reason to introduce non-economic dimension of ecological values, including amenity value, is twofold.

First of all, there are potential problems with trying to put monetary values on things we don't understand. Though, economists say we can and we should put an economic value on these uncertainties and ask what is the alternative, many environmentalists argue that the future importance of certain species, the complexity and dynamic interrelations within ecosystem or in general the enormous amount of species we haven't identified yet, are examples of our nescience regarding the natural environment (Boeraeve, Dendoncker, Jacobs, Gómez-Baggethun, & Marc, 2014; Norton, 1988)

"It is one thing to treat the valuation of biodiversity as a guessing game or as a set of very interesting theoretical problems in welfare economics. It is quite another thing to suggest that the guesses we make are to be the basis of decision making that will affect the functioning of the ecosystems on which we and our children will depend for life." (Norton, 1988, p. 204)

Consequently, an ecosystem approach in recreational fisheries is proposed, which takes safety margins, e.g. uncertainties, into account and aims for the safeguarding of the ecosystem and overall the social-ecological resilience (Arlinghaus & Cowx, 2008). This means for example, that if there is uncertainty whether management decisions, e.g. restocking of the ecosystem with fish species, are harmful to the ecosystem e.g. the health of the fish stocks, or not, these decisions should not be carried out until it is proven that they are ecologically compatible and sustainable.

Secondly and related to the first argument, ecological values are important to make holistic and comprehensive decisions. Negligence of the importance of intangible goods and services, e.g. healthiness and productivity of the ecosystem, aesthetics of the landscape and its natural features or engagement of anglers and fish, will negatively impact the resource management as it does not take account of non-monetary benefits and subsequently excludes stakeholder, their needs and perceptions. An example for this is a recreational fisher, who comes to the same fishing spot for years, because she/he has an emotional attachment to it or enjoys the aesthetical scenery or the secludedness. In other words, the fisher comes to fish because she/he enjoys it, which stands in contrast to monetary values, such as selling the fish. If however, the management does not take this into account, since the focus rests on monetary values, this fisher, who represents a larger stakeholder group with the same values and motives, is excluded from the decision-making process. Exclusion of stakeholders is however often the root of conflict. Consequently, it is necessary to include of non-monetary values to make the management more inclusive, comprehensive and finally sustainable.

The inclusion of non-monetary values in the SES framework does not imply a need to exclude economic valuation schemes, but to open management decisions to a more holistic valuation of the SES. By pairing both, new ideas, levels and perceptions of recreational fisheries can emerge and positively affect the sustainability of recreational fisheries. For example, when it comes to expanding of the recreational fisheries, e.g. by the monetary dimension of angling tourism, the inclusion of the local social and ecological values, e.g. “the recreational fisheries love for nature” (Q1, Appendix 7), can be help to convey these values to the tourists and subsequently help to maintain and safeguard the environment. Furthermore, the inclusion of social and ecological values, adding to economic values, will facilitate the incorporation of economic, environmental and social dimensions in line with broader goals of sustainable development (Boeraeve et al., 2014).

6. Conclusion

Based on a systematic literature review regarding recreational fisheries, its management and the outcomes, the basic Ostrom (2009) SES framework was updated and developed for the analysis of recreational fisheries. Contributing to this, further literature, research and publications addressing the usage and implementation of the SES framework regarding fisheries in general and recreational fisheries in particular were utilized to incorporate and define individual variables for the updated

recreational fisheries SES framework. The inclusion of these data and information sources was necessary, as the literature review revealed various research agendas, backgrounds and foci within the recreational fisheries science, as well as different emphases on individual recreational fisheries aspects, e.g. focus on environmental, social, economic or governance dimensions, institutional settings and management approaches. Though an emphasis on sustainability and sustainable development was present in most of the literature review articles, especially with regards to management decisions, the conceptualization of recreational fisheries as a complex SES is overall missing. In a second step, the updated recreational fisheries SES framework was applied to the case study site of Peenemünde to uncover potential data, knowledge and management gaps in the local SES and to reveal necessary steps to cope with a potential higher fishing pressure due to an increase of angling tourists.

Apart from contributing to the overall research and application of Ostrom's (2009) framework, this thesis addressed current limitations related to the framework. More specifically, the thesis showed that in order to address individual SES comprehensively, valuation approaches should not be limited to economic values. Though the need for the integration of social values was recently acknowledged by a few researchers, ecological values, such as amenity value, and environmental ethics, i.e. the intrinsic of environmental aspects, are so far left out of the SES framework. The thesis consequently proposed the necessary inclusion of both aspects into the SES framework to make it more comprehensive and holistic.

The contributions and insights from this study showed that future research regarding the conceptualization of recreational fisheries as a SES, as well as the empirical testing is still needed. In addition to that, future research has to acknowledge that environmental ethics and ecological values play an important role in recreational fisheries and consequently further the efforts to integrate the non-monetary values in future SES applications.

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Appendix 1-8

Appendix 1: Search string (03.02.2017)

TITLE-ABS-KEY ((recreational AND fisher OR angling) AND (arrangement OR agreement OR management OR system OR association OR club OR organization OR society OR framework OR committee OR governance OR board OR stakeholder) AND (social OR ecological) OR (ses) AND NOT (inland OR freshwater)) AND (LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009)) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))

Appendix 2: List of literature review papers

Author(s)	Title	Journal	Year
Alós, Josep & Arlinghaus, Robert	Impacts of partial marine protected areas on coastal fish communities exploited by recreational angling	Fisheries Research	2013
Arias, Adrian & Sutton, Stephen G.	Understanding Recreational Fishers' Compliance with No-take Zones in the Great Barrier Reef Marine Park	Ecology and Society	2013
Ault, Jerald S., Smith, Steven G., Bohnsack, James A., Luo, Jianguang, Zurcher, Natalia, McClellan, David B., Ziegler, Tracy A., Hallac, David E., Patterson, Matt, Feeley, Michael W., Ruttenberg, Benjamin I., Hunt, John, Kimball, Dan & Causey, Billy	Assessing coral reef fish population and community changes in response to marine reserves in the Dry Tortugas, Florida, USA	Fisheries Research	2013
Brown, Christopher James	Social, economic and environmental effects of closing commercial fisheries to enhance recreational fishing	Marine Policy	2016
Camp, Edward V., Lorenzen, Kai, Ahrens, Robert N. M., Barbieri, Luiz & Leber, Kenneth M.	Potentials and Limitations of Stock Enhancement in Marine Recreational	Reviews in Fisheries	2013

	Fisheries Systems: An Integrative Review of Florida's Red Drum Enhancement	Science	
Ferter, Keno, Borch, Trude, Kolding, Jeppe & Vølstad, Jon H.	Angler behaviour and implications for management - catch-and-release among marine angling tourists in Norway	Fisheries Management and Ecology	2013
Fujitani, Marie L., Fenichel, Eli P., Torre, Jorge & Gerber, Leah R.	Implementation of a marine reserve has a rapid but short-lived effect on recreational angler use	Ecological Applications	2012
Gao, Lei & Hailu, Atakelty	Evaluating the effects of area closure for recreational fishing in a coral reef ecosystem: The benefits of an integrated economic and biophysical modeling	Ecological Economics	2011
Hughes, Robert M.	Recreational fisheries in the USA: economics, management strategies, and ecological threats	Fisheries Research	2014
Lancaster, Darienne, Dearden, Philip & Ban, Natalie C.	Drivers of recreational fisher compliance in temperate marine conservation areas: A study of Rockfish Conservation Areas in British Columbia, Canada	Global Ecology and Conservation	2015
Lancaster, Darienne, Haggarty, Dana R & Ban, Natalie C	Pacific Canada's Rockfish Conservation Areas: using Ostrom's design principles to assess management effectiveness	Ecology and Society	2015
Lloret, J. & Font, T.	A comparative analysis between recreational and artisanal fisheries in a Mediterranean coastal area	Fisheries Management and Ecology	2013
Martin, Carol L., Momtaz, Salim, Jordan, Alan & Moltschaniwskyj, Natalie A.	Exploring recreational fishers' perceptions, attitudes, and support towards a multiple-use marine protected area six years after implementation	Marine Policy	2016
Parnell, Ed P., Dayton, Paul K., Fisher, Rachelle A., Loarie, Cina C. & Darrow, Ryan D.	Spatial patterns of fishing effort off San Diego: implications for zonal management and ecosystem function	Ecological applications	2010
Perez-Cobb, Addiel U., Arce-Ibarra, Minerva A., García-Ortega, Martha,	Artisanal Recreational Fisheries: Using a Combined Approach to Fishery Assessment	Marine Resource	2014

Valdéz-Moreno, Martha & Azueta, James Oscar	Aimed at Providing Insights for Fishery Managers	Economics	
Rees, Siân E., Mangi, Stephen C., Hattam, Caroline, Gall, Sarah C., Rodwell, Lynda D., Peckett, Frankie J. & Attrill, Martin J.	The socio-economic effects of a Marine Protected Area on the ecosystem service of leisure and recreation	Marine Policy	2015
Rife, Alexis N., Aburto-Oropeza, Octavio, Hastings, Philip A., Erisman, Brad, Ballantyne, Ford, Wielgus, Jeffrey, Sala, Enric & Gerber, Leah	Long-term effectiveness of a multi-use marine protected area on reef fish assemblages and fisheries landings	Journal of Environmental Management	2013
Solstrand, Maria Victoria	Marine angling tourism in Norway and Iceland: Finding balance in management policy for sustainability	Natural Resources Forum	2013
Thomassin, Aurélie, David, Gilbert, Duchêne, Julie & Bissery, Claire	Measuring Recreational Fishers' Social Acceptance of the Natural Marine Reserve of Reunion Island	Coastal Management	2011
Voyer, Michelle, Gladstone, William & Goodall, Heather	Understanding marine park opposition: The relationship between social impacts, environmental knowledge and motivation to fish	Aquatic Conservation: Marine and Freshwater Ecosystems	2013
Voyer, Michelle, Gollan, Natalie, Barclay, Kate & Gladstone, William	'It's part of me'; understanding the values, images and principles of coastal users and their influence on the social acceptability of MPAs	Marine Policy	2015
Wood, Apanie L., Butler, James R A, Sheaves, Marcus & Wani, Jacob	Sport fisheries: Opportunities and challenges for diversifying coastal livelihoods in the Pacific	Maine Policy	2013

Appendix 3: Complete updated SES framework list; case study Peenemünde

Attribute	Working Definition	References
GS [Governance System]		

GS1 Policy area	Rule systems tailored for a particular area of knowledge, geography, time or practice	(Basurto et al., 2013) ^o
GS1.1 Social-ecological policies	Rule systems tailored to managing and governing human and biophysical interactions with fish stocks	(Basurto et al., 2013) ^o
GS1.1.1 Spatial regulations	Policies applying to clearly distinct districts within the resources system	NA
GS1.1.1.1 Marine Protected Areas (MPA)	Policies surrounding districts with different, clearly defined permitted or not permitted, activities	(Partelow & Boda, 2015) ^o (Rife et al., 2013) ^{o*}
GS1.1.1.2 No-Take-Zones	Areas protected from all extractive uses	(Ault et al., 2013; Fujitani, Fenichel, Torre, & Gerber, 2012; Rife et al., 2013) ^{o*}
GS1.1.1.3 Spatial Zoning	Policies allocating areas to either recreational or commercial fisheries	(Brown, 2016) ^{o*}
GS1.1.2 Catch treatment	Rules prescribing the treatment of caught fish	Na
GS1.1.2.1 Catch-and-Release	Rules regarding the process of capturing and then releasing the fish at the same angling location with the intention of zero-harvest	(F. D. Johnston, Arlinghaus, Stelfox, & Post, 2011) ^o (Ferber et al., 2013; Solstrand, 2013) ^{o*}
GS1.1.3 Temporal regulations	Policies and regulations defining a time frame prohibiting the harvest of fish species	(Partelow & Boda, 2015) ^o (Gao & Hailu, 2011) ^{o*}
GS2 Geographic range	Spatial area where the rule system has effect or jurisdiction	(Basurto et al., 2013) ^o
GS3 Population	Population of actors on which the rule system has effect or jurisdiction	(Basurto et al., 2013) ^o
GS4 Organizations	Types of institutions recognized by external actors and/or authorities that facilitate formal structured interactions among actors affected by these institutions	(Basurto et al., 2013) ^o
GS4.1 Government organizations	Institutions with governmental authority mandated to protect the public trust	(Arlinghaus et al., 2017; Basurto et al., 2013; Sutinen & Johnston, 2003) ^o (Hughes, 2014) ^{o*}
GS4.1.1 National Level	Institutions mandated to protect and communicate with local level and national level	(Partelow & Boda, 2015) ^o
GS4.1.2 Regional level	Institutions mandated to protect and most directly involved in a specific area. Report and communicate mostly to regional level	(Partelow & Boda, 2015) ^o
GS4.1.3 Local Level	Institutions mandated to protect and most directly involved in a specific area. Report and communicate mostly to local level	(Partelow & Boda, 2015) ^o
GS4.1.4	Institutions with a mandate for monitoring and	(Basurto et al., 2013) ^o

Support Enforcement	enforcement of rules to access and use the resource	
GS4.1.5 Support Funding	Institutions with a mandate to provide subsidies or credit	(Basurto et al., 2013)
GS4.1.6 Restoration efforts	Institutions with a mandate to address provision problems such as the restocking of natural populations	(Basurto et al., 2013)
GS4.1.7 Underlying governance principles	Predominance of certain values, images and principles, their interaction and representation in the local decision-making	(Voyer, Gollan, Barclay, & Gladstone, 2015)**
GS4.2 Nongovernment organizations	Institutions without government authority mandated to protect public trust	(Basurto et al., 2013)
GS4.2.1 Environmental Organizations	Nongovernmental organization advocating for science and/ or policies in regarding lobster or the resource system	(Partelow & Boda, 2015)°
GS4.2.2 Research Organizations	Nongovernmental organization conducting research on lobster or the resource system.	(Partelow & Boda, 2015)°
GS4.2.3 Social/ Welfare Organizations	Nongovernmental organization involved in social dynamics surrounding fishery	(Partelow & Boda, 2015; Sutinen & Johnston, 2003)°
GS4.2.4 Restoration efforts	Nongovernmental organization conducting ecological restoration of the resource system	(Partelow & Boda, 2015)°
GS5 Decision-making structures	How decisions are made within a given institution(s), in which there may be varying levels of interactions	(Partelow & Boda, 2015)° (Wood, Butler, Sheaves, & Wani, 2013)**
GS5.1 Network structure	The connections among the rule-making organizations and the population subject to these rules	(Basurto et al., 2013)°
GS5.1.1 Vertical	Link actors with other organizations or the state across levels	(Basurto et al., 2013)°
GS5.1.2 Horizontal	Link actors with each other to act collectively for a common purpose	(Basurto et al., 2013)°
GS5.1.3 Transparency	Degree of open access to information and disclosure of activities and decisions	(Wood et al., 2013)**
GS5.2 Management Strategy	Meta-level decisions on the objectives, implementation framework, and the relevant knowledge base for decisions and implementation.	(Arlinghaus, Cooke, & Potts, 2013; Partelow & Boda, 2015)°

GS5.2.1 Top-down management	The government is in the superior position with emphasis on command and control. Stakeholder input or consent is not sought	(Solstrand, 2013) ^{°*}
GS5.2.2 Co-management	A range of institutional arrangements often depicted as a scale based on the relative proportions of responsibility and authority shared between state and stakeholders	(Partelow & Boda, 2015; Sutinen & Johnston, 2003) [°] (Wood et al., 2013) ^{°*}
GS.5.2.2.1 Consulting	Government interacts often but makes all of the decisions	(Partelow & Boda, 2015) [°] (Lancaster, Haggarty, et al., 2015) ^{°*}
GS.5.2.2.2 Collaborating	Government and stakeholders work closely and share decisions	(Partelow & Boda, 2015) [°] (Solstrand, 2013) ^{°*}
GS.5.2.2.3 Delegating	Government let formally organized users/ stakeholders make decisions	(Partelow & Boda, 2015; Sutinen & Johnston, 2003) [°]
GS5.2.3 Adaptive management	Institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organised process of learning-by-doing	(Partelow & Boda, 2015) [°] (Wood et al., 2013) ^{°*}
GS5.2.4 Self-governance/ community based	Community or user organized management	(Partelow & Boda, 2015) [°] (Lancaster, Haggarty, et al., 2015) ^{°*}
GS5.2.5 Inclusiveness	Degree of open access, inclusion and participation of relevant stakeholders and their interests in decision-making and consultation processes	(Martin et al., 2016; Rodríguez-Rodríguez, Rees, Rodwell, & Attrill, 2015) ^{°*}
GS5.2.5.1 Committee/ Board/ Council	Stakeholders are organized, often with elected representatives, through a formally organized decision making or consulting group	(Partelow & Boda, 2015) [°] (Rodríguez-Rodríguez et al., 2015) ^{°*}
GS5.2.5.2 Open forum/ Public comment	Stakeholders are involved through open, public engagement	(Partelow & Boda, 2015) [°]
GS5.2.5.3 Research involvement	Stakeholder knowledge or insights is conducted through official research mechanisms rather than direct inclusion in management	(Partelow & Boda, 2015) [°]
GS5.2.6 Multiple outcome recognition and planning	Management strategies recognize and plan for the possibility of multiple outcomes within the system	(Arlinghaus et al., 2013; Partelow & Boda, 2015) [°]
GS6 Rules-in-Use	Formal and informal rules in practice shaping human behaviour and governing social interactions. Usually there is a formal sanctioning mechanism if not followed	(Basurto et al., 2013) [°]
GS6.1 Constitutional Rules	Process in which collective-choice procedures are defined and legitimized, usually results in a state or federal fisheries guideline/ law	(Arlinghaus et al., 2017; Basurto et al., 2013) [°]
GS6.2 Collective	The processes through which institutions are constructed and policy decisions made by actors	(Arlinghaus et al., 2017; Basurto et al., 2013) [°]

Choice Rules	authorized (or allowed) to do so	
GS6.3 Operational Rules	Implementation of practical decisions by individuals authorized (or allowed) to take these actions	(Basurto et al., 2013) ^o
GS6.4 Property rights	Particular types of rules determining which actors have been authorized to carry out which actions with respect to a specified good or service	(Arlinghaus et al., 2017; Basurto et al., 2013; Daedlow, Arlinghaus, & Beckmann, 2007) ^o
GS6.4.1 Access	The right to enter a defined physical area and enjoy nonsubtractive benefits	(Daedlow, Beard, & Arlinghaus, 2011) ^o
GS6.4.2 Withdrawal	The right to harvest fish of a resource system	(Daedlow et al., 2011) ^o
GS6.4.3 Management	The right to regulate internal use patterns and transform the resource by making improvements	(Daedlow et al., 2011) ^o
GS6.4.4 Exclusion	The right to determine who will have access rights and withdrawal rights and how those rights might be transferred	(Daedlow et al., 2011) ^o
GS6.4.5 Alienation	The right to sell or lease management and exclusion rights	(Daedlow et al., 2011) ^o
GS6.5 Recreational resource management	Rules and regulations managing the recreational fisheries sector	NA
GS6.5.1 Input controls	Regulations limiting efforts and access put into harvesting the resource system	(Partelow & Boda, 2015; Pope, 2009) ^o
GS6.5.1.1 Access regulation	Permission, membership or license necessary to conduct fishing effort	(Daedlow et al., 2011) ^o (Solstrand, 2013) ^{o*}
GS6.5.1.2 Fishing moratorium	Moratorium on harvesting certain fish species	(Ault et al., 2013; Lancaster, Dearden, & Ban, 2015) ^{o*}
GS6.5.1.3 Equipment/g ear	Regulations and techniques allowing only the use of certain gear types	(Solstrand, 2013; Voyer, Gladstone, & Goodall, 2013) ^{o*}
GS6.5.1.4 Seasonal closing	Yearly time frame during which harvesting is not allowed	(Partelow & Boda, 2015) ^o (Gao & Hailu, 2011; Wood et al., 2013) ^{o*}
GS6.5.1.5 Spatial closing	Area where fishing is not allowed	(Daedlow et al., 2011) ^o
GS6.5.2 Output control	Regulations limiting what is taken out of the resource system	(Partelow & Boda, 2015; Pope, 2009) ^o
GS6.5.2.1 Harvestable size limits	Minimum size limit of a harvested fish	(Morison, 2004) ^o (Ferber et al., 2013; Wood et al., 2013) ^{o*}
GS6.5.2.2 Bag limit	Number of fish or weight of catch allowed to harvest in certain time period	(Ault et al., 2013) ^{o*}
GS7 Monitoring	Local actors or those legitimized by them are responsible to observe and report changes in the	(Basurto et al., 2013) ^o

	SES	
GS7.1 Social	Local actors, or outsiders legitimized by them, observe that other actors comply with agreed-upon behavior in the use of the resource system and units	(Partelow & Boda, 2015) [°]
GS7.2 Biophysical	Local actors, or outsiders legitimized by them, observe the condition of the resource system and units	(Partelow & Boda, 2015) [°]
GS8 Sanctions	Penalty or condition for disobeying rules or regulations	(Partelow & Boda, 2015) [°]
GS9 Public education and training	Education and training programs concerning the SES	NA
GS9.1 SES rules and regulations	Distribution of information on rules and regulations in place	(Lancaster, Dearden, et al., 2015) ^{°*}
GS9.2 Reasoning behind rules and regulations	Informing the recreational fishers and the general public concerning the reasoning behind the rules in place, in order to increase the understanding and the compliance of/with protection measures	(Voyer et al., 2015) ^{°*}
GS19.3 Fish treatment	Training of recreational fishers in sustainable fishing, fish biology and Catch-and-Release	(Brown, 2016; Lancaster, Dearden, et al., 2015) ^{°*}
GS9.4 Training of fishing guides	Training of fishing guides to promote sustainable fishing. Fishing guides distribute knowledge and educate fisher	NA

Attribute	Working Definition	References
A [Actor]		
A1 Number of actors	Number of actors affecting decision-making processes related to harvesting in the fisher	(Basurto et al., 2013; Ostrom, 2009) [°]
A1.1 Commercial	Actors dependent on the resource as part of their economic livelihood	(Partelow & Boda, 2015) [°]
A1.2 Recreational	Actors harvesting the resource for social and/ or recreational benefit	(Partelow & Boda, 2015) [°]
A1.2.1 Local recreational fisher	Recreational fishers with residence in within the Bundesland	NA
A1.2.2 Recreational fisheries tourists	Recreational fishers who travel to the area and have their residence outside the Bundesland	NA
A1.3 Tertiary/Service industry	Actors providing services to commercial and recreational actors	(Camp et al., 2013; Lancaster, Dearden, et al., 2015) ^{°*}
A1.4 Illegal, unreported, unregulated	Illegal, unreported, or unregulated (IUU) harvesting of the resource	(Partelow & Boda, 2015) [°]

(IUU) fishing actors		
A2 Socioeconomic attributes of actors	Socio-economic characteristics of actors affecting fishing dynamics, as well as social identity and norms	(Arlinghaus et al., 2017; Basurto et al., 2013; Cinner, MacNeil, Basurto, & Gelcich, 2013; Font & Lloret, 2011; Ostrom, 2009) ^o
A2.1 Socioeconomic resilience	Ability to cope financially with stress and changes in the social-ecological system, while retaining structure, functioning, self-organization	NA
A2.2 Operative costs	Costs of Gear or Equipment, license, access and/or costs necessary for harvesting the resource	(Partelow & Boda, 2015) ^o (Hughes, 2014; Solstrand, 2013) ^{o*}
A2.2.1 Replacement rates	Costs of maintaining operation over time	(Partelow & Boda, 2015) ^o
A2.2.2. Ecosystem management	Costs of maintaining the functioning of the resource system over time	(Camp et al., 2013) ^{o*}
A3 History or past experience	Past interactions that affect current actor's behavior and fisheries dynamics	(Basurto et al., 2013) ^o
A3.1 Crisis	Current use patterns triggered by a human or biophysically caused off- patterned event	(Partelow & Boda, 2015) ^o (M. A. L. Young, Foale, & Bellwood, 2014) ^{o*}
A3.2 Duration	Determined as the length of time the resource has been in use	(Partelow & Boda, 2015) ^o
A4 Location	Physical place where the actors are in relation to the resource itself and the market	(Basurto et al., 2013; Ostrom, 2009) ^o
A4.1 Accessibility	Accessibility is dependent on the location of the resource system and on physical and legal features	(Diogo & Pereira, 2014; Pinheiro & Joyeux, 2015; Rodríguez-Rodríguez et al., 2015) ^{o*}
A4.1.1 Ports/Harbors/Built Infrastructure	Artificial constructions built, and usually controlled, to access the resource system	(Partelow & Boda, 2015) ^o
A4.1.2 Beaches/Non-built/natural access	Natural access to the resource system	(Partelow & Boda, 2015) ^o
A4.2 Locational conflicts	Conflicts between residents and non-residents may be affected by angling location, distance to other angler or place attachment to particular localities	(Arlinghaus et al., 2017) ^o (Gao & Hailu, 2011) ^{o*}
A5 Leadership/entrepreneurs	Actors who have skills useful to organize collective action and are followed by their peers	(Basurto et al., 2013; Ostrom, 2009) ^o

hip		
A6 Social capital	Degree by which one or several individuals can draw upon or rely on others for support or assistance in times of need	(Basurto et al., 2013) [°]
A6.1 Spatially based	Dependent on location	(Partelow & Boda, 2015) [°]
A6.1.1 Clubs/organizations/Chapters	Social organization(s) based at a physical location	(Partelow & Boda, 2015) [°]
A6.2 Non-spatially based	Not dependent on location	(Partelow & Boda, 2015) [°]
A6.2.1 Online format, blogs, social media, publications	Digitally or print based social organization	(Partelow & Boda, 2015) [°]
A6.3 Norms, cognitions and emotions	Formal or informal arrangements and underlying social conditions influencing stakeholders, fishers' intentions and actions	(Arlinghaus et al., 2017) [°] (L. M. Hunt, Sutton, & Arlinghaus, 2013; Perez-Cobb, Arce-Ibarra, García-Ortega, Valdéz-Moreno, & Azueta, 2014; Voyer et al., 2015) ^{°*}
A6.4 Values	Goals, principles and structures affecting management prioritization and guiding human behaviour	(Arlinghaus et al., 2017; Manfredo et al., 2016) [°] (Voyer et al., 2015) ^{°*}
A7 Knowledge of SES/mental models	Degree to which stakeholders understand and make sense of the characteristics and/or dynamics of the SES	(Basurto et al., 2013; Ostrom, 2009) [°]
A7.1 Local/traditional ecological knowledge (LEK/TEK)	Practical skills and cross-generational stakeholder knowledge about environmental and social dynamics	(Basurto et al., 2013; Partelow & Boda, 2015) [°] (Voyer et al., 2013; Wood et al., 2013) ^{°*}
A7.2 Western Science and Management Knowledge (SMK)	--	(Partelow & Boda, 2015) [°]
A7.3 Knowledge sharing/Social learning	Actors' fishing practices allow them to learn characteristics of the resource at sufficiently rapid rates leading to behaviors affecting the state of the resource	(Basurto et al., 2013) [°]
A8	--	(Basurto et al., 2013; Ostrom,

Importance of the resource		2009) ^o
A8.1 Economic dependence	The resource constitutes a source of monetary income and plays a major role in fishers' ability to sustain their livelihoods	(Basurto et al., 2013) ^o
A8.2 Cultural dependence	The resource constitutes a source of cultural values, practices, and services, and plays a major role in the fishers' ability to sustain their livelihoods	(Basurto et al., 2013) ^o
A9 Technology used	Harvesting and monitoring efficiency dependent on the available technology	(Arlinghaus et al., 2017; Basurto et al., 2013) ^o
A9.1 Ownership of technology by fishers	Degree of fishing gear used by fishers owned by those same fishers	(Basurto et al., 2013) ^o
A9.2 Homogeneity	Degree by which fishers use the same harvesting technology	(Basurto et al., 2013) ^o
A9.3 Gear restrictions and limits	Rules in place forbidding, limiting or restricting the use of certain gear types	(Alós & Arlinghaus, 2013; Rife et al., 2013; Solstrand, 2013) ^{o*}
A9.4 Environmental impact of gear	Use of gear that is potential environmental harmful	(Lloret & Font, 2013) ^{o*}

Attribute	Working Definition	References
RU [Resource Unit]		
RU1 Resource Unit Mobility	Potential of fish stocks moving beyond existing boundaries of governance structures reducing the incentive for local management	(Arlinghaus et al., 2017; Ostrom, 2009) ^o
RU1.1 Recruitment	Open-water spawning and entering the overall fish stock	(Wood et al., 2013) ^{o*} (Rova & Pranovi, 2017) ^o
RU1.2 Spatial distribution	Migratory resource unit or overlap of spawning ground and adulthood habitat	NA
RU2 Growth or replacement rate	Absolute or relative descriptions of changes in quantities (x) of resource units over time (t)	(Basurto et al., 2013; Ostrom, 2009) ^o
RU3 Interaction among resource units	Interactions among resource units during different life stages affecting the future structure of the population	(Basurto et al., 2013; Ostrom, 2009) ^o
RU3.1 Reproduction	Fish reproduction process characterized by females and males depositing eggs and sperm	(FishBase, 2017) ^o

	into the water simultaneously or in succession so as to fertilize the eggs	
RU3.2 Interaction between different resource species	Competition within and between different fish stocks and feeding on other resource units	(Arlinghaus et al., 2017) [°]
RU4 Socio-economic values	Economic and social values attributed to coastal fish stocks	NA
RU4.1 Economic Values	Value of resource units in relation to the portfolio of resources available to actors	(Basurto et al., 2013) [°] (Solstrand, 2013) [*]
RU4.1.1 Fish Harvest	Value of fish per kilo caught	(Solstrand, 2013) ^{°*}
RU4.1.2 Economic mechanisms	Effect of changes on the supply or the demand side on the economic value of caught fish	(Camp et al., 2013) ^{°*}
RU4.1.3 Economic spillover effects	Economic importance of fish affecting subsequent sectors	(Brown, 2016; Hughes, 2014) ^{°*}
RU4.2 Social values	Non-monetary, cultural and recreational attitudes and asset associated with resource unit	NA
RU4.2.1 Cultural values	Importance of resource unit due to cultural, historical or traditional aspects	(Voyer et al., 2015) ^{°*} (Arlinghaus et al., 2015) [°]
RU4.2.2 Recreational values	Importance of the resource unit to tourists and the tourist industry	NA
RU4.2.2.1 Use value	Importance of interacting, e.g. luring, catching, etc., with the resource unit	(Arlinghaus, 2014; Schramm, 2008) [°]
RU4.2.2.2 Recreational industry revenues	Economic significance of the resource unit to the regional, tourist and recreational industry	NA
RU5 Number of units	Number of coastal fish harvested or that could be potentially harvested	(Basurto et al., 2013; Ostrom, 2009) [°]
RU5.1 Legal harvest rate	Allowed, legally permitted and reported harvest rate	(Partelow & Boda, 2015) [°]
RU5.2. Illegal, unreported, unregulated (IUU) fishing	Rate and/ or social-ecological system implications of illegal fishing	(Partelow & Boda, 2015) [°]
RU5.2.1 By-catch	Resource unit is unintended by-catch or fishing the resource unit causes by-catch	(Ferber et al., 2013; Lancaster, Haggarty, et al., 2015) ^{°*}
RU5.2.2 Catch-and-release	Percentage of post-release mortality among resource unit	(Jensen et al., 2010) [°] (Ferber et al., 2013)
RU5.3	Relevance of the resource unit within the local	(Arlinghaus et al., 2013; Post

Ecological Importance of resource units	food web	et al., 2002) [°] (Brown, 2016) ^{°*}
RU6 Distinctive characteristics	Markings and/or behavioral patterns that can be identified in resource units and affect actors' behavior toward them	(Basurto et al., 2013) [°]
RU6.1 Minimum length	Regulated minimum size of resource unit to be harvested	(Alós & Arlinghaus, 2013) ^{°*}
RU6.2 Fish species	Certain fish species considered as trophy fish, in connection with fish length	(Camp et al., 2013; Martin et al., 2016; Voyer et al., 2013) ^{°*}
RS7 Spatial and temporal distribution	Allocation patterns of resource units across a geographic area in a particular time period	(Basurto et al., 2013; Ostrom, 2009) [°]
RS7.1 Seasonal distribution	Seasonal movement or migration patterns	(Partelow & Boda, 2015) [°]
RU7.2 Natural home range	Limited resource unit habitat affecting fishing and protection patterns	(Ault et al., 2013) ^{°*}

Attribute	Working Definition	References
RS [Resource System]		
RS1 Sector	Characteristic(s) of a resource system that distinguishes it from other resource systems	(Basurto et al., 2013; Ostrom, 2009) [°]
RS1.1 Coastal Fish Species	Fish communities inhabiting permanently or seasonally, i.e. migratory species, coastal water bodies	(Helsinki Commission (HELCOM), 2006) [°]
RS2 Clarity of system boundaries	Biophysical characteristics that make feasible for actors to determine where the resource system starts or ends	(Basurto et al., 2013; Ostrom, 2009) [°]
RS2.1 Life history	Importance of the resource system to different life stages, larvae, juvenile and adult, of coastal fish species.	(Brochier, Ecoutin, de Morais, Kaplan, & Lae, 2012) [°] (Ault et al., 2013; Parnell et al., 2010) ^{°*}
RS2.1.1. Within governance system boundaries	--	(Partelow & Boda, 2015) [°]
RS2.1.2. Outside governance system boundaries	--	(Partelow & Boda, 2015) [°]
RS2.2 Zonal management areas	RS is fully or partly covered by areas in which different fishing activities are permitted or not permitted in order to promote socio-ecological	(Parnell et al., 2010) ^{°*}

	sustainability	
RS2.3 International or binational waters	RS is within, shares or overlaps in international or binational waters	(Partelow & Boda, 2015) [°]
RS3 Size of resource system	Absolut or relative descriptions of the spatial extent of a resource system	(Basurto et al., 2013; Ostrom, 2009) [°]
RS3.1 Carrying capacity	The maximum number of resource units that the biophysical setting can sustain indefinitely	(Basurto et al., 2013) [°]
RS4 Productivity of the system	Rate of generation of units of biomass determined by production-consumption rates per unit of time, surface, or volume	(Basurto et al., 2013) [°]
RS4.1 Stock status	Rate of generation of units of biomass as determined by production in a given year	(Basurto et al., 2013) [°]
RS4.2 Biophysical factors	Upwelling, biogeographic or geomorphological factors affecting the generation of units of biomass	(Arlinghaus et al., 2017; Basurto et al., 2013) [°]
RS4.3 External productivity variables	Anthropogenic and environmental factors influencing the biomass reproduction	NA
RS4.3.1 Indirect factors	Spatially and temporal disconnected factors influencing the resource system	(Brown, 2016; Hughes, 2014) ^{**}
RS4.3.2. Direct factors	Fishing and management attributes affecting fish stocks directly	(Camp et al., 2013; Ferter et al., 2013) ^{**}
RS5 Equilibrium properties	Characterization of the type of attractor of a resource system along a range from one to multiple (chaotic) attractors	(Basurto et al., 2013) [°]
RS6 Predictability of system dynamics	Degree to which actors are able to forecast or identify patterns in environmentally driven variability on recruitment degree	(Basurto et al., 2013) [°]
RS7 Human constructed physical features	Human constructed features placed in the RS	(Arlinghaus et al., 2017) [°]
RS7.1 Access structures	Structures build to access or to interact with the RS	(Lancaster, Dearden, et al., 2015; Lancaster, Haggarty, et al., 2015) ^{**}
RS7.2 Delineation structures	Structures placed in the RS to indicating protected and managed areas	(Lancaster, Dearden, et al., 2015; Martin et al., 2016) ^{**}
RS7.3 Expanding infrastructure	Structures build to satisfy social needs due to increased recreational fishery in close proximity to RS	(Rees et al., 2015) ^{**}
RS8 Connectivity	Gene flow between different populations of resource units	(Basurto et al., 2013; Diogo & Pereira, 2014) [°]
RS9 Location	Spatial and temporal extent where resource	(Basurto et al., 2013; Ostrom,

	units are found by actors	2009) [°]
	[Based on: (Ostrom, 2009) & (Basurto et al., 2013) & (Partelow & Boda, 2015)	[°] : Definition source *: Recreational fisheries literature review paper

Appendix 4: Stakeholder meeting participants

Adam, Rainer	BUND-Gruppe, Ostvorpommern-Usedom
Prof. Dr. Benkenstein, Martin	Universität Rostock
Hannes, Mareike	REM Consult
Herhaus, Leoni	EUCC - Die Küsten Union Deutschland e.V.
Herrmann, Julia-Sophie	WWF (World Wide Fund For Nature)
Hoffmann, Florian	WWF (World Wide Fund For Nature)
Horn, Theresa	EUCC - Die Küsten Union Deutschland e.V.
Karpe, Sebastian	Tourismusverband Mecklenburg-Vorpommern e.V. (TMV)
Lanz, René	University Lund, Schweden
Markstein, Günter	Angler; ehemals Deutscher Angelfischerverband e.V.
Mühlwinkel, Ralf	KI JU Reisen (Kinder- und Jugendreisen)
Rosenow, Ralf	Landkreis Vorpommern-Greifswald; Sachgebietsleiter Kreisentwicklung/Wirtschaftsförderung
Sauck, Martina	Landkreis Vorpommern-Greifswald; Sachbearbeiterin Tourismus
Schröder, Manfred	Das Grüne Klassenzimmer-Umweltbildung in der Natur
Schütt, Michael	Fischereigenossenschaft "Peenemündung" Freest e.G.
Stark, Horst	Angler
Stybel, Nardine	EUCC - Die Küsten Union Deutschland e.V.
Wilke, Winfrid	Kreisanglerverband Ostvorpommern e.V.
Wohlthat, Hartmut	Angelcamp Peenemünde

Appendix 5: Survey link

https://docs.google.com/a/student.lu.se/forms/d/1IPauxx6x8jZSALNWQ2fs7k_fZ7cv3D8gh1g5AJoWPeQ/edit?usp=drive_web

Appendix 6: Applied updated SES framework

	Coastal Recreational Fisheries in the Eastern Greifswalder Bodden
Governance System	
GS1 Policy area	--
GS1.1 Social-ecological policies	Yes
GS1.1.1 Spatial regulations	Yes
GS1.1.1.1 Marine Protected Areas (MPA)	Yes, MPA is present in the RS
GS1.1.1.2 No-Take-Zones	Yes
GS1.1.1.3 Spatial Zoning	Yes
GS1.1.2 Catch treatment	--
GS1.1.2.1 Catch-and-Release	Informal; formal regulations in preparation
GS1.1.3 Temporal regulations	Yes, seasonal

GS2 Geographic range	Yes
GS3 Population	Depending on the rule system
GS4 Organizations	--
GS4.1 Government organizations	Yes
GS4.1.1 National Level	Bundesministerium für Land u. Forstwirtschaft [Federal Ministry of Food and Agriculture]
GS4.1.2 Regional level	Ministerium für Landwirtschaft und Umwelt Mecklenburg-Vorpommern [Ministry of Agriculture and the Environment]; Landesamt für Landwirtschaft, Lebensmittelsicherheit und Fischerei Mecklenburg-Vorpommern [LALLF M-V]
GS4.1.3 Local Level	--
GS4.1.4 Support Enforcement	Yes
GS4.1.5 Support Funding	Medium
GS4.1.6 Restoration efforts	No; if then local fish clubs mandated to do so
GS4.1.7 Underlying governance principles	“Conservation ideals” vs. “cultural and traditional rights”
GS4.2 Nongovernment organizations	--
GS4.2.1 Environmental Organizations	Yes
GS4.2.2 Research Organizations	Yes
GS4.2.3 Social/ Welfare Organizations	Yes
GS4.2.4 Restoration efforts	Yes
GS5 Decision-making structures	--
GS5.1 Network structure	--
GS5.1.1 Vertical	Yes
GS5.1.2 Horizontal	Yes
GS5.1.3 Transparency	Medium
GS5.2 Management Strategy	--
GS5.2.1 Top-down management	Depending on the recreational fisheries aspect; top-down especially for catch regulations
GS5.2.2 Co-management	Yes
GS5.2.2.1 Consulting	No
GS5.2.2.2 Collaborating	Medium
GS5.2.2.3 Delegating	Yes

GS5.2.3 Adaptive management	Yes
GS5.2.4 Self-governance/community based	Yes
GS5.2.5 Inclusiveness	Medium
GS5.2.5.1 Committee/ Board/ Council	Yes
GS5.2.5.2 Open forum/ Public comment	No
GS5.2.5.3 Research involvement	Yes
GS5.2.6 Multiple outcome recognition and planning	Yes
GS6 Rules-in-Use	--
GS6.1 Constitutional Rules	Yes
GS6.2 Collective Choice Rules	Yes
GS6.3 Operational Rules	Yes
GS6.4 Property rights	Common property rights
GS6.4.1 Access	Fishing licence and permit holders
GS6.4.2 Withdrawal	Fishing licence and permit holders
GS6.4.3 Management	Angling club members
GS6.4.4 Exclusion	Fishing rights holders
GS6.4.5 Alienation	Water owners
GS6.5 Recreational resource management	--
GS6.5.1 Input controls	--
GS6.5.1.1 Access regulation	Yes, fishing license (from 14 years onwards) and fishing permit (day, week and year permits) necessary
GS6.5.1.2 Fishing moratorium	Yes, depending on fish species
GS6.5.1.3 Equipment/gear	Yes
GS6.5.1.4 Seasonal closing	Yes, depending on fish species
GS6.5.1.5 Spatial closing	Yes
GS6.5.2 Output control	--
GS6.5.2.1 Harvestable size limits	Yes, depending on fish species
GS6.5.2.2 Bag limit	Yes, depending on fish species
GS7 Monitoring	
GS7.1 Social	No
GS7.2 Biophysical	Limited; no obligation to report recreational

	catches
GS8 Sanctions	Yes
GS9 Public education and training	--
GS9.1 SES rules and regulations	Limited
GS9.2 Reasoning behind rules and regulations	No
GS9.3 Fish treatment	Limited
GS9.4 Training of fishing guides	No
Actors	
A1 Number of actors	
A1.1 Commercial	255 coastal commercial fisher
A1.2 Recreational	
A1.2.1 Local recreational fishers	Angler Association "Ostvorpommern" [regional]: ~2200 members Angler Association Mecklenburg-Vorpommern (LAV) [state wide]: ~43.000 members
A1.2.2 Recreational fisheries tourists	No regional data Mecklenburg-West Pomerania tourist recreational fisheries license: ~17.000 Mecklenburg-West Pomerania temporary recreational fishing license: ~147.000 [Data both for 2015]
A1.3 Tertiary/Service industry	No regional data German wide: 52.000 jobs attached to recreational fisheries (2002); General economic revenues/direct and indirect gains: high
A1.3 Non-consumptive recreational	Yes, Catch-and-Release practices
A1.4 Illegal, unreported, unregulated (IUU) fishing actors	No regional data Mecklenburg-West Pomerania estimated 20% illegal recreational fisher
A2 Socioeconomic attributes of actors	--
A2.1 Socioeconomic resilience	Yes

A2.2 Operative costs	Medium > 500€ spending/year/angler in Mecklenburg-West Pomerania
A2.2.1 Replacement rates	Renewal of fishing permit (One-year permit: 30€)
A2.2.2. Ecosystem management	Data limited Mecklenburg-West Pomerania: Eel restocking ~ 101.278,00 €
A3 History or past experience	--
A3.1 Crisis	No
A3.2 Duration	--
A4 Location	Eastern part of the Greifswalder Bodden, Peenestrom
A4.1 Accessibility	Good accessibility Limitations for people with disabilities
A4.1.1 Ports/ Harbours/ Built Infrastructure	Harbours, marinas, piers and slipways
A4.1.2 Beaches/ Non-built/ natural access	Public access to the Resource System Limited by breeding grounds for birds
A4.2 Locational conflicts	No
A5 Leadership/entrepreneurship	Yes (especially in the recreational fisheries clubs)
A6 Social capital	--
A6.1 Spatially based	Yes
A6.1.1 Clubs/organizations/Chapters	Esp. angling clubs
A6.2 Non-spatially based	Yes
A6.2.1 Online format, blogs, social media, publications	Boards, fora, Facebook, etc. concerning recreational fisheries and recreational activities. Including reports from anglers, tips and recommendations
A6.3 Norms, cognitions and emotions	Yes Socio-cultural and environmental importance, e.g. in terms of respect for the fish or appreciation of unique nature present
A6.4 Values	Yes
A7 Knowledge of SES/mental models	

A7.1 Local/traditional ecological knowledge (LEK/TEK)	High
A7.2 Western Science and Management Knowledge (SMK)	Present, especially ecological
A7.3 Knowledge sharing/Social learning	High
A8 Importance of the resource	--
A8.1 Economic dependence	No
A8.2 Cultural dependence	High
A9 Technology used	--
A9.1 Ownership of technology by fishers	--
A9.2 Homogeneity	Yes
A9.3 Gear restrictions and limits	Yes, e.g. max. three fishing rods/person
A9.4 Environmental impact of gear	Medium, esp. by loss of gear Higher with tourists Depending on the experience of the angler
Resource Unit	
RU1 Resource Unit Mobility	--
RU1.1 Recruitment	Depending on the species, in general well understood
RU1.2 Spatial distribution	Well understood distribution patterns ~42 fish species
RU2 Growth or replacement rate	Depending on the species and individual reproduction age
RU3 Interaction among resource units	---
RU3.1 Reproduction	Yes
RU3.2 Interaction between different resource species	Yes, esp. piscivorous fish (e.g. pike)
RU4 Socio-economic dynamics	
RU4.1 Economic Values	--
RU4.1.1 Fish Harvest	~5000 tons commercial caught Herring (high economic value) Limited economic value in the recreational fisheries segment (see spillover effects)
RU4.1.2 Economic mechanisms	Unknown
RU4.1.3 Economic spillover effects	High

RU4.2 Social values	--
RU4.2.1 Cultural values	High
RU4.2.2 Recreational values	High
RU4.2.2.1 Use value	High
RU4.2.2.2 Recreational industry revenues	~ 21€/person (Germany, no local data)
RU5 Number of units	Unknown
RU5.1 Legal harvest rate	Cod (February/march: three cod/day; rest of the year: 5 cod/day) Pike/pikeperch (three fish/day) Salmonids (three fish/day)
RU5.2. Illegal, unreported, unregulated (IUU) fishing	--
RU5.2.1 By-catch	Unknown
RU5.2.2 Catch-and-release	Unknown
RU5.3 Ecological Importance of resource units	Key species: perch, cod and flounder
RU6 Distinctive characteristics	--
RU6.1 Minimum length	Yes, depending on species
RU6.2 Fish species	Yes, e.g. pike
RS7 Spatial and temporal distribution	Yes
RS7.1 Seasonal distribution	Yes, e.g. herring; spawning and nursery areas in the case study area
RU7.2 Natural home range	Yes
Resource System	
RS1 Sector	Coastal Recreation Fishery
RS1.1 Coastal Fish Species	~42 fish species Key species for recreational fisheries: Herring, garfish, pikeperch and perch
RS2 Clarity of system boundaries	Yes, well understood
RS2.1 Life history	--
RS2.1.1. Within governance system boundaries	Partly
RS2.1.2. Outside governance system boundaries	Partly, presence of migratory fish species e.g. eel, herring and garfish

RS2.2 Zonal management areas	Yes, numerous protected areas, e.g. Natura 2000 or biosphere reserves
RS2.3 International or binational waters	No
RS3 Size of resource system	Eastern part of the Greifswalder Bodden (total: 514 km ²) and the Peenestrom
RS3.1 Carrying capacity	Unknown
RS4 Productivity of the system	High
RS4.1 Stock status	Overall stable or increasing, but fish species dependant
RS4.2 Biophysical factors	Yes, mixing of salt- and freshwater in the RS. The “Greifswalder Boddenrandschwelle”, a shallow geographic formation between the island of Rügen in the West and Usedom in the East, separating the Bodden and the Baltic Sea, determines the salinity of the Bodden. Only during high tide and certain wind directions the shoals are covered allowing water exchange.
RS4.3 External productivity variables	--
RS4.3.1 Indirect factors	Agricultural run-off, heavy industry pollution, tourism, shipping, modification of shipping routes, etc. have or might have negative impact on the Bodden ecosystem
RS4.3.2. Direct factors	Commercial fishery catch surpass the recreational fishery catches, esp. with regard to herring.
RS5 Equilibrium properties	Unknown
RS6 Predictability of system dynamics	Limited Insufficient data on number of recreational fishers, the catch quotas, the post-release mortality of fish, etc.
RS7 Human constructed physical features	--
RS7.1 Access structures	Presence of harbours, marinas, slipways, etc.
RS7.2 Delineation structures	No
RS7.3 Expanding infrastructure	Yes, museums, hotels, camping grounds, restaurants, etc. in the RS

Appendix 7: Survey responses

Q1: According to you, what are the main aspects of sustainable recreational fisheries?	
<p>T:</p> <ul style="list-style-type: none"> – Income should stay within the region and with local businesses to foster regional development (employer, tax revenues, investments) – Recreational fisheries tourism increases occupancy rate in the off-season and consequently creates job perspectives for the whole year – The natural resource, i.e. fish, is not threatened by recreational angling tourism. Therefore local providers will continue to have this important resource – Broad range of offers/supply (not concentrated on one fish species, expansion of offer) <p>A:</p> <ul style="list-style-type: none"> – Clear information regarding fishing spots – Intensive training, e.g. ecological dynamics, less harmful angling practices – Focusing on the recreational fishers love for nature – Nature- and water protection <p>E:</p> <ul style="list-style-type: none"> – Acceptance and compliance with no-take zones and current regulations 	<p>R:</p> <p>Recreational fishery is sustainable, because</p> <ul style="list-style-type: none"> – targeted fishing for size and species – rarely unwanted bycatch – Reintroduction of small, unwanted or protected fish without harming them – Big fish, with good genes, often released too – Quantitative overexploitation of fishing resources rarely caused by recreational fisher – Ecological damages by fishing gear impossible – Recreational fisher take care of their water bodies and shores – Ban or limitations on motorized boats in protected and ecological important areas – Important biotopes won't be fished – Renaturation of polluted and eutrophicated water bodies, reintroduction of fitting fish species – Reintroduction and renaturation schemes and efforts, as well as fish ladders help migratory fish to complete their life cycles and protect them – Recurring educational programs by experts in angling clubs; scientific approved ecological maintenance – Distribution of information in own club newspapers about latest scientific insight regarding fish biology, changes in the fish stock and maintenance of the water bodies

Q2: Where do you see the main threats to sustainable recreational fisheries in the region of Peenemünde?	
<p>E:</p> <ul style="list-style-type: none"> – Many recreational fisher in a small area and the consequently disturbance of resting birds – Noncompliance with conservation area regulations, disturbances of birds in the area of the island Struck <p>A:</p> <ul style="list-style-type: none"> – None <p>R:</p> <ul style="list-style-type: none"> – Incomprehensible regulations for the recreational fisheries tourism – If that is maintained, no tourism 	<p>T:</p> <ul style="list-style-type: none"> – Current bag limits for cod (less negative impacts than in Western coastal Mecklenburg-Western Pomerania) – Fishing area is not well known among recreational fisheries tourists – Infrastructure, i.e. missing highways, often traffic jams, small bridges) – MolaBeach is the only operator in the area (area is dependent on its success)
Q3: Which actions are necessary to ensure sustainable recreational fisheries?	
<p>T</p> <ul style="list-style-type: none"> – Increase of touristic offer (wellness, excursion to sights, etc.) and broader positioning in various fishing techniques and species – Intensive advertisement of the fishing grounds and the businesses, to stand out in the competition – Cooperation with other companies and actors in the region (clubs, administrations,...) – Investment of the revenues in the business and the maintenance of the resource – Monitoring and controlling of the compliance with the regulations in the resource area 	<p>R</p> <ul style="list-style-type: none"> – First of all, delete sustainable. It is sustainable! – Fostering recreational fisheries: get rid of the incomprehensible regulations limiting fishing effort. This includes: limited access to nature reserves, bag limits, prohibition of trolling – Improve accommodation infrastructure. This includes: freezers for the catch, modern kitchens for fish preparation, tables for butchering the fish, waste bins, Wifi, tv – Easier access to fishing licenses and local permissions – Provisioning with modern boots, with GPS and sonar <p>E</p> <ul style="list-style-type: none"> – The volunteer management plan lead to an improved contact between angler and

<p>A</p> <ul style="list-style-type: none"> – It is necessary to have and maintain good environmental conditions, e.g. clean water – Controlling compliance with regulations 	<p>environmental protection. Conflict issues are not discussed.</p>
--	---

<p>Q4: How would you characterize the current cooperation with other stakeholder groups regarding recreational fisheries?</p>	<p>Good: 50% (T;E) Satisfactory:25% (R) Sufficient: 25% (A)</p>
<p>Comments: T: From the TMV viewpoint: The cooperation with other interest groups happens on the basis corresponding cooperation agreements (LAV [Landesanglerverband Mecklenburg-Vorpommern e.V.] and LALLF [Landesamtes für Landwirtschaft, Lebensmittelsicherheit und Fischerei Mecklenburg-Vorpommern]). The expansion of these agreements would be most welcome and should happen on these levels/R: The tourism sector as well as recreational fisheries and corresponding administrations have to be more/better integrated.</p>	
<p>Q5: The stakeholder workshop is an important and good opportunity to get in contact with other involved stakeholder groups</p>	<p>Yes: 100%</p>
<p>Comments: T: With the direct contact with suppliers and other interest groups we will get new insights and knowledge. Such workshops are very important for us (to see beyond one's own nose). Most of the time we are focused only on aspects of the whole topic./R: Replace the word “involved” with “to be integrated”.</p>	
<p>Q6: Meetings with other stakeholder groups is important to improve the understanding of each other’s management preferences, aims and point of views.</p>	<p>Yes: 100%</p>
<p>Q7: The meeting helped to openly communicate own values and aims regarding recreation fisheries and recreational fisheries tourism</p>	<p>Yes: 100%</p>
<p>Comments: T: The character of the workshop is very good to communicate with other interest groups openly and present the own viewpoint.</p>	
<p>Q8: Concrete and common goals are necessary to achieve sustainable recreational fisheries tourism and minimize conflict between stakeholder groups</p>	<p>Yes: 100%</p>
<p>Comment: T: Sustainable recreational fisheries tourism is only possible if all stakeholder groups act in concert. Therefore concrete and common goals are important./R: What is recreational fishery? See above.</p>	

Q9: Compromises, compensations and/or concessions on your site are necessary to ensure sustainable recreational fisheries and recreational fisheries tourism	Yes: 75% (T;E;A) No: 25% (R)
Comments: A: It has to be said, independent from our answer, that the county is not directly affected/ T: Compromises, compensations and/or concessions are necessary to define common goals./ R: I would have voted yes, if you delete “sustainable recreational fisheries”	
Q10: Your stakeholder group was represented appropriately in the meeting	Neither disagree nor agree: 50% (T;E) Agree: 50% (R;A)
Comment: E: The focus rests, in my opinion, in the development of recreational fisheries tourism in order to promote the economy of the rural region and aims only little on the ecological dimension. The protection of the habitats by ecological-based approaches (e.g. No-take zones) should be explained to the participants. And awareness should be raised, that by having intact and untouched habitats (refuges for certain fish species) the surrounding areas will benefit from that and the fishing success can be raised. T: Regional representatives of the tourist unions were missing (local and regional unions).	
Q11: Other stakeholder groups were represented appropriately in the meeting	Disagree: 50% (R;A) Agree: 50% (T;E)
Comments: A: The tourist unions (TVV [Tourismusverband Vorpommern e.V.], and TVIU [Tourismusverband Insel Usedom]) and representatives of the leader management are missing/ R: The tourist unions were missing	
Q12: Local knowledge and experience were incorporated in the stakeholder meeting	Agree: (R;T;A;E)
Comments: T: The excursion of the angel camp areal was very insightful.	
Q13: Participation in the project helps gaining insight in other aspects, e.g. economy, fish biology or ecological dynamics	Yes: 100%
Comment: T: See comment for Q5	
Q14: Learning processes in the workshop and the project help all involved parties to reach satisfying results	Yes: 75% (R;T;A) Undecided to this point of the project: E
Comment: E: I can't comment on this so far.	
Q15: Participation in the project helps your stakeholder group to organize itself better, to communicate relevant topics and to increase influence on decision-making processes	Neither disagree nor agree: 25% (A) Agree: 75% (R;T;E)
Q16: The management process should become a permanent structure, e.g. regular meetings, and include decision-making competences to	Disagree: 25% (E) Neither disagree nor

react better and faster to changes	agree: 25% (R) Agree: 25% (A) Strongly agree: 25% (T)
Comments: R: I do not know the current discretionary competence. Regular meetings should be defined. Half a year? Or when necessary	
Q17: What is your main concern associated with an increase of recreational fisheries tourism?	<ul style="list-style-type: none"> – More prohibitive rules and regulations (R) – Threats to the resource fish, due to high fishing pressure (T) – Conflicts with other recreational water activities (T) – Destruction of natural habitat due to increase of fishing pressure (E) – Interference with breeding and resting habits of birds (E)
Q18: It is clear how future fishing challenges, e.g. increase of recreational fisheries tourists, are managed within the CATH project	Yes: 25% (T) No: 75% (R;E;A)
Comments: T: The initial steps are good. It remains to be seen whether the project duration is enough to reach long-term success and establish sustainable, durable concepts, which will remain after the project./ R: The main challenge is the tourist industry, which has to see the recreational fishery as an opportunity and therefore adjust to its needs	
Q19: Despite the economic benefits of the recreational angling tourism, ecological aspects shouldn't be left out and have to be discussed in the meetings	Agree: 50% (R;A) Strongly agree: 50% (T;E)
Comments: R: But please constructive and without prejudice	
Q20: Despite the economic benefits of the recreational angling tourism, social and cultural aspects shouldn't be left out and have to be discussed in the meetings	Agree: 75% (R;E;A) Strongly agree: 25% (T)
Comments: R: During the funding process of the recreational fisheries tourism, fishing for the family or social and cultural interests of non-angling family members have to be considered	
Q21: Further comments: A: Results and goals have to presented an communicated better./ R: Maybe	

pisca-tourism should be included. Commercial fishers should have the opportunity to bring tourists along on their boats while going fishing. That helps financially and helps tourists to understand the oldest still existing profession. I understand the term “sustainable” in this survey, as describing the sustainable management of the recreational fishery.

Respondents: environmental NGO (E); Tourism organization (T); Administration (A); Recreational fisher (R)

Appendix 8: Research and fisheries characteristics for the literature review.

Classification and Analyzation – Recreational fisheries and research characteristics	
Recreational Fisheries characteristics	Specifications
Location of the fishery	Region, Country, Ocean, etc. mentioned in the article.
Name of the fishery and the fish species	Main fish species mentioned in the article.
Type of fishery	Which type of fishery or fishing technique, including Catch-and Release, is mentioned in the article?
Main fishery stakeholder group	Which fishery stakeholder, commercial or recreational fisher, is most important in the case study site?
Size of the fishery	Number of users or related fishery data, e.g. trips to the fishing location, number of harvest fish or number of available boats, indicating the size of the fishery mentioned in the article
Monetary value of the fishery	Indirect and direct monetary benefits Including: Value of the fishery in \$; monetary spill-over effects to subsequent industries
Non-monetary benefits	Social, traditional, cultural or religious importance of the fishery and/or amenity value of the fisheries
Importance of the fishery as a recreational fisheries tourist destination	Yes/No Number of recreational fisheries tourists mentioned in the article
Conflicts between the fishery stakeholders	Yes/No If yes, type of conflicts and conflict partners
Threats to the fishery	Yes/No If yes, which types of threat (e.g. internal threats, e.g. overharvesting, and external threats, e.g. agricultural nutrient

	input)
Type of management system used/mentioned	Mentioned management system included in the article E.g. Involvement of the relevant stakeholders in the decision-making process; top-down or bottom-up management approach
Rules and regulations concerning the fishery	Mentioned rules and regulations in the article E.g. Input/output controls, restricted areas, etc.
Effects of the management decisions on the fishery and the ecosystem	Mentioned effects of the management decisions on the ecology of the fishery and the ecosystem
Trade-offs of the management system	Occurrence of negative impacts on the social, economic or ecological dimension of the fishery due to management decisions
Attitudes of the stakeholders towards the management decisions	Responses and attitudes of stakeholders mentioned in the article E.g. compliance, disregard, etc.
Management recommendations	Mentioned management recommendations in the article
Research aspects	Specifications
Overall perspective of the paper	Ecology: Focused on the ecological aspects of the fishery Social: The social impacts of the fishery and its cultural/traditional importance for the community are focused on. Economics: Monetary benefits/impacts of the fishery and the spill-over effects are analyzed Governance: Policies, governance aspects, management or decision-making within the fishery is in the focus of the article Other: The perspective of the paper rests on other aspects than the above mentioned (e.g. integration of ecocentric considerations)
Description of the fishery as a social-ecological system	Yes/No If yes, is an aspect of the SES emphasized?
Mentioning or use of the SES framework	Yes/No (Ostrom, 2009) If yes, is it a central part of the article?
Other theoretical concepts	Mentioned theoretical concept related to the SES framework

used to analyze the fishery or linked to the SES framework	mentioned in the article E.g. Ecosystem Services framework
Is the management of the fishery related to sustainability?	Is the management and its outcomes related and discussed against the backdrop of sustainability Use of specific terms (Sustainability, sustainable, unsustainable, resilience, resilient, etc.)
Identified or addressed sustainability challenges	Yes/No If yes, which challenges are addressed?