Using Transdisciplinary Research Solutions to Support Governance in Inland Fisheries: Analysis and Practice

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Chapter 18
Using Transdisciplinary Research Solutions to Support Governance in Inland Fisheries

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Abstract The diverse nature of internal and external threats and fishery attributes in inland fisheries indicates that the development of long-term solutions to governance issues will require interaction among multiple disciplines and actors. Pollution, habitat alteration, invasive species, and hydropower development are widespread problems that are often external to threats imposed by inland fisheries, but greatly impact fishery productivity. Within inland fisheries, challenges of overfishing, equitable access, conflict, and an overall lack of political will to sustain inland fisheries at the regional, national, and international policy levels serve to pressure the sector further. Power dynamics, governance systems, and regulations play a role in determining the perspectives from which solutions to these issues are viewed, and thereby the perspectives from which they are defined as a success. Promoting transdisciplinary research in inland fisheries can support development of successful governance solutions by providing relevant insights to identify and inform these perspectives. Here, we offer examples of redefined governance problems and potential strategies for addressing them using

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transdisciplinary research approaches. We conclude by offering suggestions for improving transdisciplinary research in inland fisheries.

Keywords Freshwater fisheries · Inland fisheries · Sustainability · Transdisciplinary research

18.1   Introduction

Inland fisheries are often overlooked in the predominantly marine-focused global discussions of fisheries sustainability, yet they can be crucial to nutrition and livelihoods, particularly in developing countries (Béné 2006; Andrew et al. 2007; Kolding et al. 2016; Lynch et al. 2017). Inland fisheries face similar governance challenges to their coastal and marine counterparts, including complex economic relationships and value-chains (e.g. welfare vs wealth-based; Béné et al. 2010; Kolding et al. 2014), inequitable governance relationships (Chuenpagdee and Song 2012; Jentoft and Chuenpagdee 2015) and unsustainable fishing practices (Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries, FAO 2015). Inland fisheries are also challenged by additional factors that are not experienced by their coastal and marine counterparts, including sharing fishing areas with multiple users from other sectors and industries (Beard et al. 2011; Lynch et al. 2016, 2017; Song et al. 2017a) and their reliance on external drivers such as rainfall and land development. These competing demands on water from other sectors include irrigation, hydropower, drinking water, and flood controls. The high degree of connectivity in inland systems means that inland fisheries in one part of a watershed may be challenged by situations occurring in another part of the watershed, outside of their sphere of governance and influence (Nguyen et al. 2016). Thus, pollution, habitat loss or alteration, invasive species, hydropower development, and lack of policy supports are all key issues that have a broader governance dimension that affects global inland fisheries governance (Beard et al. 2011; Welcomme et al. 2010; Lynch et al. 2016).

The complexity and interlinked nature of governance challenges in inland fisheries suggest that these constraints likely act as 'wicked problems', or issues that are characterized by high uncertainty, complex linkages to other issues, and lack clear solutions (Rittel and Webber 1973). Wicked problems are complex, persistent, or re-occurring (Khan and Neis 2010), and it is not clear when they are solved, as no right or wrong solution can be proved scientifically (Jentoft and Chuenpagdee 2009). The tightly coupled nature of inland fisheries and freshwater ecosystems and the resulting complexity of issues faced within the sector (as wicked problems), means that successful solutions will require interaction among multiple disciplines and perspectives.

Transdisciplinary research is defined as "research that addresses questions of broad societal interest and fosters integration not only among researchers from different disciplines but also with individuals and organizations from outside academia" (Blythe et al. 2017, 114). This indicates that outcomes developed through transdisciplinary research will not be based in a single field of interest or study but will encompass aspects of each in a mutual learning scenario (Roux et al. 2017). To ensure adequate representation from all fields, transdisciplinary research approaches

for inland fisheries should include participation from multiple arenas, including: fishers, community representatives, physical and natural sciences, social sciences, policy, management, and other stakeholders. Transdisciplinarity in inland fisheries will include multiple jurisdictions and broad geographical issues, thereby requiring similar participation considerations across boundaries (Song et al. 2017b).

18.2 Transdisciplinary Research Teams

Transdisciplinary research has been used to solve governance problems in multiple areas of study, such as sustainability science (Brandt et al. 2013) and public health (Hall et al. 2012) and has been applied in coastal and marine fisheries scenarios to support ecosystem-based management (e.g. Paterson et al. 2010). However, few examples of genuine transdisciplinary research processes have been applied to inland fisheries issues. In other fields and examples, transdisciplinary research teams feature processes such as team development, issue identification, analysis, implementation, and translation (Hall et al. 2012; Jahn et al. 2012; Brandt et al. 2013); though, it should be noted that a generalized framework for transdisciplinary team formation and function is lacking (Brandt et al. 2013).

Given the need to include perspectives from fishers and community members when considering inland fisheries issues, it is essential to consider power dynamics in transdisciplinary team development. Power dynamics are an important consideration in terms of defining success if marginalized communities are not present during the solution development process. Power asymmetry can act as a barrier to governance during the implementation and translation process (from team outcomes to governance body) (Crona and Bodin 2010). Power dynamics can also hinder adaptation to potential solutions (Sathyapalan and George 2015). Thus, we recommend ensuring that fishers and community members are actively involved and empowered from the start of the transdisciplinary process to collaborate on identifying issues and to define success on an issue by issue basis, such that all group members can strive to agree on which proposed solution constitutes a success. Mechanisms for identifying and actively collaborating with essential partners described in the literature are introductory workshops, formation of stakeholder advisory committees, and regularly scheduled workshops and meetings, for instance (DeLorme et al. 2016).

During the issue identification and analysis process, various tools are recommended to create opportunities for finding common ground to improve the success of transdisciplinary approaches. Blythe et al. (2017) focus on having participants identify interrelated components within the system as a bridge to finding common ground. Roux et al. (2017) suggest that 'bridging agents' are helpful for knowledge sharing. 'Bridging agents' (also known as 'boundary agents' and 'knowledge brokers') are individuals whose skill sets include strong social networks and social capital who can effectively interface between different perspectives and knowledge types (Roux et al. 2017). Blythe et al. (2017) also identify the need to embrace complexity and contrast in perspective and approach when weighing options. Roux et al. (2017) suggest that using boundary objects, such as models or maps, and

encouraging discussion in novel and neutral locations are effective strategies for dealing effectively with transdisciplinary complexity.

The processes described above for the formation and function of transdisciplinary teams are unlikely to be universal and may vary on an issue by issue basis, potentially hampering reproducibility (Jahn et al. 2012). Indeed, outcomes and implementation for similar issues may be very different for transdisciplinary teams, depending on the team members involved and the issues and solutions defined.

Implementation of research results and translation into governance processes are considered integral components of transdisciplinary research (Brandt et al. 2013). In other words, the transdisciplinary process is not complete until outcomes have been implemented, which involves governance and management processes. However, translating research results into policy decisions is challenging as translation can be negatively impacted by power asymmetry in the transdisciplinary process (as described above) and occurs over different timelines and under different influences than research processes (e.g. political influences; Simon and Schiemer 2015). Ideally, these issues can be mitigated by ensuring that stakeholders and policy representatives are involved from initial stages through to, and including, translation.

Following these recommendations for the function of transdisciplinary teams, it follows that modes of interactive governance are a suitable lens for translating transdisciplinary research team outcomes. Kooiman et al. (2005, 17) defined interactive governance as "the whole of interactions taken to solve societal problems and create societal opportunities, including the formulation and application of principles guiding those interactions and care for the institutions that enable them." Ideally, by involving stakeholders in an ongoing, solution-driven research process, all team members become familiar with each point of view and possible solution. This sense of ownership of the process would be more likely than other approaches to encourage long-term awareness of and participation in governance (Kapoor 2001; Bulkeley and Mol 2003). Thus, transdisciplinarity can provide a specialized microcosm that reflects the macrocosm displayed by the issue at hand, as a transdisciplinary team would ideally include representatives of all viewpoints and specialties. The movement from macrocosm (fishery) to specialized microcosm (fishery governance bodies) allows for the complexity of the issues to be managed more effectively. This in turn suggests that applying transdisciplinarity via interactive governance processes that move from disagreement (on problems) to agreement (on solutions) can result in longer term success.

At first glance, using a transdisciplinary research approach to support this idealized governance process in inland fisheries appears as complex and challenging as the wicked problems the approach attempts to solve. However, a key feature of transdisciplinary approaches is that there is no *a priori* requirement to agree on the problem. Indeed, it can be expected that most parties involved in a transdisciplinary approach will not agree on the source or focus of the issue (Kahane 2017). However, in transdisciplinary approaches, while it is not necessary to agree on the source of the problem, it is necessary to agree on the solution (Jentoft and Chuenpagdee 2009; Kahane 2017).

18.3   Using Transdisciplinary Research Approaches to Address Governance Issues

The use of transdisciplinary research approaches in any field requires a more complex definition of a 'successful' solution. Since success in solving wicked problems eludes universal definition, it is better to say that we create effective solutions to existing problems in their current form, on the understanding that new forms of the same problem may arise (Rittel and Webber 1973; Game et al. 2014). Defining 'success' in solutions is subjective, but can we draw conclusions about an enabling environment that supports governance solutions that are broadly viewed as successful? What role does transdisciplinary research play in supporting the development of this enabling environment? Research examining attributes in fisheries management and decision making show stakeholder participation in policy and legislation development, defined boundaries and local leadership are part of what supports successful implementation of co-management initiatives in marine and coastal small-scale fisheries in Asia (Pomeroy et al. 2001). When success was defined as increases in stock abundance and unit price, a similarly oriented study by Gutiérrez et al. (2011) identified strong leadership, quotas (individual/community), social cohesion, and protected areas as the most important components of success. In the latter example, it is noteworthy that these criteria were established by the authors and based on a large-scale commercial paradigm. However, in both cases, success was more likely when multiple positive attributes (such as those identified above) were present in a fishery. It is important to recognize that numerous possible solutions could be viewed as successful and that no one solution is optimal, but the presence of similar 'enabling' attributes can be encouraged, and the likelihood of successful solutions (as defined by transdisciplinary teams) can be enhanced by encouraging enabling environments in transdisciplinary research processes. If implemented according to system- and issue-specific needs during team processes, translation stages can be used to connect optimum external (defined boundaries, legislation, external partners) and internal (local leadership, stakeholder participation) management attributes to promote an enabling environment of success (e.g. success of multiple attributes) in interactive governance.

Unfortunately, there are few examples of transdisciplinary research-based solutions to wicked problems in inland fisheries literature through which to identify attributes that could support an enabling environment for interactive governance in this sector. However, there are numerous case study examples that can help identify some of the most common scenarios in inland fisheries issues that could help guide the identification of these attributes. Here, we explore some examples of problem situations in inland fisheries to illustrate how these issues are transdisciplinary in nature, and discuss whether attributes similar to those that contributed to fisheries management successes could support successful governance solutions through transdisciplinary research. We discuss the ways in which transdisciplinary research has played, or could play, a role in developing solutions, and offer suggestions of a way forward

towards improving transdisciplinary research through redefining successful solutions to wicked problems in inland fisheries. The first two examples (Laurentian Great Lakes, Fraser River basin) are compiled from external sources. The final example is from Too Big to Ignore's Inter-Sectoral Governance of Inland Fisheries Ebook, with chapter authors indicated in the case study title (Mhlanga and Nyikahadzoi 2017).

18.4   Case Study Examples

18.4.1   *Pacific Salmon Science and Management in the Fraser Basin, British Columbia*

Pacific salmon are socioeconomically, culturally, and ecologically valuable, and the Fraser Basin of British Columbia is the most important watershed for Pacific salmon in Canada. It is for this reason that the Pacific salmon fisheries in the Fraser are among the most intensively managed in the world. The governance system is complex and includes real time in-season management, co-management efforts between government and stakeholders, joint management between the US and Canada, and First Nation treaty rights. The fisheries are also complex, with three fishing sectors targeting adult Pacific salmon during the freshwater phase of their spawning migration: First Nations, commercial, and recreational. All three fishing sectors are managed by the Canadian Department of Fisheries and Oceans with a subset of fishing activities (those that are trans-boundary between Canada and USA at some point during migration) subject to the international Pacific Salmon Treaty. Given the complexity of the actors and institutions involved, it is not surprising that there has been occasional conflict. Nonetheless, collective concern for the state of the Pacific salmon resources has led to all parties embracing a science-based approach to management. Beyond the routine stock assessment needed to inform fisheries management, there have also been extensive efforts to engage in transdisciplinary research to support decision making. To that end, teams of researchers spanning the natural and social sciences have been assembled to tackle some of the more pressing challenges. For example, ongoing concern for understanding the fate of salmon released as bycatch led to a research program that included field studies that engaged various fishing sectors, laboratory studies to understand mechanisms, and parallel social science studies to understand fisher and manager perspectives on salmon science and management. Despite the coproduction of the research program, it took over 5 years and the accumulation of much evidence before there was opportunity to validate and operationalize this science into formal science advice via the Canadian Science Advisory Secretariat process (Patterson et al. 2017). The social science findings regarding barriers to knowledge mobilization were particularly important for understanding the factors that influence whether new knowledge will be accepted or rejected by managers and stakeholders (Young et al. 2016). The burden of evidence and long-standing (and ongoing) stakeholder/manager engagement were critical for generating meaningful changes in fisher behaviour and policy.

This case study shows several features described by the fisheries management example as supporting an enabling environment. Stakeholders representing different fisheries, scientists from multiple disciplines, managers, and policy-makers are involved in an ongoing research program and have a say in its development. This indicates that stakeholders participate on equal levels in the process, and the agreement to prioritize a science-based approach to management indicates a degree of social cohesion.

While this case study represents the most coherent transdisciplinary approach to inland fisheries research of those presented, it is important to note that it was not originally intended to be a transdisciplinary process. Indeed, this example shows that the benefits of a transdisciplinary approach become evident over time and accumulation of scientific evidence. This case study also illustrates the potentially lengthy timeline between research outcomes and implementation and translation processes of outcomes (into formal science advice, in this case).

18.4.2   The North American (Laurentian) Great Lakes

The North American (Laurentian) Great Lakes is a large-scale freshwater system that connects five major lakes (Lake Superior, Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario) and smaller tributaries with a complex mosaic of human settlements and activities that stretch over 650 jurisdictional units ranging from municipal to bi-national (McCrimmon 2002). The Great Lakes fishery experienced several major developments throughout its history, including the decline of a commercial sector, the rising socioeconomic importance of a recreational fishery, as well as the persistent political struggle of Indigenous fishers in asserting their resource rights (Hudson and Ziegler 2014). Similar to the Fraser River example, the governance system for the Great Lakes fishery involves multiple groups, including joint management between US and Canada and advisory co-management through the Great Lakes Fishery Commission which includes representatives from stakeholder states and provinces. Supported by an ecosystem-based management approach (Minns 2013; Jackson 2015), the Great Lakes fisheries have over time presented several key examples of effective multi-jurisdictional collaboration, including the control of sea lamprey (*Petromyzon marinus*; Gaden et al. 2013). However, active collaboration among different stakeholder groups has proven a challenge. In particular, a lack of consideration of fishers' experiential knowledge among fisheries managers, as well as the historical failure to recognize fishing rights of Indigenous peoples have been lasting sources of contestation that have hindered progress towards mutually agreeable management successes (Norman 2015). Multidisciplinary research collaboration in the Great Lakes does occur, though Indigenous groups have, indeed, been the weakest partner (i.e. small and blue; Fig. 18.1; Song et al. 2016), suggesting this collaboration has not strongly informed management processes.
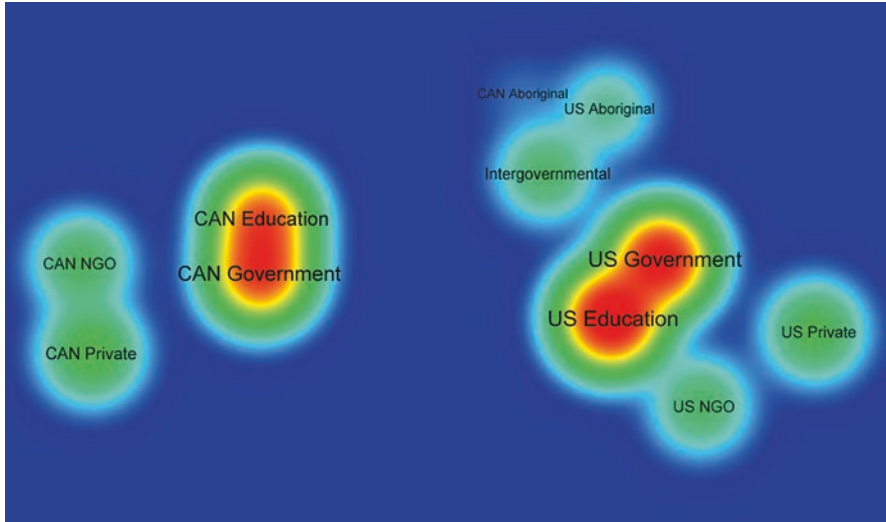
Fig. 18.1 Density visualization ('heat map') showing the pattern of research collaboration in the North American Great Lakes-based organizations. The Canadian Indigenous group (shown as CAN Aboriginal) is nearly invisible; detached from other Canadian groups and only closely supported by US Indigenous counterparts (shown as US Aboriginal) and the Great Lakes Fishery Commission. Node color indicates the level of collaboration each organizational type engages in. Distance between nodes denotes the intensity of collaboration (Source: Song et al. 2016)

Though many similar elements appear in the Great Lakes case study that can be seen in the Fraser River case study (stakeholder participation, research collaboration), the presence of ongoing resource-access conflict and negative perceptions surrounding Indigenous peoples' access to research collaboration indicate that this approach has not been as successful. The issue identified by Song et al. (2016) suggests that adopting a more idealized transdisciplinary approach, beginning with concrete strategies for ongoing active collaboration with Indigenous communities may help to narrow the gap identified in the research process and contribute to more successful long-term solutions to the issue. Further, the issue described in this case study highlights a critical point: transdisciplinary team formation and processes are not external to existing problems or conflict, but to function as intended will need to account for them and actively include conflicting viewpoints.

18.4.3   Competing Resource Claims on Lake Kariba, Mhlanga and Nyikahadzoi 2017

Lake Kariba on the Zambezi River is the world's largest man-made lake by volume, designed for hydropower generation and shared by Zambia and Zimbabwe. Fishing activities play a central role in the governance of Lake Kariba and include offshore

commercial operations and inshore small-scale artisanal producers. Governance structures featuring transdisciplinary collaboration are not formalized at the national level, but there is an underfunded, bilateral committee set up between Zimbabwe and Zambia to discuss joint fisheries management issues. Despite massive support to enable governance-level collaboration (Jul-Larsen et al. 1998), fishing regulations and management differ between the two countries (Kolding et al. 2003, 2015), for example, with respect to allowable mesh sizes, and conflict occurs between gill net fishers and fisheries managers in both countries. The combination of historical racial segregation in Zimbabwe, large numbers of fishers in different fishing sectors (artisanal, offshore, recreational) in two countries sharing the same body of water has led to a series of conflicts and tensions between artisanal and offshore (kapenta) fishers over wealth and opportunity. For historical political reasons, artisanal/gillnet fishers are typically from the Black community and less wealthy, while kapenta fishers are typically from the White community and more wealthy. Between 1988 and 1997, a large bilateral and transdisciplinary management project was conducted to enable and facilitate collaborative processes (Jul-Larsen et al. 1998), which initially had good results. However, the deteriorating political situation in Zimbabwe caused isolation and retracted donor support resulted in a collapse of most activities. A permit redistribution exercise by the Zimbabwean government reallocated permits to Black community members, such that 80% of kapenta licenses are now owned by Black fishers, but the conflict between the two sectors remains a recurring conflict.

To develop long term successful solutions, decision-makers will have to address resource status (natural science), regulatory measures (law), historical racial tensions (social science), and the links between these issues and fishery activity (social-ecological systems approach). Solutions to these problems appear to be nascent, but a transdisciplinary research approach could be used at multiple scales here: both to address the historical tensions among fishers, and to address the different management methods between countries. Thus, the Kariba case illustrates that if the political landscape is not conducive, or external constraints not identified, then even the best intentions may not flourish. Cross-boundary collaboration at the governance level would be required for translation of relevant research outcomes, suggesting that, in this case, transdisciplinary research may require development of interactive governance systems prior to successful initiation.

18.5 Patterns of Governance Problems and Solutions in Case Studies

Collectively, the case studies presented here illustrate the 'wicked' nature of governance problems in inland fisheries. Competition for resources among inland system users, unequal power dynamics, shared boundaries, and a lack of communication among parties are featured in the examples provided, and showcase the additional

complexity of inland fisheries problems. The case studies also illustrate complex management and conflict situations occurring at different scales (local to international) that governance systems are required to address. Attributes of successful solutions that were identified for fisheries management also appear in these inland case studies. For example, social cohesion and stakeholder participation evidently played a role in the successful development of formal scientific advice in the Fraser River case study, as all parties agreed to embrace a science-based approach to management. In contrast, the North American Great Lakes management example showed that Canadian Indigenous fishers are insufficiently recognized in research collaboration, which indicates that their essential perspectives are not adequately incorporated into the process of developing solutions.

The case studies also serve to highlight the differences between the idealized processes in transdisciplinary research and the real-world processes likely to constrain development or execution of transdisciplinary processes. For example, in the Great Lakes case study, we see how failure to collaborate with stakeholder groups effectively during research phases can lead to negative stakeholder perceptions of solutions. Additionally, while we argued in the earlier sections that transdisciplinary research teams can support interactive governance processes, the Lake Kariba example illustrated the uneasy relationship between research and management, where deep, unresolved political tensions prevented willingness to implement interactive governance processes.

In addition to the challenges posed by potentially inter-dependent research and governance processes, a further challenge in highly complex systems is that solutions to wicked problems can have unintended consequences in one or more of the system attributes (Game et al. 2014), resulting in unforeseen tradeoffs. Social and economic tradeoffs often compromise the ecological system, which results in instances where the ecological system is harmed by both the conflict and the solution, which may result in increased risk to the social-ecological system over time (e.g. Nayak et al. 2016). The harm in the tendency to favour tradeoffs that negatively impact the longer-term integrity of the ecosystem is compounded by the challenge of measuring current system performance (Game et al. 2014). This makes it harder to quantify negative effects on the ecosystem. The use of a transdisciplinary research teams for developing management solutions can alleviate this risk, particularly if representatives from all viewpoints participate in the solution creation process, as these consequences are more likely to be foreseen. However, it is likely that unforeseen consequences of management solutions will occur, and indeed, solutions developed through transdisciplinary processes may also lead to unforeseen consequences.

18.6   Enabling Environments in Transdisciplinary Approaches

In much the same way that an enabling environment of success has been determined for fisheries management, we see here that a similar enabling environment for success needs to be identified for transdisciplinary research approaches to solution development in inland fisheries. A crucial point is that these enabling environments are likely synonymous. Blythe et al. (2017) note that transdisciplinarity is challenged by favouring dominant paradigms (such as favouring natural sciences over social sciences; Visser 2004), in much the same way that fisheries management is challenged by lack of inclusion of marginalized communities or inadequate representation (Pomeroy et al. 2001). If one discipline or paradigm dominates the dialogue process, outcomes will be hampered, and essential inputs lost (Kolding and van Zwieten 2011; Blythe et al. 2017). The case study examples illustrate how difficult this problem can be to overcome.

Pomeroy et al. (2001) noted that clearly defined boundaries supported positive fisheries management outcomes, and Roux et al. (2017) suggest that exploring boundaries through various mechanisms can support transdisciplinary approaches by clearly defining perspectives and finding common ground. It was difficult to discern the nature of boundary exploration beyond geographical boundaries and delineation among representative groups (such as stakeholders and scientists) in the case studies. Indeed, the connectivity of inland systems and the inherent complexity of inland fisheries governance structures suggest that clearly identifying and exploring boundaries and external constraints early in a transdisciplinary research process may be of particular use in solving problems in inland fisheries systems.

Some challenges to adopting transdisciplinary research approaches may be more likely to occur for inland fisheries than in other sectors. It is reasonable to posit that a similar enabling environment for inland fisheries governance (through transdisciplinary research) to that of fisheries management will also involve consideration and inclusion of multiple factors (e.g. representation, knowledge brokers, transparency, neutral locations). However, the number and diversity of stakeholders in inland fisheries issues suggests that the need for both representative and epistemological diversity will be a key feature in successful inland fisheries governance.

18.7   Conclusions/Recommendations

Although transdisciplinary research is not necessarily new, the value of a transdisciplinary research approach for developing long-term, successful solutions to wicked problems is increasingly relevant to inland fisheries issues. In this chapter, we have explored the ways in which inland fisheries governance issues can be viewed as wicked problems that would benefit from a transdisciplinary research approach. We have explored the enabling environment of success surrounding

long-term solutions in fisheries, examined case studies to see whether this enabling environment was present, and how transdisciplinary research played, or could have played, a role in fostering positive outcomes. It is noteworthy that none of the case study examples offer 'completed' processes or permanent solutions, but rather reflect on ongoing and dynamic nature of inland fisheries governance. We ended by examining some key challenges in adopting transdisciplinary approaches and considered how these challenges would apply to inland fisheries scenarios. We conclude by summarizing chapter outcomes to support transdisciplinarity in problem solving for inland fisheries governance:

- The case studies of inland fisheries examined in this paper highlight the wicked nature of inland fisheries governance problems and the realized or potential value of transdisciplinary approaches to solving them;
- Issue-specific solutions may be well-served by use of processes known to solve wicked problems that include features involving ongoing dialogue, interactivity, and iterative decision making: all are necessary components of transdisciplinary research approaches;
- Certain factors applying to representation (e.g. marginalized or unrepresented interest groups), boundary definition, and paradigm dominance are likely to be common in inland fisheries transdisciplinary approaches due to the number of competing sectors/stakeholder types and should thus be planned for and prioritized;
- Identifying attributes that foster an enabling environment for successful translation of transdisciplinary research outcomes to governance processes should be a research priority for inland fisheries.

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