Involving recreational fisheries stakeholders in development of research and conservation priorities for mahseer (*Tor* spp.) of India through collaborative workshops

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Abstract

The mahseer (*Tor* spp.) of India are a group of potamodromous cyprinids currently facing numerous challenges in their native ranges including overfishing, pollution, and hydropower development. As a result of such challenges, four of the seven Indian species of *Tor* have been listed as 'Endangered' on the IUCN Red List, including two of the most popular recreationally fished species, *Tor khudree* and *Tor putitora*. Stakeholders in the mahseer recreational fishery may serve as an ally for this group of iconic fishes, fostering aquatic stewardship and providing livelihood alternatives for poachers. Yet, information regarding species-specific responses to recreational fishing practices is lacking and a 2009 decree equating fishing with hunting in the Indian Wildlife Protection Act (1972) has since 2011 effectively banned angling within protected areas and rendered the future of mahseer recreational fisheries elsewhere uncertain. In 2014, our team collaborated with local organizations, fisheries professionals, non-governmental organizations (NGOs), and anglers to conduct two stakeholder workshops designed to develop a research agenda for various species of Indian mahseer. General knowledge gaps identified in the two workshops were very similar and included biological, sociological, and economic considerations. The resulting research priorities in both locations strongly highlighted local context, indicating that while opportunities for addressing knowledge gaps through collaboration exist at the national scale, there is a need for regional- or fishery-specific governance strategies and approaches to mahseer research and conservation.

Keywords: recreational fisheries, freshwater fish, migratory fish, social-ecological systems, stakeholder engagement

Highlights

- Stakeholder workshops were used to develop research agendas for Indian mahseer
- Knowledge gaps constraining mahseer research and conservation are multi-disciplinary
- Participants identified similar knowledge gaps, but prioritized research goals differently
- Research priorities identify opportunity for multi-scale governance strategies

1. Introduction

Stakeholder engagement, the active participation of individuals in planning, research, or management processes that impact them (Sloan 2009), has become a popular topic in fisheries research (e.g., in the US, Feeney et al. 2010; in the UK, Hartley and Robinson 2008; in Europe,

Mackinson et al. 201; for spatial planning, Pomeroy and Douvere 2008). A number of concerns associated with the incorporation of stakeholder engagement into research have been identified (e.g., negative impacts on scientific integrity, Abbott and Guijt 1997; the potential exclusion of already marginalized groups from the engagement process, Kothari 2001; Prell et al. 2008; potential consequences of negative trust relationships, Smith et al. 2012). Other studies, however, have noted that incorporating local context led to improved research outcomes as a result of access to more relevant information (e.g., anticipating problems or conflict, Koontz and Thomas 2006; facilitating social learning Steyaert et al. 2011; promoting trust among collaborators, Yochum et al. 2012). These benefits may be critical for developing sound management strategies for data deficient recreational fisheries. For example, Arlinghaus and Krause (2013) suggested that under certain conditions stakeholder estimates of population size could be as reliable as more traditional stock assessment methods. Other benefits associated with the stakeholder engagement process include improved relationships between researchers and the public, the development of ongoing partnerships, and acceptance and self-enforcement of management decisions based on research outcomes (Reed 2008, Steyaert et al. 2007).

Recreational fisheries have been recognized as a complex social-ecological system, where changes to either component result in changes to the other (Mora et al. 2009). In these systems, wicked problems, or problems that by their nature are difficult to solve due to a combination of complexity and stochasticity, can arise which require extensive communication and efforts among numerous disciplines to tackle effectively (Jentoft and Chuenpagdee 2009). Stakeholder engagement and partnership strategies have proven successful in recreational fisheries research and conservation efforts by incorporating multiple viewpoints and facilitating angler participation to engender cooperation and support (e.g. see Armitage et al. 2008; Granek et al. 2008; Hartley and Robertson 2006). Indeed, when consultation and participatory conditions are met, harnessing the support of freshwater and marine anglers can contribute greatly to aquatic stewardship (Cowx et al. 2010; Granek et al. 2008; Tufts et al. 2015; but see also Danylchuk and Cooke 2011).

An example of this potential can be found in the management and conservation challenges surrounding the mahseer (*Tor* spp.) recreational fishery of India. Mahseer are a group of large-bodied potamodromous cyprinids targeted by commercial, subsistence and recreational fishers in Asia. Despite the fact that four of the seven *Tor* species in India have been listed as endangered (an additional species is listed as ‘Near Threatened’, IUCN 2015), very little information is currently available describing the ecology of these species (but see Bhatt et al. 2004; Bhatt and Pandit *In Press*; Nautiyal et al. 2008; Nautiyal 2013 describing migration behaviours and ecology of *Tor putitora*). Catch and release (C&R) was advocated as an angling ethic in the 1970s in an effort to control poaching activities after anglers noted a decline in the body size and rate of catch (Gupta et al. 2015a). In an effort to mitigate concerns surrounding the state of the fishery, anglers developed ‘coalitions’ and leased property along river reaches, developing training programs for guides and monitoring river activities to reduce poaching (Everard and

Kataria 2011; Gupta et al. 2015b; Pinder and Raghavan 2013). Angler catch data collected from a former angling camp on the Cauvery River has demonstrated an increase in catch rate (along with concomitant decreases in body size), indicating strong recruitment has occurred since this type of fisheries management model was established (Pinder et al. 2015b). However, in 2009, a legislative decree equating C&R fishing with hunting effectively shut down the recreational fishery in protected areas, while leaving other locales virtually unaffected. This uneven application of regulations has since resulted in anecdotal reports of elevated poaching and illegal fishing activity within the Cauvery Wildlife Sanctuary (Pinder et al. 2015a, 2015b).

In 2013, WWF India issued a report detailing the current status and challenges surrounding mahseer conservation (see WWF India 2013). A key report finding was the need to develop an evidence based research agenda to support mahseer conservation. In 2014, our team collaborated with local organizations, fisheries professionals, NGOs, and anglers in two regions to conduct stakeholder workshops designed to meet this need by facilitating discussions to clarify the current state of mahseer research, identify key knowledge gaps constraining mahseer conservation, and to develop a research agenda based on the outcomes of these discussions.

2. Methods

The goal of both stakeholder workshops was to collaborate with researchers, industry and stakeholder partners to identify key knowledge gaps and develop a research agenda for mahseer that addresses these knowledge gaps and supports current and future research and conservation efforts. The unique characteristics of each location, and associated fisheries, threats, and focal species necessitated different approaches for each workshop. In both cases, preparation consisted of identifying local experts in the target areas to seek their partnership in facilitating workshops through planning and participation (as per Reed et al. 2006). These facilitators populated a balanced list of key stakeholders from multiple arenas, including fisheries managers, representatives from fishing associations (including the Coorg Wildlife Society, the Wildlife Association of South India, Jungle Lodges, The Himalayan Outback, Baobab Educational Adventures), lodge and homestay owners, anglers, and representatives from conservation NGOs (WWF India and Zoo Outreach Organization).

The South India workshop took place at Jungle Lodges and Resorts, Bannerghatta Nature Camp, Bangalore, Karnataka on March 28 and 29, 2014. Mahseer recreational fishing was firmly established in the southern states, including Karnataka (Gupta et al. 2015b; Sehgal 1999). Participants in this workshop were interested in discussing developments in the recreational fishery, including rules and regulations governing fishing activity, including the angling ban in protected areas. The North India workshop took place on April 5, 2014 at the Byasi Beach Camp, Rishikesh, Uttarakhand, on the banks of the Ganges River, and on April 6, 2014 at Atali Ganga, Rishikesh, Uttarakhand. Mahseer recreational fishing is growing as a tourism industry in the northern states (including Uttarakhand), though it is not known to be a popular activity undertaken by domestic recreational anglers. Participants of this workshop were interested in

discussions regarding the role of tourism in promoting the sport, and strategies for achieving balance between tourism- and locally-based activities (e.g., small-scale commercial and subsistence fishing).

The nature and type of both workshops was developed in response to the preferences of participants and partners. For example, the workshop held in South India (Bannerghatta) was very structured, with specific time frames allotted for presentations and discussion. In North India (Byasi/Atali Ganaga), the workshop process was more flexible, leaving more time for ad hoc discussions and deviations from planned topics. Time frames were estimated for individual topics and were adjusted according to how much/how little participants had to contribute.

Both workshops were scheduled over two days, with different goals set for each day. We opted to provide numerous opportunities for relationship-building and conversation prior to initiating discussion regarding the research agenda (as per Allen et al. 2011; Reed 2008). For example, on Day 1, participants identified local and regional-scale issues impacting mahseer, discussed the management and conservation context for these issues, and background topics associated with the research (i.e., current state of recreational fisheries research, C&R research and associated best practices; Figure 1, Figure 2). This method transformed the process from a top-down scenario to a bottom-up process in accordance with Reed's (2008) best practices for stakeholder engagement, and afforded the opportunity to discuss any potential flashpoint issues in an open atmosphere. These flashpoint issues were aired, but not considered an essential part of the research agenda by any attendees. The list of knowledge gaps was populated at the end of Day 1 in both workshops. The second day (Day 2) was devoted to developing a research agenda for mahseer based on knowledge gaps and discussion from Day 1.

3. Results

Stakeholder workshop participants identified knowledge gaps across disciplines (e.g., biological, sociological, economic). While similar points were recognized in both workshops, location-specific knowledge gaps were also identified (Table 1). Twelve knowledge gaps were identified by Bannerghatta workshop participants (5 biological; 4 sociological; 3 economic). Fifteen knowledge gaps were identified by Byasi/Atali Ganga workshop participants (6 biological; 7 sociological; 2 economic). Both locations shared similarities among five biological knowledge gaps, three sociological knowledge gaps, and one economic knowledge gap.

In both workshops, participants developed the list of top six research priorities from the established knowledge gaps. These identified priorities were also multi-disciplinary but exhibited fewer similarities than occurred through developing the list of knowledge gaps (Table 2). Both groups retained three of the shared knowledge gaps, but on refining them into more detailed research priorities differentiated greatly on focus (Table 2).

4. Discussion

The knowledge gaps and research priorities identified in both workshops highlight the need to establish research programs that acknowledge the integrated nature of fisheries, including multi-disciplinary approaches in research (a need also identified in Europe, Arlinghaus 2006), and addressing the requirements of location-specific stakeholders and sectors (e.g., balancing participation among different forms of tourism and fisheries). Indeed, workshop participants identified a greater number of sociological and economic knowledge gaps than biological knowledge gaps constraining mahseer conservation. The shared identified knowledge gaps indicate that there are opportunities to collaborate among states/regions to establish an evidence base for mahseer biology, ecology, and behaviour, in addition to opportunities for research studying the biological, social, and economic impacts of recreational (and other sector) fisheries.

Both groups prioritized the research agenda items based on local issues and concerns (i.e., context mattered) and no individuals or groups disagreed with any included items. For example, both groups identified impacts of invasive species and hydropower development as knowledge gaps, but on prioritizing issues for the research agenda, participants in the Bannerghatta workshop prioritized invasive species concerns over hydropower development, while participants in the Byasi/Atali Ganga workshop prioritized issues arising from hydropower development over invasive species. Bannerghatta workshop participants were interested in partnering with management entities to explore enforcement options and alternatives in an already established fishery, while Byasi/Atali Ganga workshop participants identified community engagement and benefit-sharing as a priority management strategy to build the mahseer fishery. These differences in priority setting highlight the need for multi-scale approaches (i.e., national and state) to fisheries research and management. Shared knowledge gaps (including impacts to mahseer by invasive species, hydropower development, illegal fishing methods, and the use of mahseer as an umbrella species to promote freshwater conservation) could be studied at the national level, while adopting management strategies based on research outcomes may benefit from a state- or location-level focus.

Regional-level differences in dominant mahseer species and ecology further support the need for multi-level mahseer research and management strategies. Recent research by Everard and Kataria (2011) and Gupta et al. (2014a) suggests that the golden mahseer (*T. putitora*) may be useful as a flagship species for promoting freshwater conservation throughout the Himalaya Rivers in Northern India, where this species is found (Nautiyal 2013). *T. khudree*, while endangered in its native waters (IUCN 2015), has been artificially cultured and since the 1970's been periodically introduced to the Cauvery. This intended augmentation of the stock is now strongly suspected to have played a role in the decline of the yet to be described humpback mahseer endemic to the Cauvery River in the South (Pinder et al. 2015a). These nuances indicate that while priorities for mahseer research (as identified by workshop participants) may be similar, there will be a need for species-specific approaches in order to sufficiently address the identified knowledge gaps.

The occurrence of mahseer species in different countries in Asia (e.g., *T. putitora*, Nguyen et al. 2008) suggests collaboration and cooperation may also be possible at the international level. Current research efforts examining the behavioural ecology of *T. putitora* in Bhutan (Claussen 2015) for example, could offer valuable insights for the same species in the Himalayan watershed across the border in India. Similarly, ongoing research efforts in India may be useful in supporting the development of research priorities for mahseer in other countries (e.g., in Malaysia, Nguyen 2008). As such, we suggest that international collaboration of mahseer researchers may be beneficial for aligning goals and strategies to identify synergies in research priorities and opportunities for collaboration.

The involvement of stakeholders in the research agenda development process was integral to identifying priority focal points that may have otherwise been missed, or possibly discounted. Through stakeholder participation, we were not only able to benefit from the varied perspectives and expertise of workshop participants, but incorporate regional and local priorities into goal setting in a manner that may not have been possible at a more formalized national meeting. It is essential to note that while we took care to invite individuals representing as many viewpoints as possible, a strong majority of the invitees viewed recreational fisheries positively, and none of the attendees were representatives of management organizations other than the Fisheries Department (i.e. Forestry Department), subsistence fishers, or members of migrant communities. As such, priorities of these communities may not be adequately represented in the respective research agendas (see Kothari 2001; Prell et al. 2008). The views of local communities and stakeholders vary among fisheries (for e.g., see Gupta et al. 2014b). As such, we recommend that any future efforts to adopt research outcomes into management strategies include consultation with these stakeholder groups also.

This workshop process is an example of the overall value of stakeholder engagement for addressing data deficiencies in global recreational fisheries. Stakeholder engagement affords the opportunity to gather many perspectives together, thereby bringing more information to the table through which to develop a knowledge base (Hartley and Robertson 2008; Reed et al. 2008; Steyaert et al. 2011). Many recreational fisheries around the world are data deficient, and many managing bodies may be constrained in supporting fisheries research by limited expertise and funding (Mahon 1997). Creative approaches will be essential in addressing deficiencies effectively as we move towards improving global fisheries management and conservation using best available science. Several tools have been developed and used as a way of addressing such data deficiencies in recreational fisheries to ensure that we are not ‘managing blind’ (rapid assessments, Bower et al. 2016, Lennox et al. 2015; species-specific C&R research, see examples in Cooke and Schramm 2007, Cooke and Suski 2005), but to date these approaches have heavily favoured the biological responses of species to fisheries processes. There continues to be a dearth of suitable tools available for rapidly and thoroughly incorporating sociological and economic considerations in fisheries research (Arlinghaus 2005), though strategies for incorporating adaptive management and co-management processes are increasing in other fields

(e.g., see Armitage et al. 2008; Mackinson et al. 2011; Pomeroy and Douvere 2008). Using effective methods of stakeholder engagement can help researchers to address data deficiencies by allowing researchers to incorporate local knowledge into priority and goal setting, and better understand the socio-economic context of specific fisheries.

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